

Sea Level Change Table

ARI Years	2008 ⁽¹⁾ Design Still Water Levels (m AHD)	Sea Level Rise ⁽³⁾ Scenerio	2050 ⁽¹⁾ (m AHD)	2100 ⁽¹⁾ (m AHD)
1	1.235	Low	1.275	1.395
		Medium	1.445	1.765
		High	1.615	2.125
2	1.275	Low	1.315	1.435
		Medium	1.485	1.805
		High	1.655	2.165
5	1.315	Low	1.355	1.475
		Medium	1.525	1.845
		High	1.695	2.205
10	1.345	Low	1.385	1.505
		Medium	1.555	1.875
		High	1.725	2.235
20	1.375	Low	1.415	1.535
		Medium	1.585	1.905
		High	1.755	2.265
50	1.415	Low	1.455	1.575
		Medium	1.625	1.945
		High	1.795	2.305
100	1.435	Low	1.475	1.595
		Medium	1.645	1.965
		High	1.815	2.325
PMF ⁽⁴⁾	1.8	Low	1.84	1.96
		Medium	2.01	2.33
		High	2.18	2.69

Notes

1. Levels taken from Table 6.3 Fort Denison Sea Level Rise Vulnerability Study (DECC, 2008)
2. Levels assume a linear increase rounded to the nearest 5mm
3. Low, Medium, High refer to climate change projections outlined in the table below
4. PMF calculated by taking the highest astronomical tide of 1.175m AHD plus a surge component of 0.6m and then rounded to 1.8m

Table 6.2 Fort Denison Sea Level Rise Vulnerability Study (DECC, 2008)

Sea Level Rise Scenario	Year 2050 (cm)	Year 2100 (cm)
Lower Bound Estimate (LOW)	4 ⁽¹⁾	16 ⁽³⁾
Medium Estimate (MED) ⁽⁵⁾	21	53
Upper Bound Estimate (HIGH)	38 ⁽²⁾	89 ⁽⁴⁾

Notes

1. SLR estimate derived from Figure 11.12 (IPCC, 2001) corrected for application from 2008.
2. SLR estimates derived from Figure 11.12 (IPCC, 2001) corrected for application from 2008 (26cm) with the addition of 12 cm to account for the upper bound regional increase in SLR above the global average (CSIRO, 2007).
3. SLR estimate from Table SPM.3 (IPCC, 2007) using the 18cm advised, corrected for application from 2008 assuming average increase in MSL of 1.8mm/year from 1999.
4. SLR estimate from Table SPM.3 (IPCC, 2007) using the 59cm advised, corrected for application from 2008 assuming average increase in MSL of 1.8mm/year from 1999. An additional 20cm has been added to account for the possibility of ice sheet flow rates increasing linearly with increased temperature for upper bound projections as advised by IPCC (2007). A further 12cm has been added to account for the upper bound regional increase in SLR above the global average (CSIRO, 2007).
5. Medium position between “lower” and “upper” bound derived estimates rounded up to nearest cm.

APPENDIX F

RAINFALL, COCKLE BAY WATER LEVEL AND CATCHMENT RUNOFF COINCIDENCE

20 Worst Rainfall Events from 1914-2012

Event	Recorded Rainfall Observatory Hill			Approximate ARIs from Bureau of Meteorology			Approximate Timing of Events		Recorded Water Levels Fort Denison			Calculated From Predicted Tide	
Date	25min (mm/hr)	60min (mm/hr)	Daily Rainfall (mm)	25min ARI	60min ARI	24hr ARI	Start of Severe 25min	Peak Runoff	Peak Tide (m AHD)	Tide ARI	Approx Tide at Peak Runoff	Peak Anomaly (m)	Anomaly ARI
10/05/25	36.6	27.8	178.5	1yr	<1yr	5yr - 10yr	11:11 AM	11:33 AM	1.01	<1 month	0.211	0.01	< 1 yr
18/04/27	75.2	33.4	101.0	2-5yr	1yr	1yr	07:35 PM	07:57 PM	1.04	<1 month	0.801	0.37	5 yr
6/07/31	46.5	16.0	197.8	<1yr	<1yr	10yr - 20yr	07:11 AM	07:33 AM	1.01	<1 month	-0.035	0.49	20 yr
31/01/38	75.4	67.0	174.7	2-5yr	10yr - 20yr	5yr - 10yr	06:31 AM	06:53 AM	0.79	<1 month	0.629	0.04	< 1 yr
27/03/42	66.0	41.4	241.7	2yr	2yr	20yr-50yr	11:23 PM	11:45 PM	0.77	<1 month	-0.076	0.18	< 1 yr
23/01/55	47.5	47.5	173.5	<1yr	2yr - 5yr	5yr - 10yr	05:07 AM	05:29 AM	0.73	<1 month	0.251	-0.04	< 1 yr
10/02/56	34.7	23.3	192.5	<1yr	<1yr	10yr	06:41 AM	07:03 AM	0.94	<1 month	0.776	0.25	< 1 yr
10/03/58	37.1	31.1	199.2	<1yr	1yr	10yr - 20yr	04:05 PM	04:27 PM	1.10	1 month	-0.052	0.37	5 yr
27/04/66	36.8	28.0	194.7	<1yr	<1yr	10yr - 20yr	11:23 AM	11:45 AM	0.88	<1 month	0.161	0.20	< 1 yr
21/08/71	105.5	73.6	132.9	10-20yr	20yr	2yr	04:59 PM	05:21 PM	0.70	<1 month	-0.02	0.04	< 1 yr
8/01/73	62.2	62.2	174.2	2yr	10yr	5yr - 10yr	12:49 AM	01:11 AM	0.78	<1 month	-0.125	0.14	< 1 yr
10/03/75	87.7	87.7	175.2	5yr	50yr - 100yr	5yr - 10yr	09:25 AM	09:47 AM	0.58	<1 month	0.157	0.03	< 1 yr
8/11/84	199.8	119.4	240.4	>100yr	>100yr	20yr-50yr	09:59 PM	10:21 PM	0.69	<1 month	0.169	0.09	< 1 yr
5/08/86	57.9	44.0	309.7	1yr	2yr - 5yr	>100yr	01:59 PM	02:21 PM	1.01	<1 month	-0.293	0.34	3 yr
17/01/88	33.6	33.2	166.1	<1yr	1yr	5yr	04:17 AM	04:39 AM	0.98	<1 month	0.465	0.04	< 1 yr
30/04/88	53.3	37.7	192.5	1yr	1yr - 2yr	10yr	03:11 AM	03:33 AM	0.78	<1 month	-0.125	0.10	< 1 yr
6/01/89	104.5	42.2	46.8	10-20yr	2yr	<1yr	02:23 PM	02:45 PM	0.91	<1 month	-0.389	0.12	< 1 yr
10/06/91	63.5	44.1	169.7	2yr	2yr - 5yr	5yr	10:29 PM	10:51 PM	0.69	<1 month	-0.36	-0.07	< 1 yr
10/04/98	87.8	67.2	209.4	5yr	10yr - 20yr	10yr - 20yr	09:53 AM	10:15 AM	0.71	<1 month	0.304	0.13	< 1 yr
7/08/98	42.6	31.6	175.8	<1yr	1yr	5yr - 10yr	07:35 PM	07:57 PM	1.23	1 yr	1.2	0.34	3 yr

15 Worst Tide Events from 1914-2012

Event	Recorded Water Levels Fort Denison		Calculated From Predicted Tide		Recorded Rainfall Observatory Hill	
Date	Peak Tide (m AHD)	Tide ARI	Peak Anomaly (m)	Anomaly ARI	Daily Rainfall (mm)	24hr ARI
3/8/21	1.31	2yr-5yr	0.29	1 yr	1.0	<1yr
19/6/47	1.29	2yr-5yr	0.20	< 1 yr	0.0	<1yr
12/12/50	1.30	2yr-5yr	0.26	< 1 yr	0.8	<1yr
10/6/56	1.40	20yr - 50yr	0.30	1 yr	18.8	<1yr
10/7/64	1.34	5yr - 10yr	0.29	1 yr	0.0	<1yr
2/6/73	1.28	2yr	0.16	< 1 yr	0.0	<1yr
25/5/74	1.48	>100yr	0.62	> 100 yr	82.6	<1yr
22/7/78	1.32	5yr	0.32	1 yr	2.8	<1yr
30/6/84	1.35	10yr	0.36	5 yr	0.0	<1yr
27/4/90	1.43	50yr - 100yr	0.37	5 yr	0.0	<1yr
13/6/99	1.29	2yr - 5yr	0.17	< 1 yr	0.0	<1yr
19/8/01	1.34	10yr	0.31	1 yr	0.0	<1yr
1/1/02	1.26	1yr - 2yr	0.28	<1 yr	0.0	<1yr
15/6/03	1.26	1yr - 2yr	0.18	< 1 yr	0.4	<1yr
14/6/07	1.32	5yr	0.27	< 1 yr	0.0	<1yr

Notes

Rainfall data supplied by the Bureau of Meteorology

Tidal recordings and predictions supplied by Sydney Ports Corporation

Anomaly ARIs approximated using NSW Ocean Water Levels, MHL, 2011

Anomaly refers to the water level recorded above the predicted.

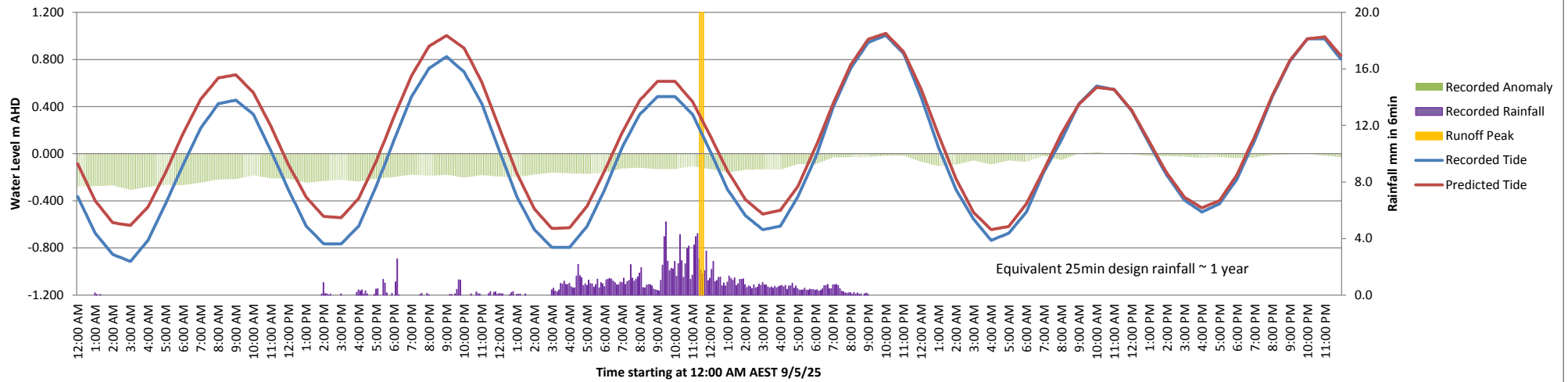
Peak runoff times to Cockle Bay estimated based on catchment hydrology

Tide ARIs approximated using the Fort Denison Sea Level Rise Vulnerability Study, DECC, 2008

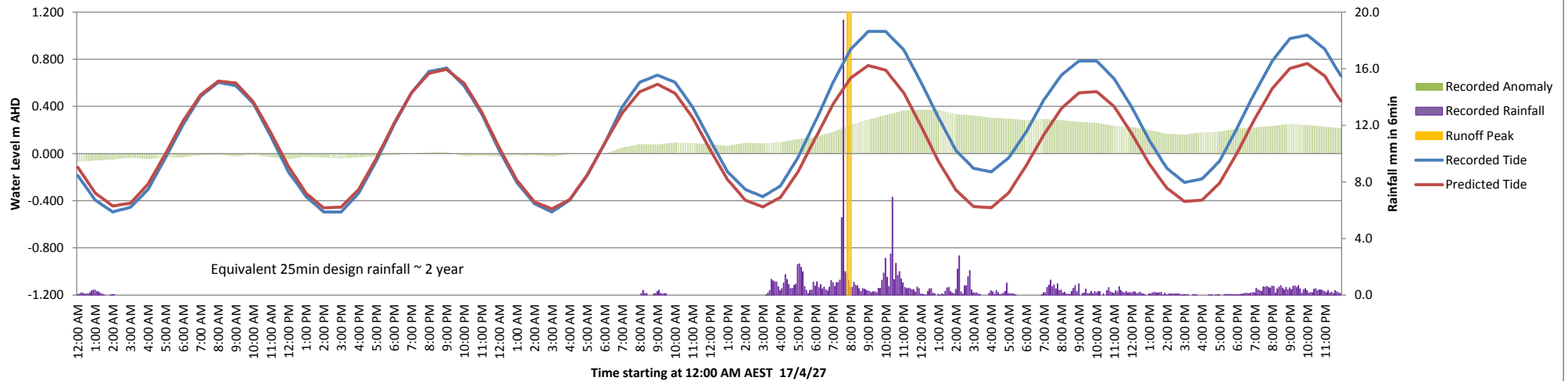
Each event is monitored for 3 days with peaks referring to peaks which occur at anytime during this period

Anomalies are mainly caused by meteorological effects above the tidal recorder

Severe Rainfall Event 10/5/25



Severe Rainfall Event 18/4/27



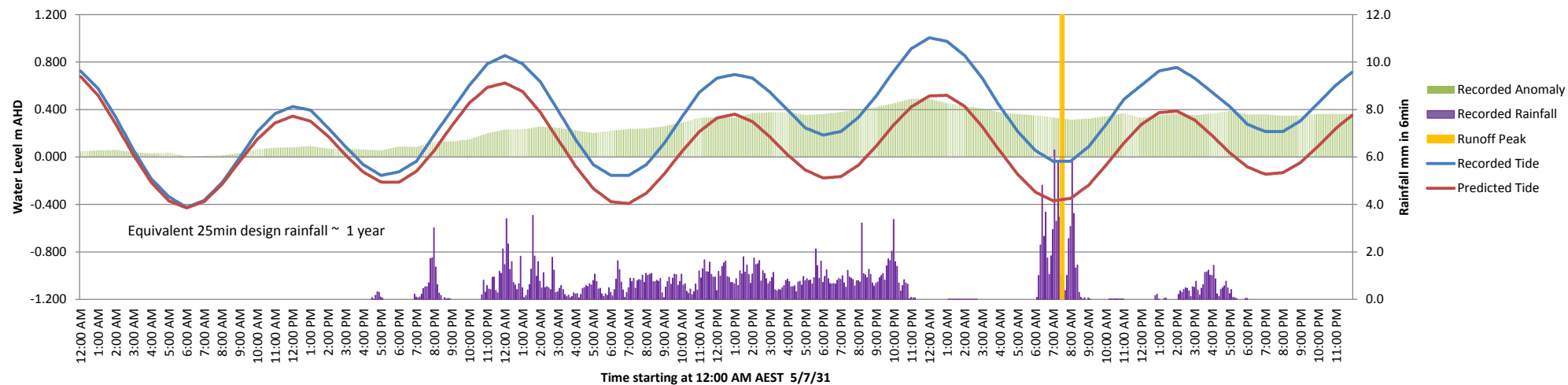
Notes

Rainfall data recorded at Observatory Hill Sydr Anomallies are mainly caused by meteorologica; Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

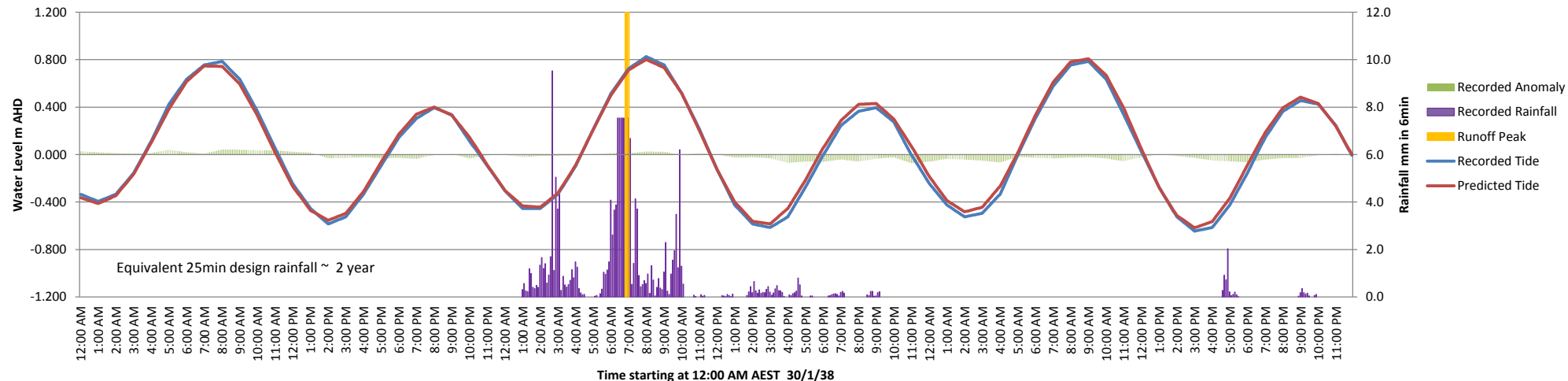
Tide data recorded at Fort Denison

Tide data and predicted tide data supplied by the Sydney Ports Corporation

Severe Rainfall Event 6/7/31



Severe Rainfall Event 31/1/38



Notes

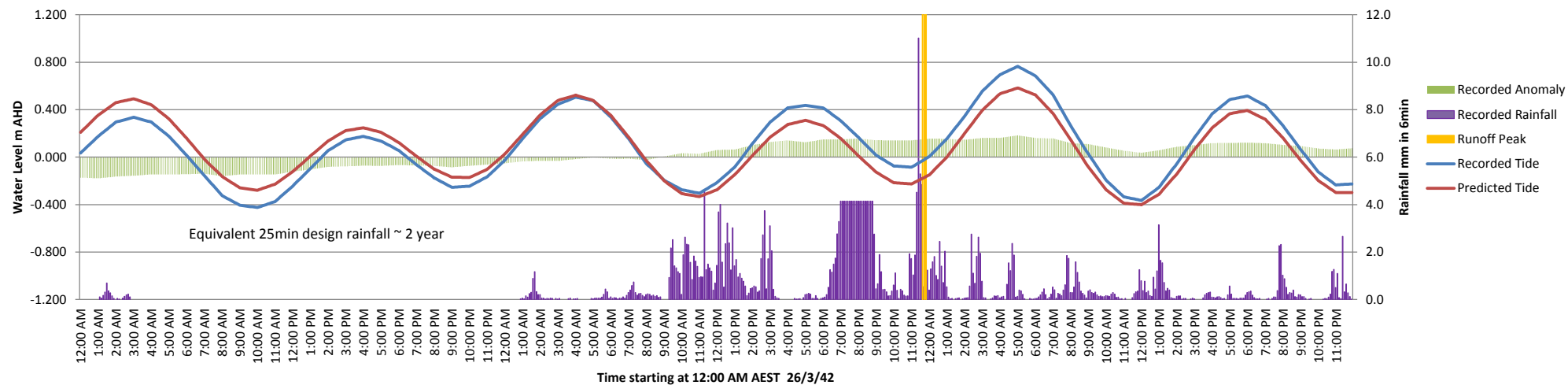
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

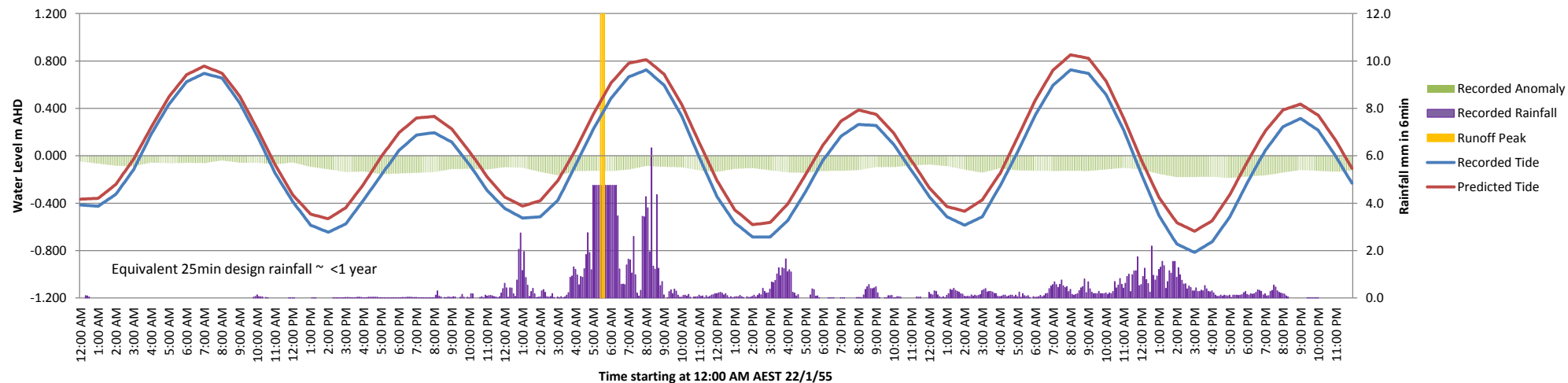
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 27/3/42



Severe Rainfall Event 23/1/55



Notes

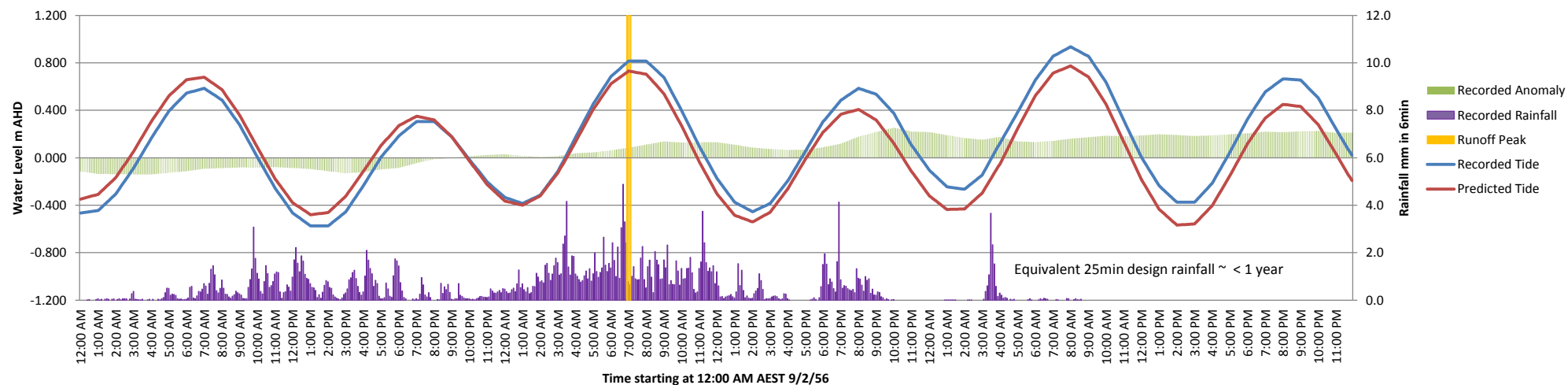
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Tide data recorded at Fort Denison

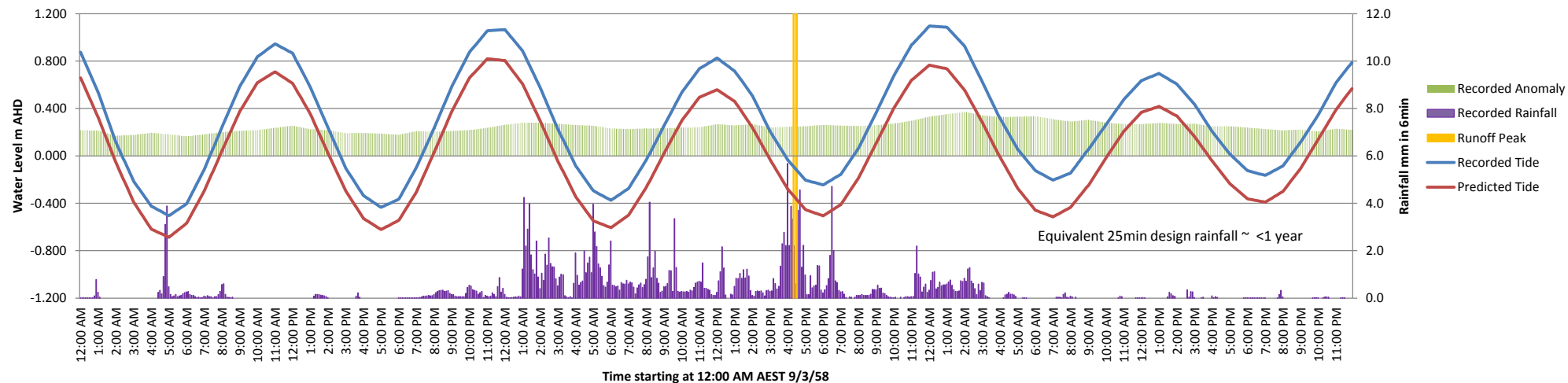
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 10/2/56



Severe Rainfall Event 10/3/58



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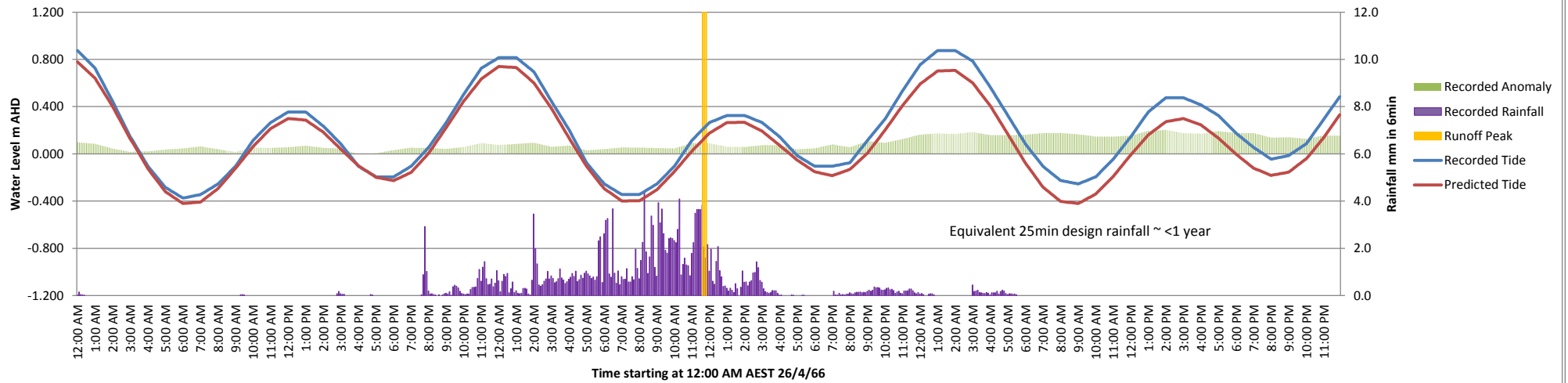
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

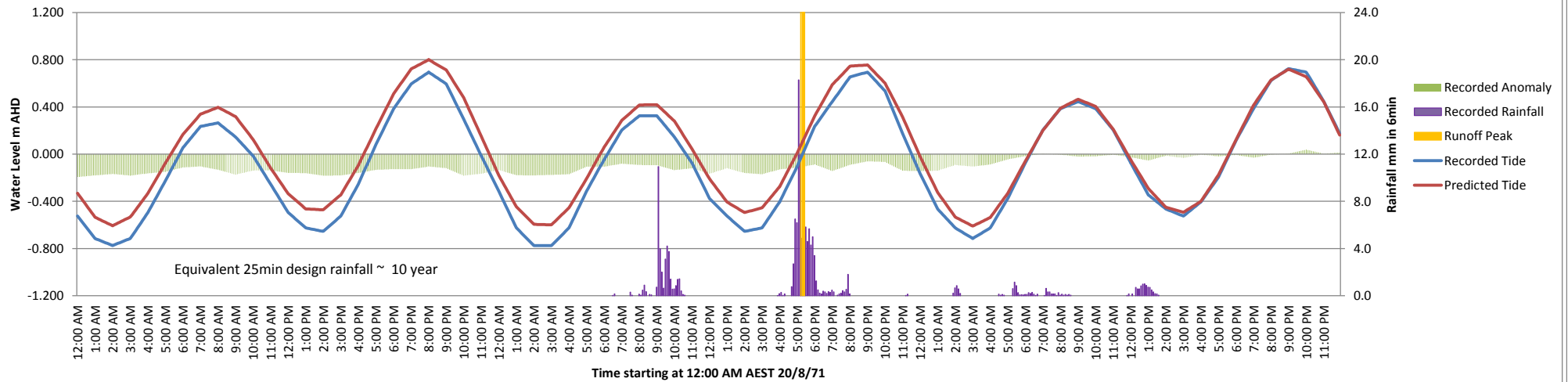
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 27/4/66



Severe Rainfall Event 21/8/71



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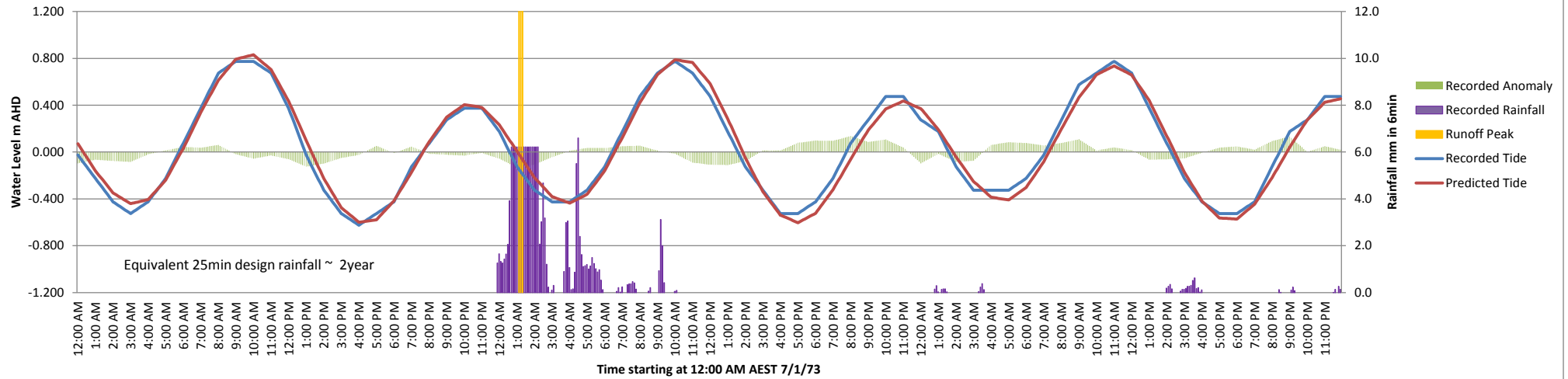
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

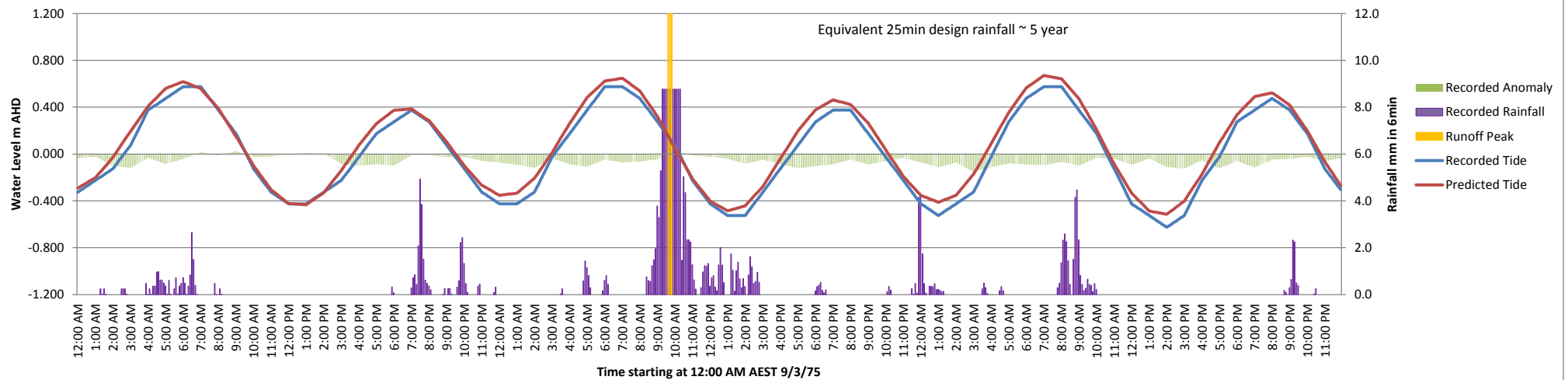
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 8/1/73



Severe Rainfall Event 10/3/75

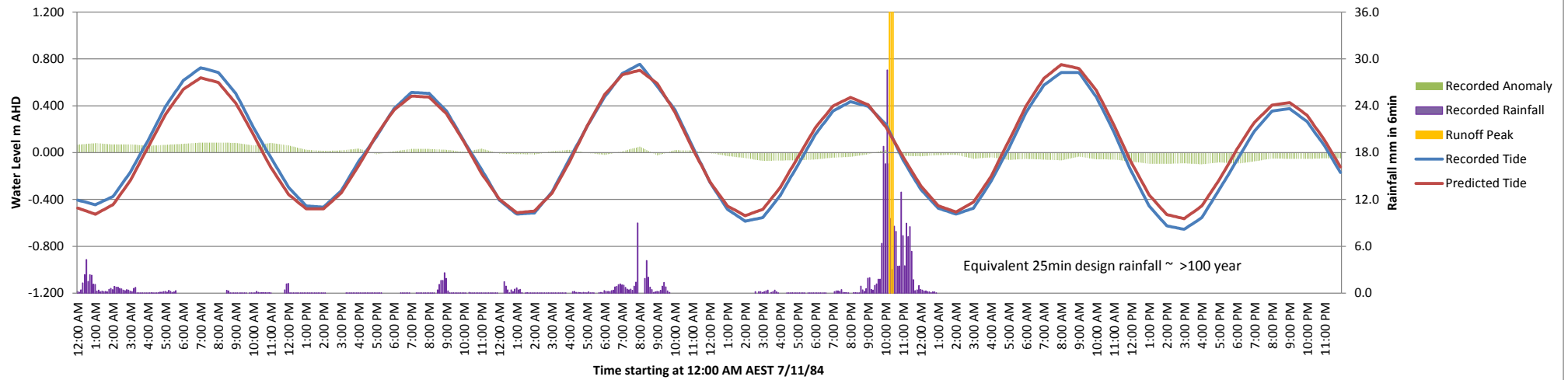


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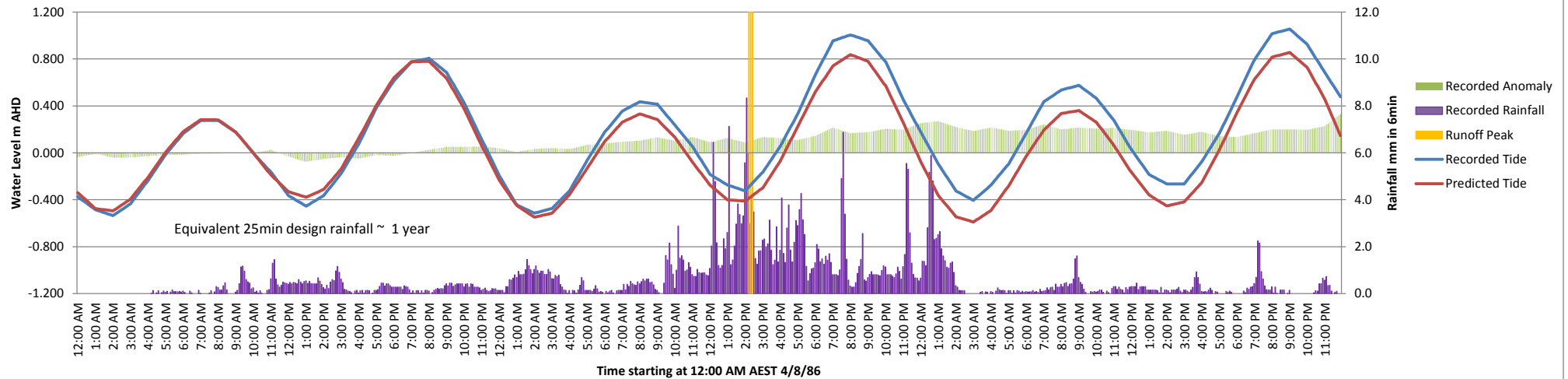
Rainfall data recorded at Observatory Hill Sydney, Station number 66062
Tide data recorded at Fort Denison
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Tide recordings from this time (1972-1976) were rounded to the nearest 100mm.
Therefore anomalies of the order of +/- 100mm are likely due to rounding error.
Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 8/11/84



Severe Rainfall Event 5/8/86



Notes

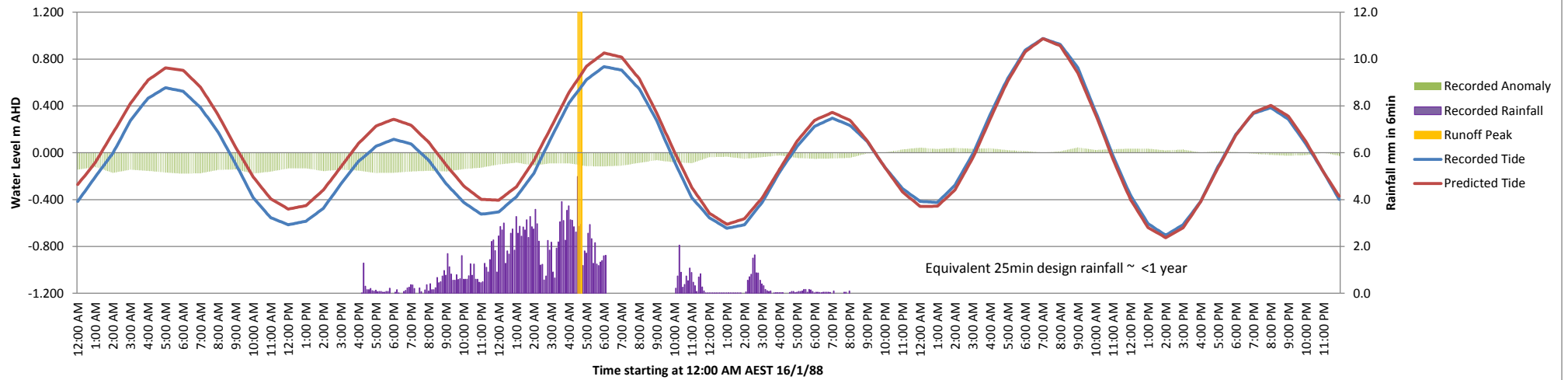
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

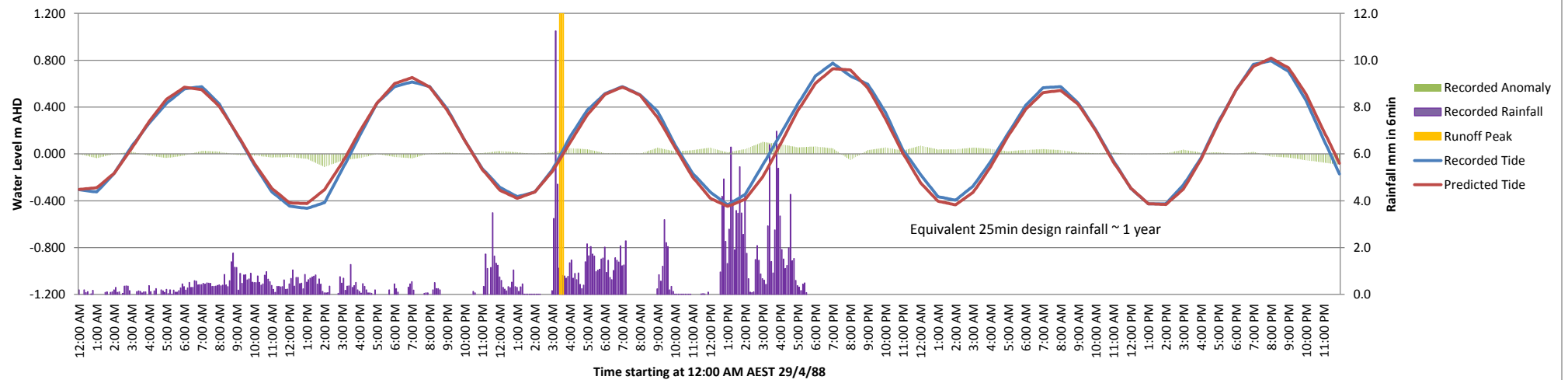
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 17/1/88



Severe Rainfall Event 30/4/88



Notes

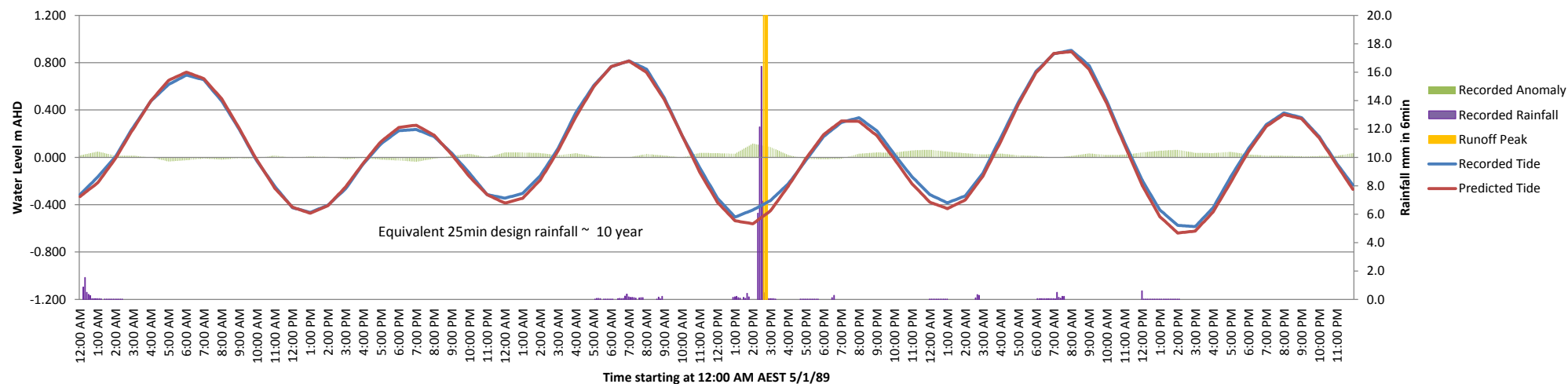
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

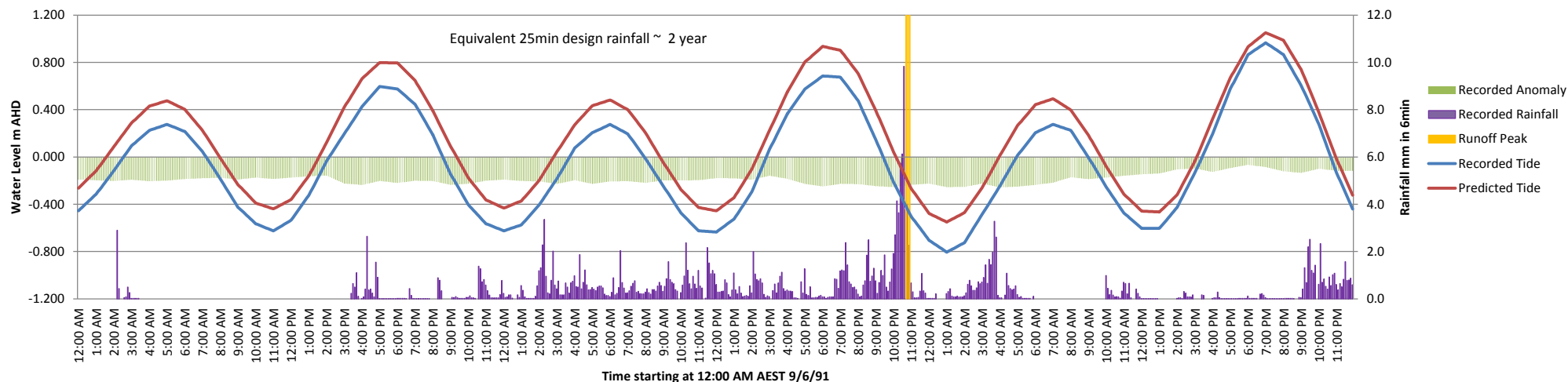
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 6/1/89



Severe Rainfall Event 10/6/91



Notes

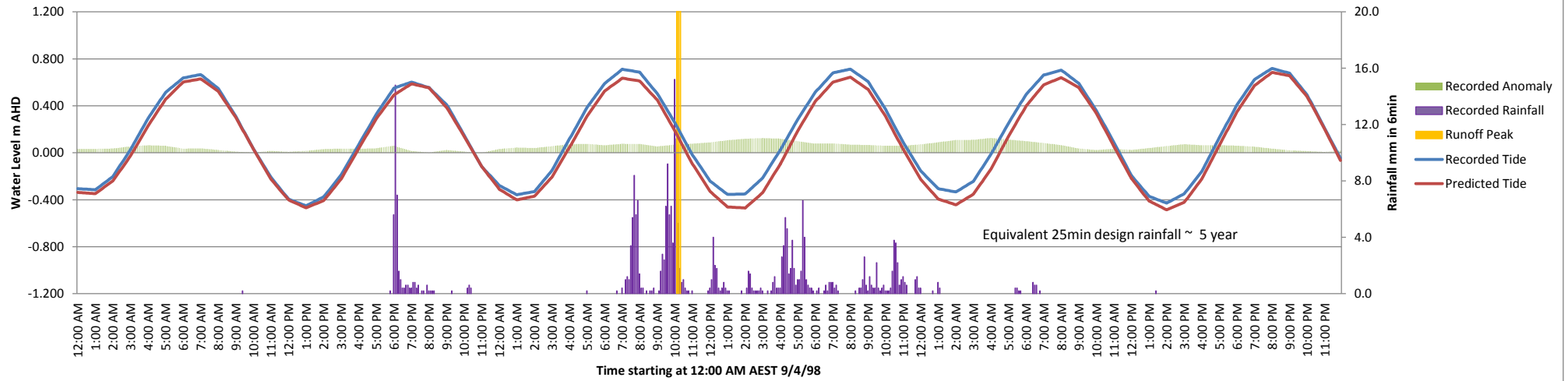
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

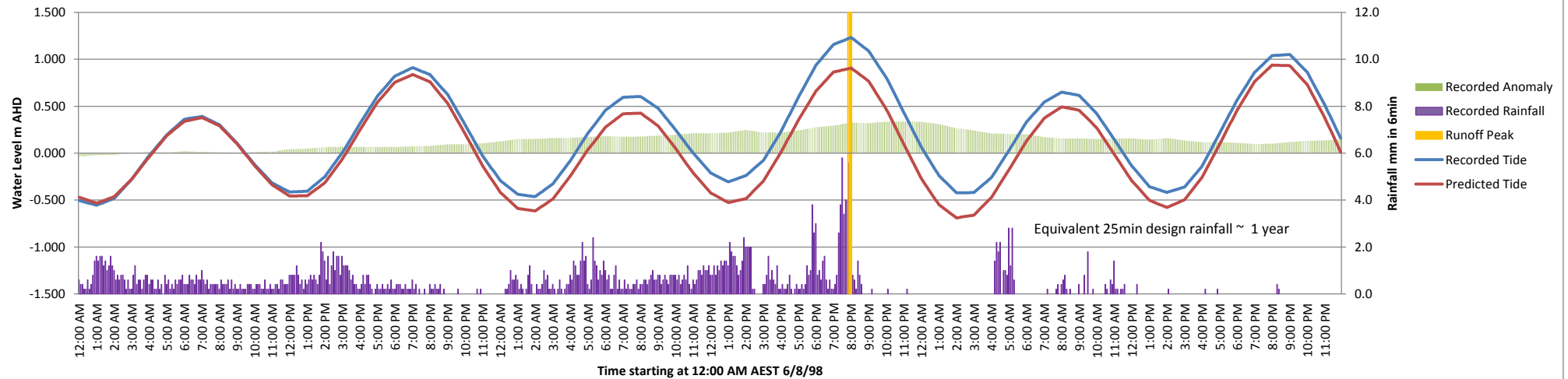
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Rainfall Event 10/4/98



Severe Rainfall Event 7/8/98



Notes

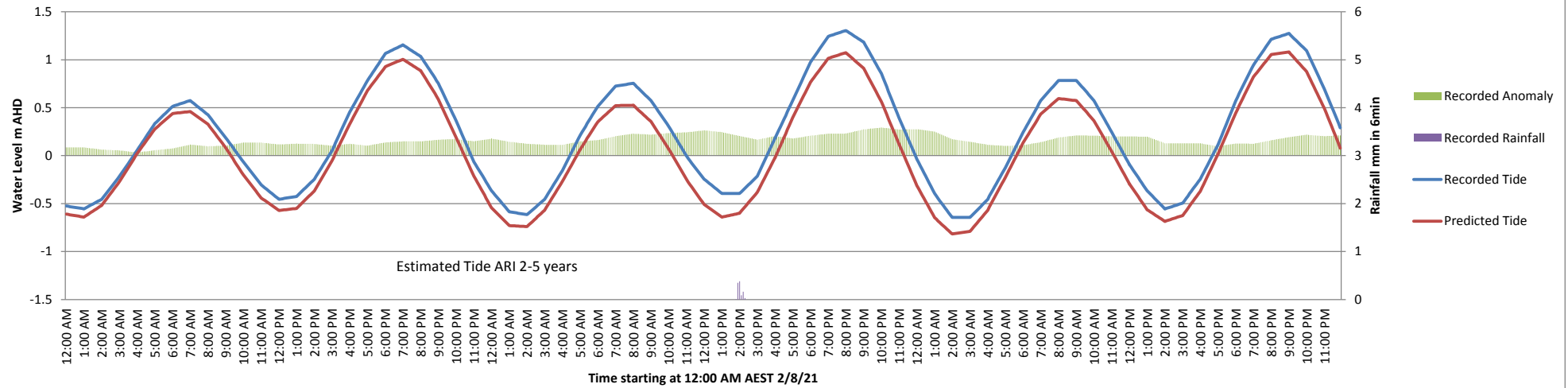
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

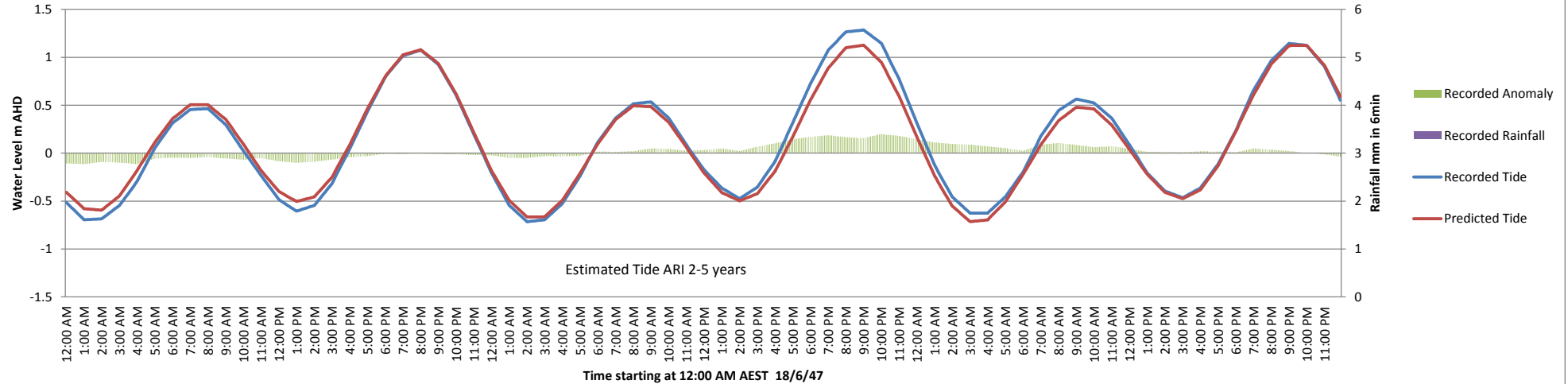
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay

Severe Tide Event 3/8/21



Severe Tide Event 19/6/47



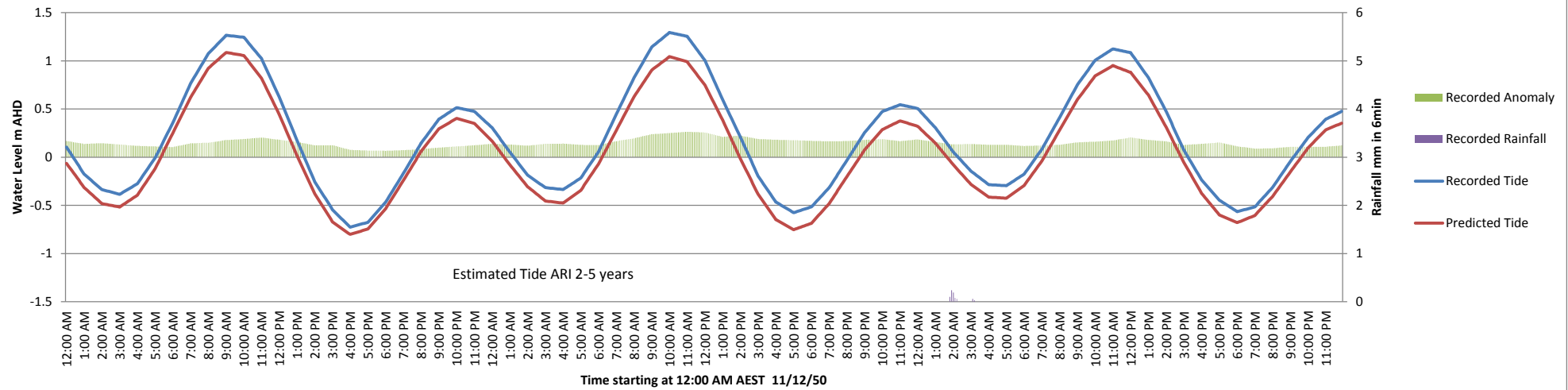
Notes

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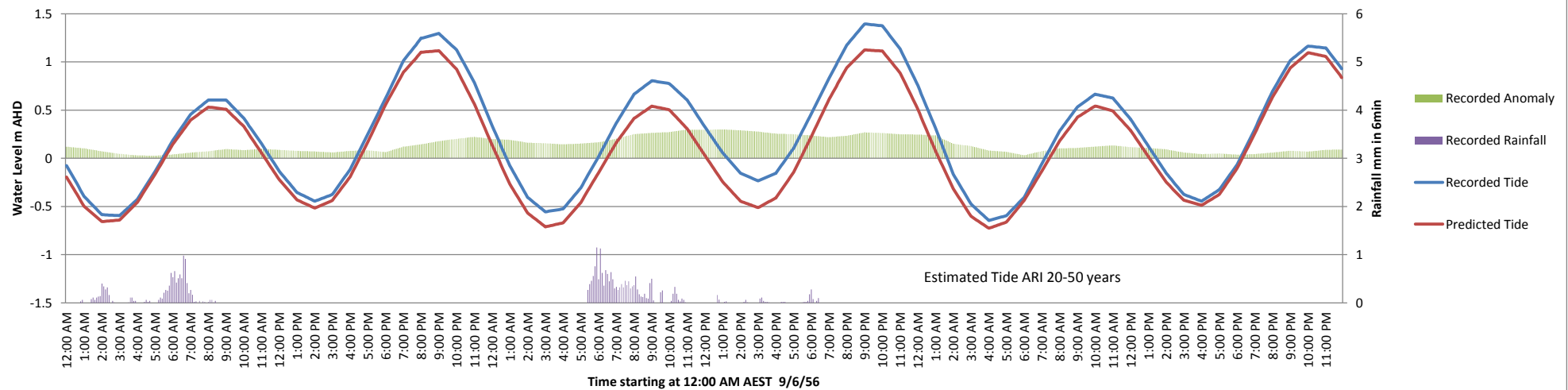
Tide data recorded at Fort Denison

Tide data and predicted tide data supplied by the Sydney Ports Corporation

Severe Tide Event 12/12/50



Severe Tide Event 10/6/56



Notes

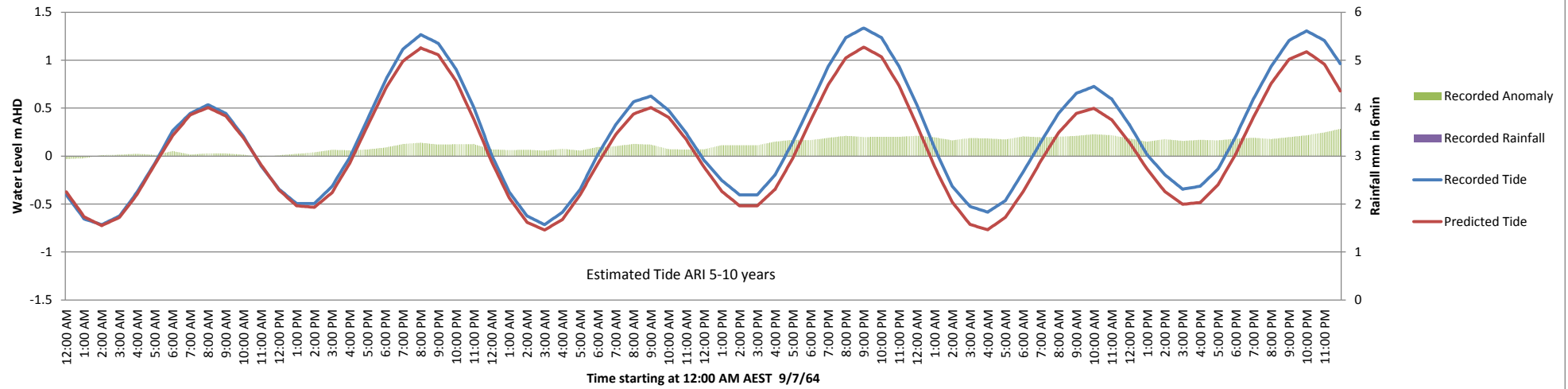
Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

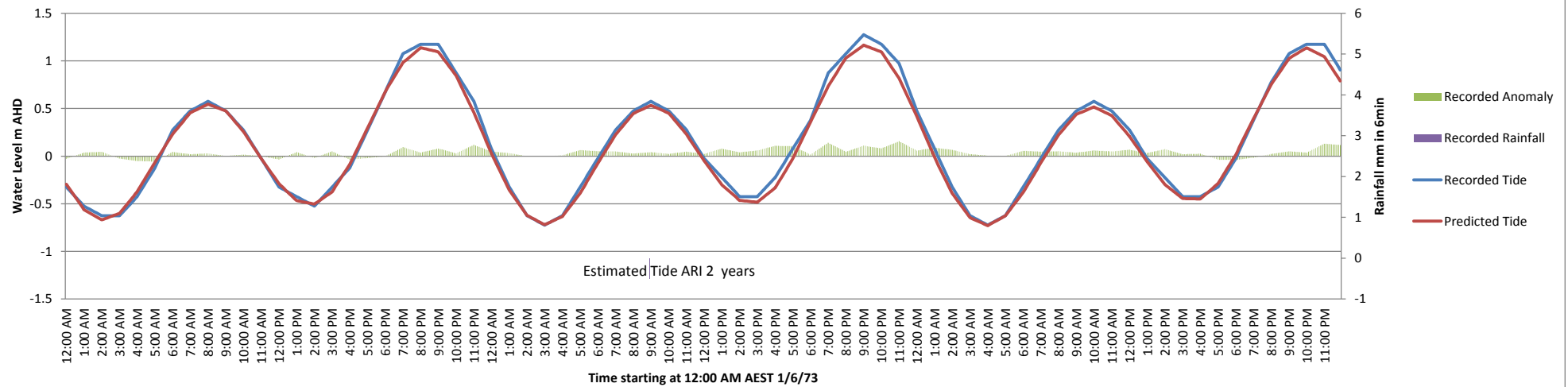
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Tide ARI estimations made using Fort Denison Seal Level Rise Vulnerability Study, DECC 2008

Severe Tide Event 10/7/64



Severe Tide Event 2/6/73

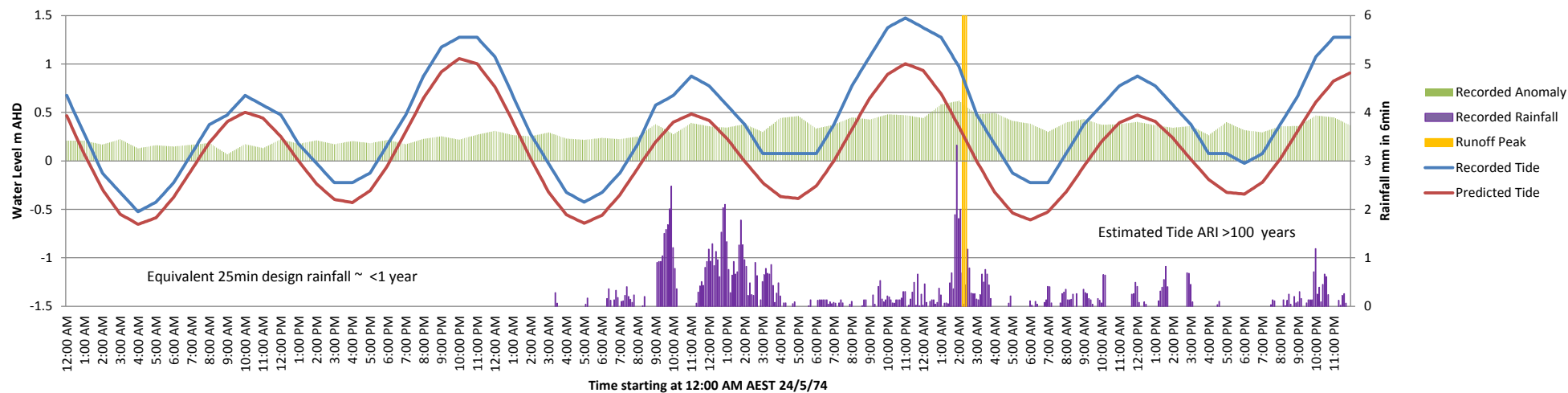


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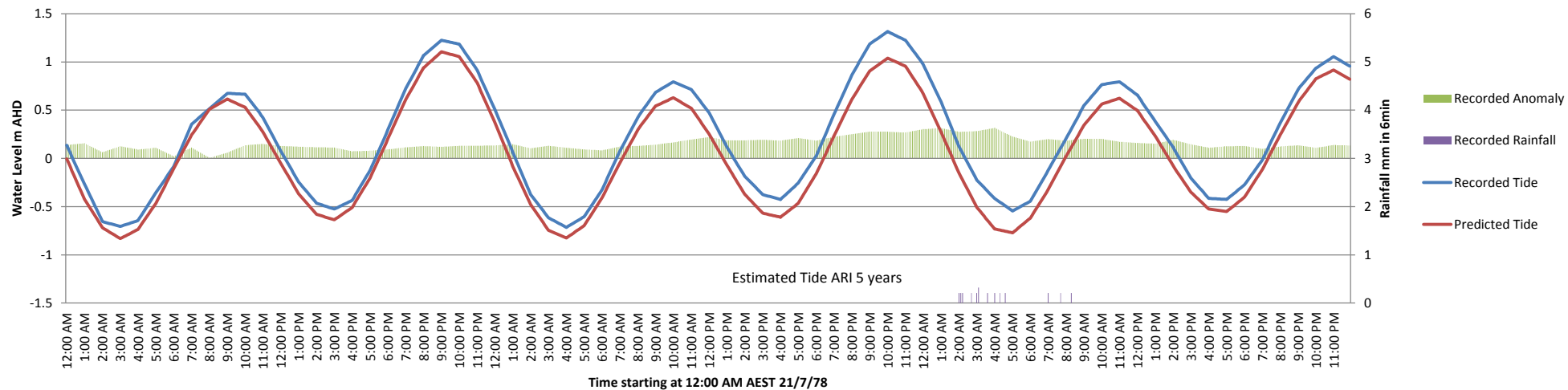
Rainfall data recorded at Observatory Hill Sydney, Station number 66062
Tide data recorded at Fort Denison
Tide data and predicted tide data supplied by the Sydney Ports Corporation

Tide recordings from this time (1972-1976) were rounded to the nearest 100mm.
Therefore anomalies of the order of +/- 100mm are likely due to rounding error.
Tide ARI estimations made using Fort Denison Seal Level Rise Vulnerability Study, DECC 2008

Severe Tide Event 25/5/74



Severe Tide Event 22/7/78



Notes

Rainfall data recorded at Observatory Hill Sydney, Station number 66062

Tide data recorded at Fort Denison

Tide data and predicted tide data supplied by the Sydney Ports Corporation

Tide recordings from this time (1972-1976) were rounded to the nearest 100mm.

Therefore anomalies of the order of +/- 100mm are likely due to rounding error.

Runoff Peak refers to the estimated time at which maximum flow reached Cockle Bay