SPITFIRE CHANNEL DREDGING
TURBIDITY MONITORING

Prepared for: Port of Brisbane Corporation

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Document No: 8831.1.1

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Document No:	8831.1.1
Archive Document No:	00015738
Original Date of Issue:	22/5/95
Project Manager:	C Witt

Title:	Spitfire Channel Dredging, Turbidity Monitoring
Author:	A Charteris
Client:	Port of Brisbane Corporation
Client Contact:	Mr John Dobson
Client Reference:	POBC Order No. 13498
Synopsis:	Turbidity monitoring associated with maintenance dredging of Spitfire Channel in northern Moreton Bay has been undertaken. This report documents the results of the monitoring exercises.

REVISION/CHECKING HISTORY

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1.0 INTRODUCTION

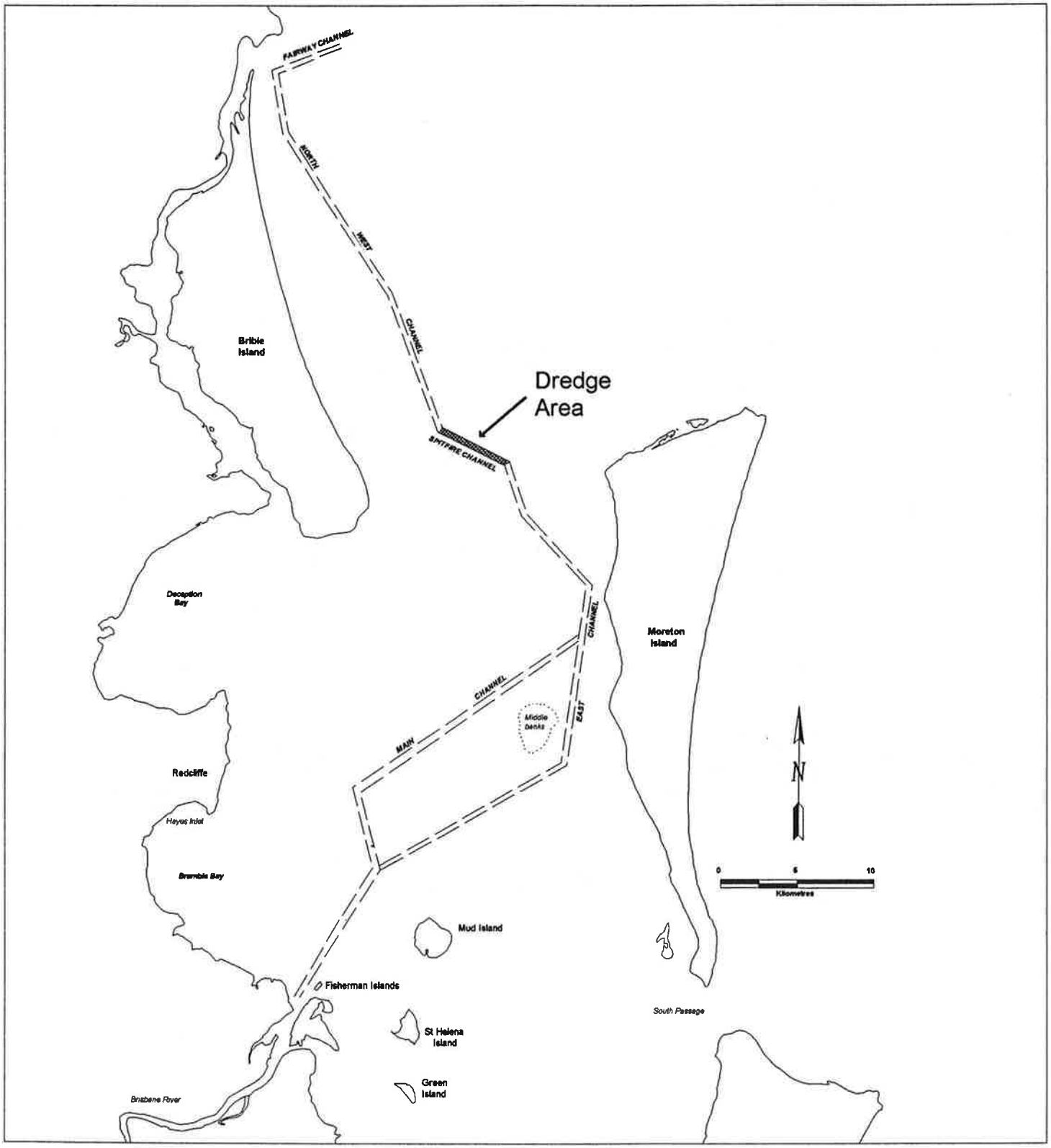
WBM Oceanics Australia were commissioned by the Port of Brisbane Corporation to undertake turbidity monitoring associated with dredging activities at Spitfire Channel in northern Moreton Bay.

The vessel "Pearl River" was undertaking the channel maintenance dredging. The Pearl River is a dual trailing arm suction dredge. Dredging occurred in Spitfire Channel between channel markers M1 and NW12 with dredged material being pumped ashore at Fisherman Islands. (see Figure 1 for locality).

Turbidity created in Spitfire Channel as a consequence of dredging was monitored for a near continuous period from 24/1/95 to 28/2/95. The following monitoring activities were carried out.

- continuous in-situ turbidity monitoring at sites near Spitfire Channel;
- continuous in-situ turbidity monitoring at a control site removed from the dredging area;
- turbidity profiling of background conditions;
- aerial inspections of dredge plume movement and dispersion;
- drogue tracking of plume movement and turbidity profiling of plume dispersion;
- water sample collection and analyses;
- equipment calibration.

This report documents the results of the turbidity monitoring and brings together notes and observations made as part of the monitoring exercises.



FIGURE

LOCALITY MAP

1

WBM OCEANICS AUSTRALIA

2.0 EQUIPMENT AND METHODOLOGY

2.1 EQUIPMENT

The instruments used for the monitoring exercises included the following:

- 5 high resolution nephelometers
- 2 Yeo-kal SDL water quality instruments
- 1 Hydrolab H20 water quality instrument

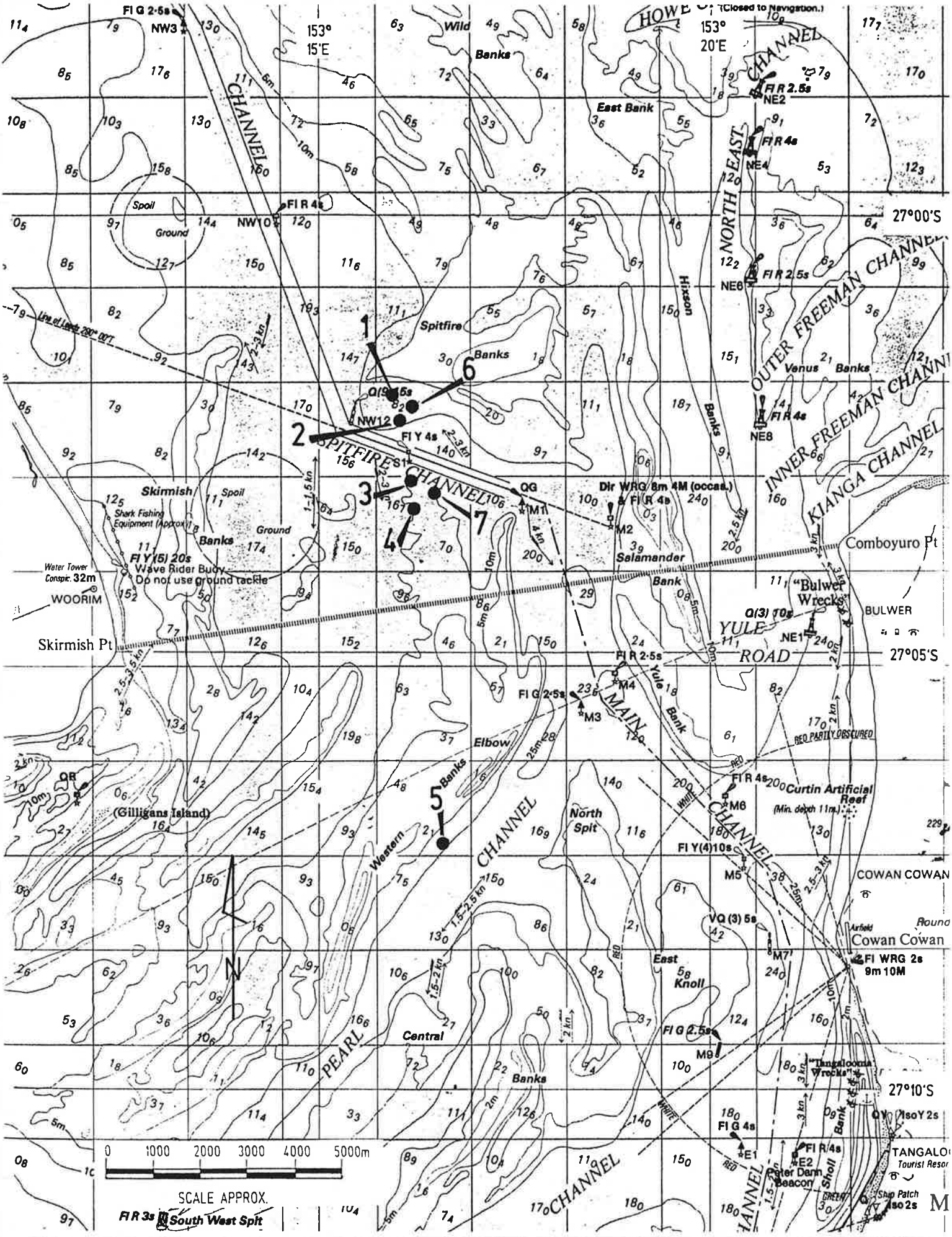
The various instruments have differing methods for measuring turbidity. The five high resolution nephelometers use a 180° backscatter method while the Yeokals and the Hydrolab use a 90° backscatter method.

The high resolution nephelometers were programmed to record every two minutes, averaging twenty half second samples. The Yeokals do not have an onboard averaging facility and recorded instantaneous turbidities at two minute intervals. Because of this difference, the Yeokal data sets tend to appear more 'spikey' or sensitive. Apparent inconsistencies in sensitivity in the data records can be attributed to this difference.

Deployment of the instruments was as follows:

Site	Period 1	Period 2	Period 3
	19/01/95 to 31/01/95	31/01/95 to 17/02/95	17/02/95 to 28/02/95
1	nephelometer	nephelometer	nephelometer
2	nephelometer	nephelometer	nephelometer
3	nephelometer	nephelometer	nephelometer
4	yeokal	nephelometer	nephelometer
5	nephelometer	nephelometer	nephelometer
6	yeokal	-	-
7	-	yeokal	yeokal

Four (4) nephelometers and two (2) Yeokal SDL's were deployed at locations about Spitfire Channel to continuously monitor turbidity. The fifth nephelometer was deployed in Pearl Channel as a control to monitor natural turbidity variations in isolation from dredge activities. The various deployment sites are illustrated in Figure 2.



FIGURE

TURBIDITY MONITORING SITES 2

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The Hydrolab H20 was utilised for profiling purposes aboard WBM Oceanics Australia survey vessel "Resolution II" during drogue tracking and spot sampling exercises. Drogues were tracked to determine plume movement and profiling of turbidity was conducted to indicate plume dispersion characteristics. Drogue locations were fixed using an onboard GPS.

2.2 METHODOLOGY

Remote recording instruments were deployed at sites illustrated in Figure 2. The instruments were tethered to mooring lines such that they were suspended approximately 2 m above the seabed. The instruments were downloaded, cleaned and serviced regularly throughout the deployment period.

On 24/01/95, 30/01/95 and 12/04/95, tracking and turbidity profiling of plumes created by dredge activities were carried out to monitor movement and dispersion characteristics. The plumes were tracked by drogues together with coordinated aerial inspections to identify movements and locations for turbidity profiling. Water samples were collected at various depths in conjunction with turbidity profiling at regular intervals during the first two tracking exercises. The first tracking and profiling exercise coincided with the first dredging pass of the channel and straddled high water slack tide when currents were low. The second exercise was undertaken during a period of strong ebb currents. The third exercise was undertaken during a flood tide towards the end of the dredging period.

All instruments were calibrated under laboratory conditions using samples of hopper overwash water, high in suspended sediment, as the calibration medium.

3.0 RESULTS

Results are presented in figures and notes collated in Appendices as follows:

- Appendix A Site 1 - 1 200 m NW of S1
- Appendix B Site 2 - 800 m NW of S1
- Appendix C Site 3 - 800 m S of S1
- Appendix D Site 4 - 1 500 m S of S1
- Appendix E Site 5 - Pearl Channel
- Appendix F Site 6 - 800 m N of S1
- Appendix G Site 7 - 1 500 m SE of S1
- Appendix H Turbidity Profiling - 24/01/95
- Appendix I Turbidity Profiling - 30/01/95
- Appendix J Turbidity Profiling - 12/04/95
- Appendix K Instrument Calibration

Plots in Appendices A to G show turbidity with time at each site. For reference, a tidal water level is indicated below the x axis and periods of dredge activity are marked by symbols, also below the x axis.

Some data sets have been influenced detrimentally by biological fouling including:

- aquatic growth
- algae
- squid eggs

Each appendix is headed by a note indicating the period of deployment and identify periods where the data set may have been influenced by such fouling.

Appendices H, I and J contain aerial inspection and field notes from the three turbidity profiling exercises together with plots of the turbidity profiles and the results of water sample analyses.

The instrument calibration results giving relationships between suspended sediment concentrations and turbidity levels are presented in Appendix K.

4.0 SUMMARY

Turbidity induced by dredging activities and natural phenomena at Spitfire Channel has been monitored via continuous in-situ measurements at a number of sites and mobile profiling of dredge plumes under varying conditions. Peak turbidities measured, attributed to dredging alone were up to about 20 NTU immediately after dredging. These turbidities showed limited spatial and temporal extent with levels dropping quickly back towards background conditions. The direction and distance dredging plumes moved was dependent on the time of dredging in relation to the tidal cycle and the range of the tide.

The data set shows periods of naturally high turbidity and fluctuations due to the prevailing tide, wind and wave conditions.

All data collected has been presented and illustrates some periods where in-situ turbidity recordings were corrupted by fouling.

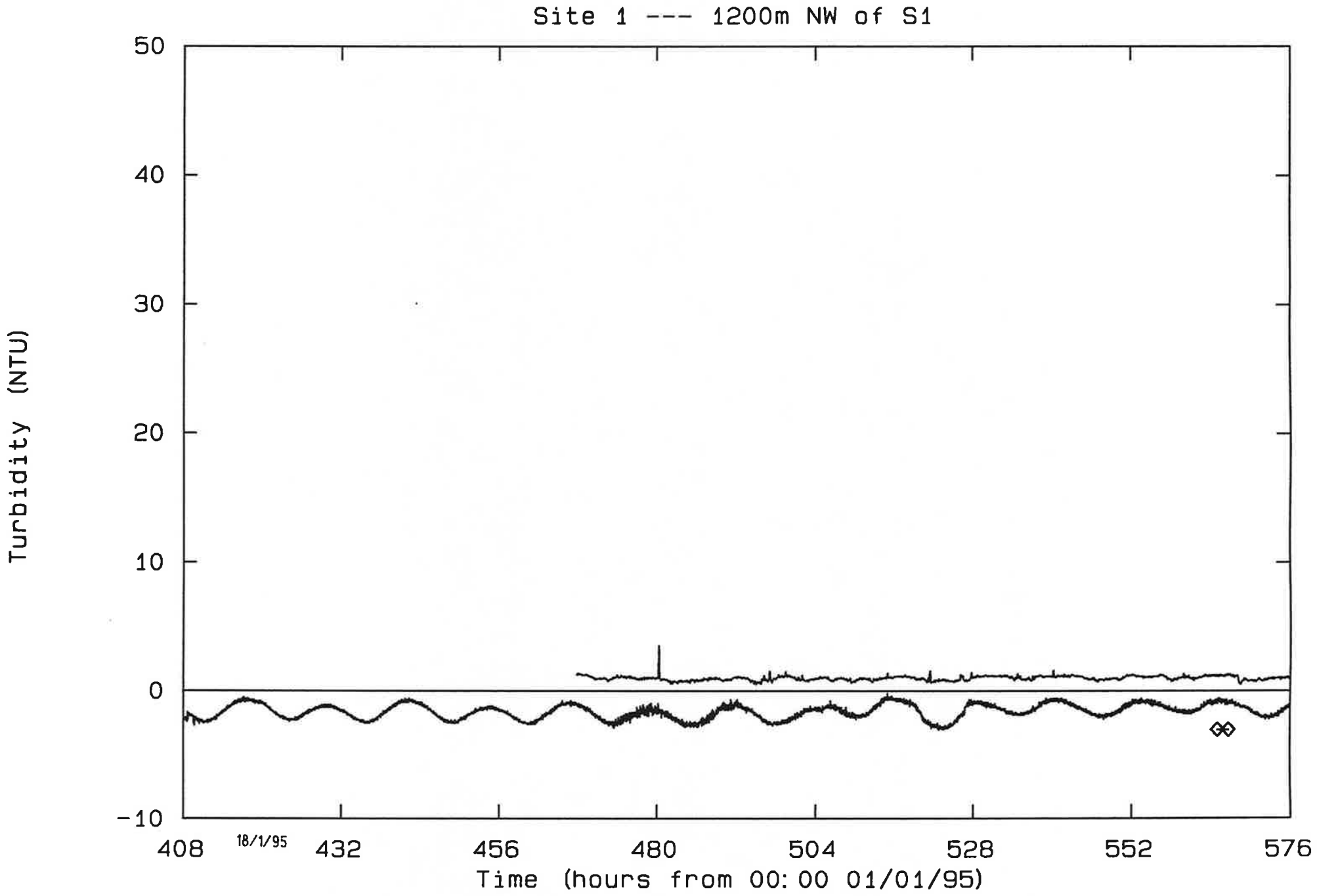
APPENDIX A

Site 1 - 1 200 m NW of S1

Instrument : Nephelometer 331

Period of Deployment:
468 hrs - 1401 hrs
12:00 20/01/95 - 09:00 28/02/95

Periods of Fouling : 1170 hrs - 1401 hrs (approximately)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Turbidity (NTU)
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40
30
20
10
0
-10
408
18/1/95
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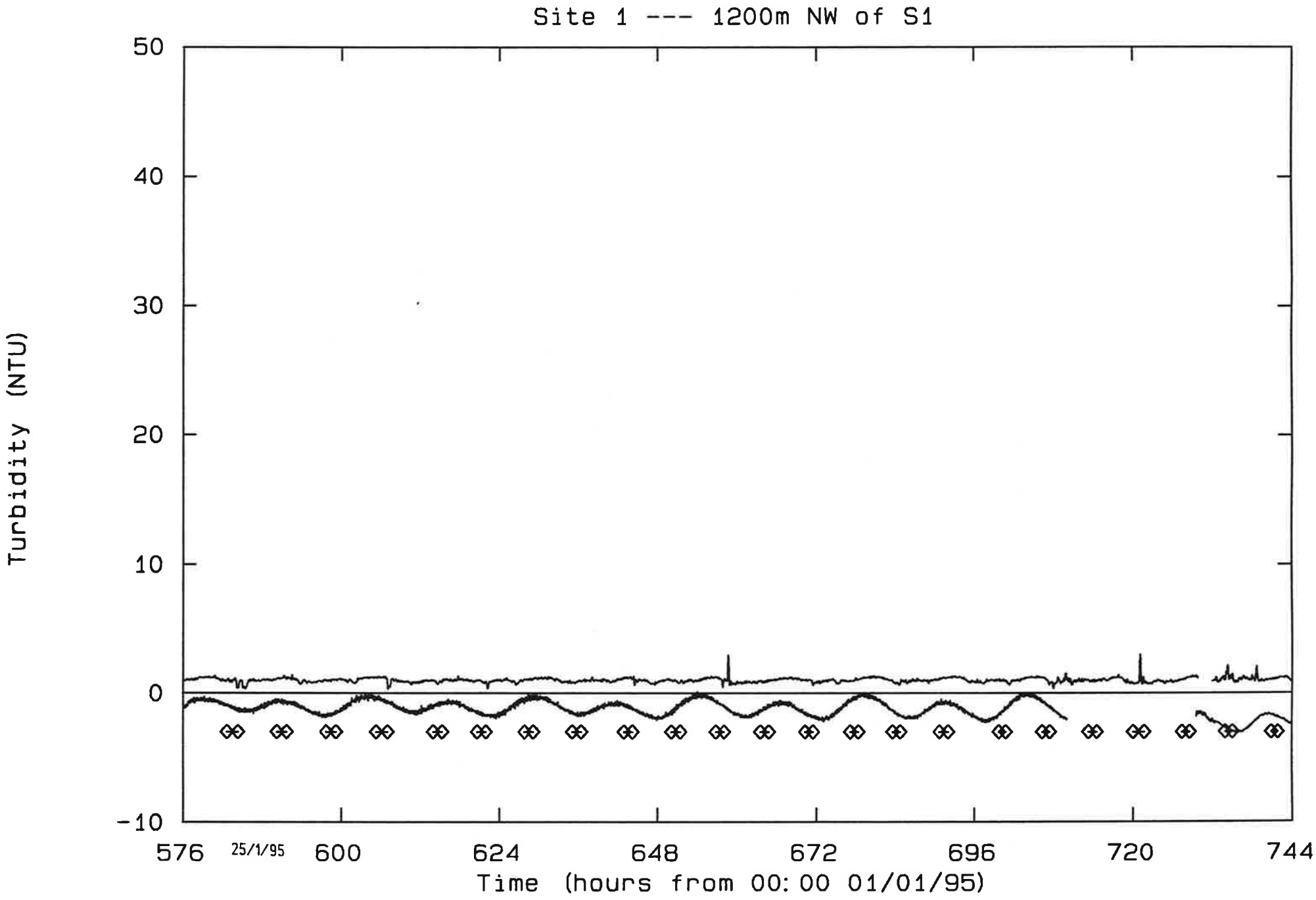
480
504
528
552
576
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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40
30
20
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-10
576
25/1/95
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624
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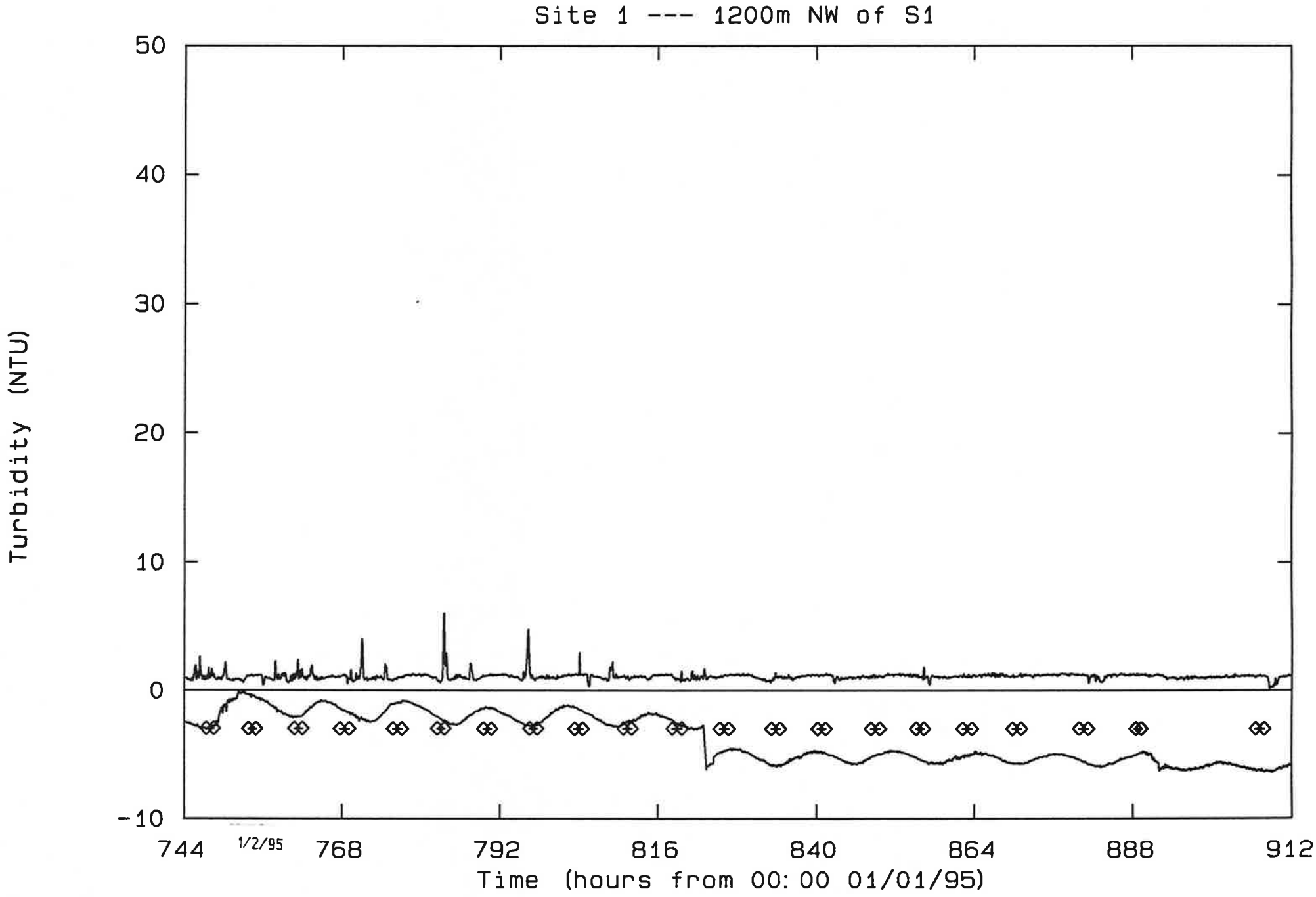
672
696
720
744
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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40
30
20
10
0
-10
744
1/2/95
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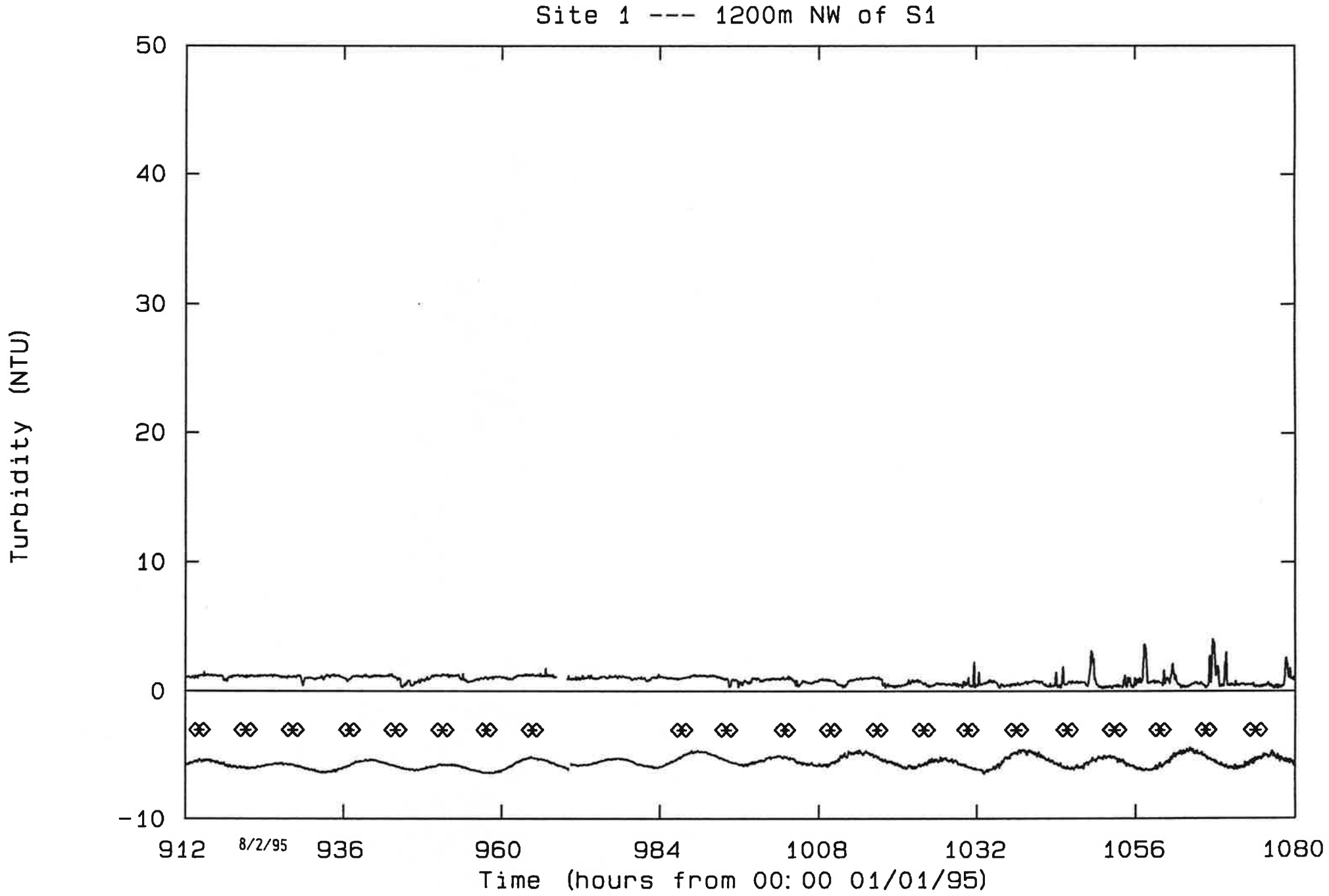
792
816
840
864
888
912
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
50
40
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8/2/95
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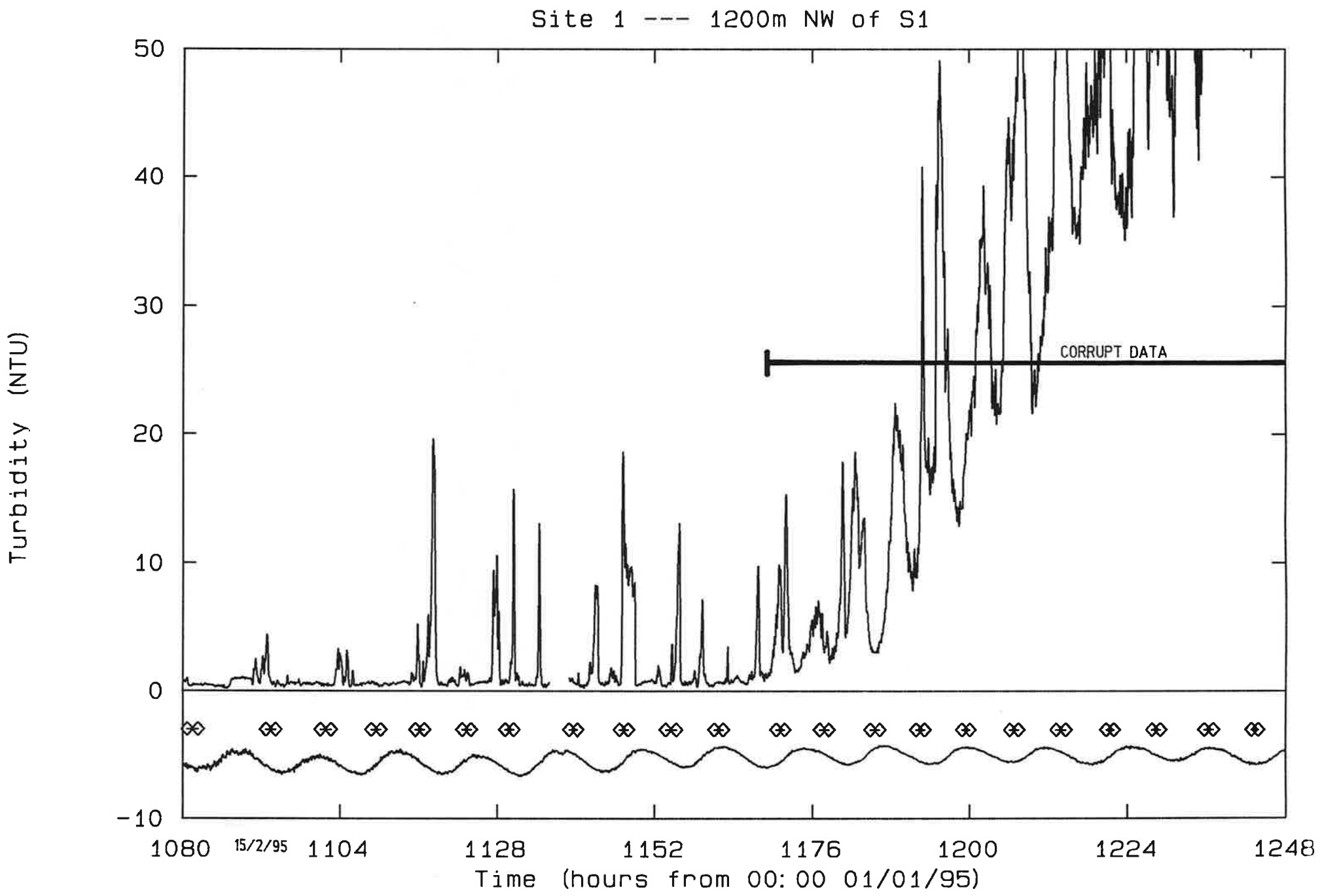
984
1008
1032
1056
1080
Time (hours from 00:00 01/01/95)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40
30
20
10
0
-10
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15/2/95
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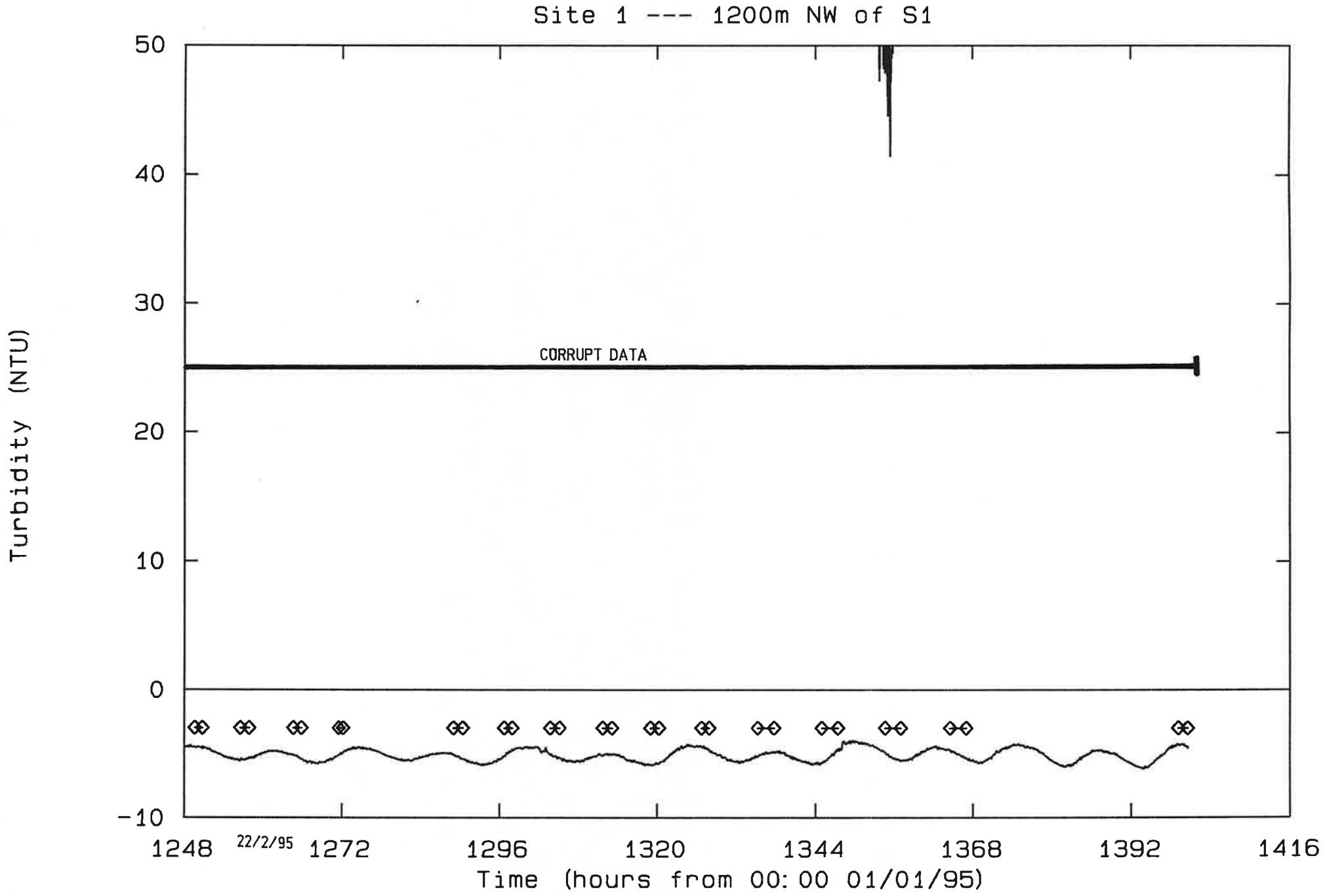
1200
1224
1248
Time (hours from 00:00 01/01/95)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20
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0
-10
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1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

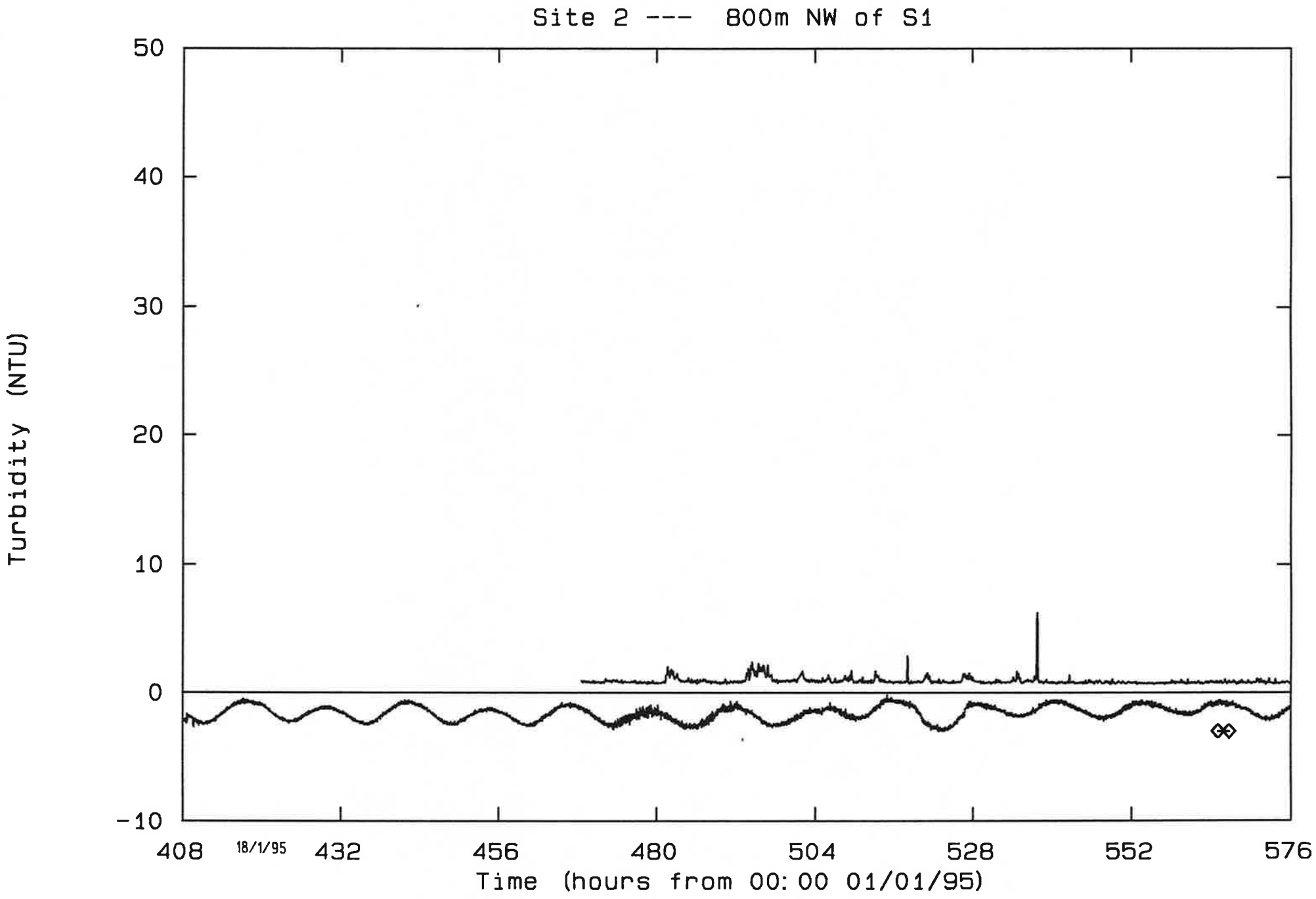
APPENDIX B

Site 2 - 800 m NW of S1

Instrument : Nephelometer 330

Period of Deployment : 468.7 hrs - 1400 hrs
12:42 20/01/95 - 08:00 28/02/95

Periods of Fouling : 893 hrs-1135 hrs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Turbidity (NTU)
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40
30
20
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-10
408
18/1/95
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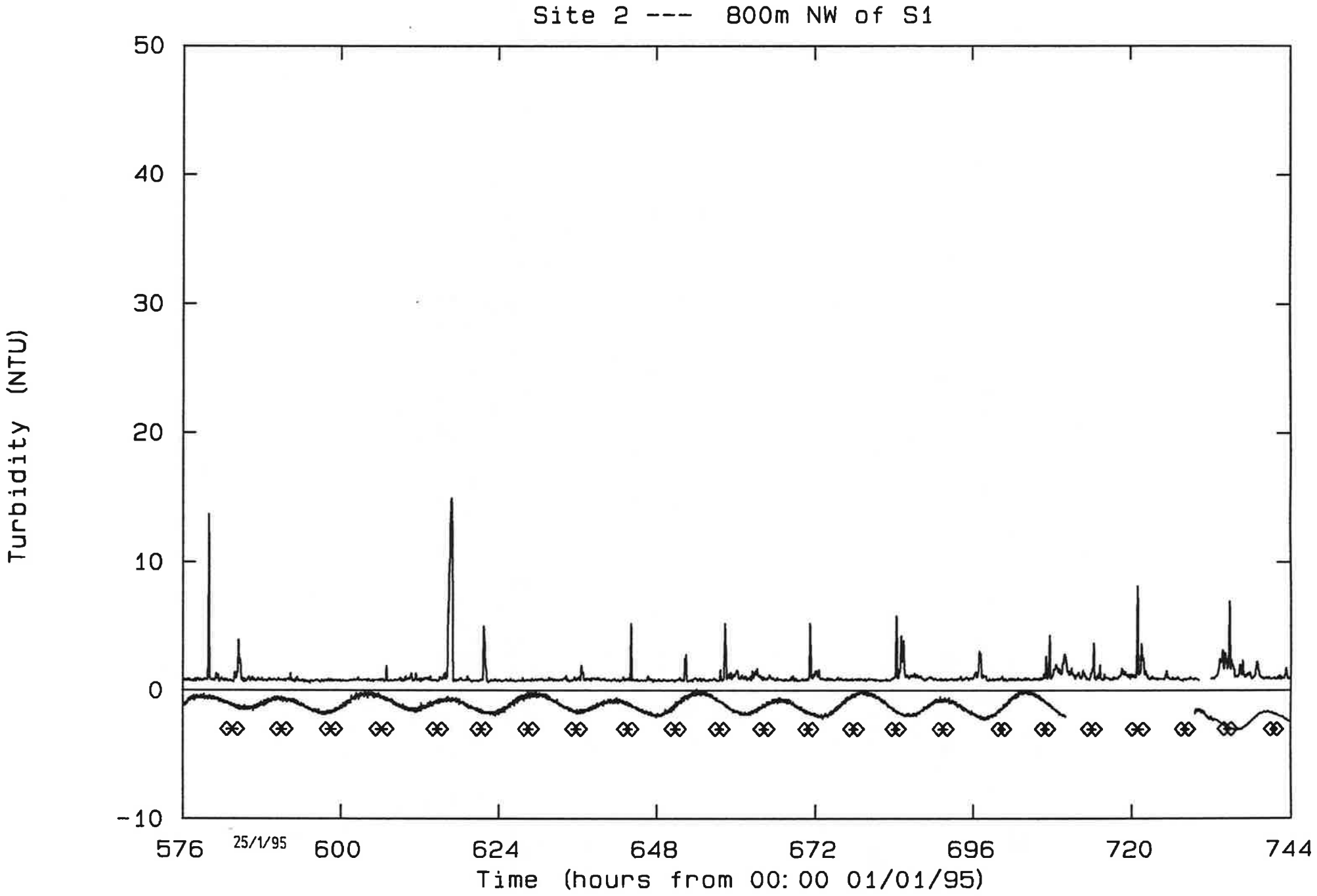
480
504
528
552
576
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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40
30
20
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-10
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25/1/95
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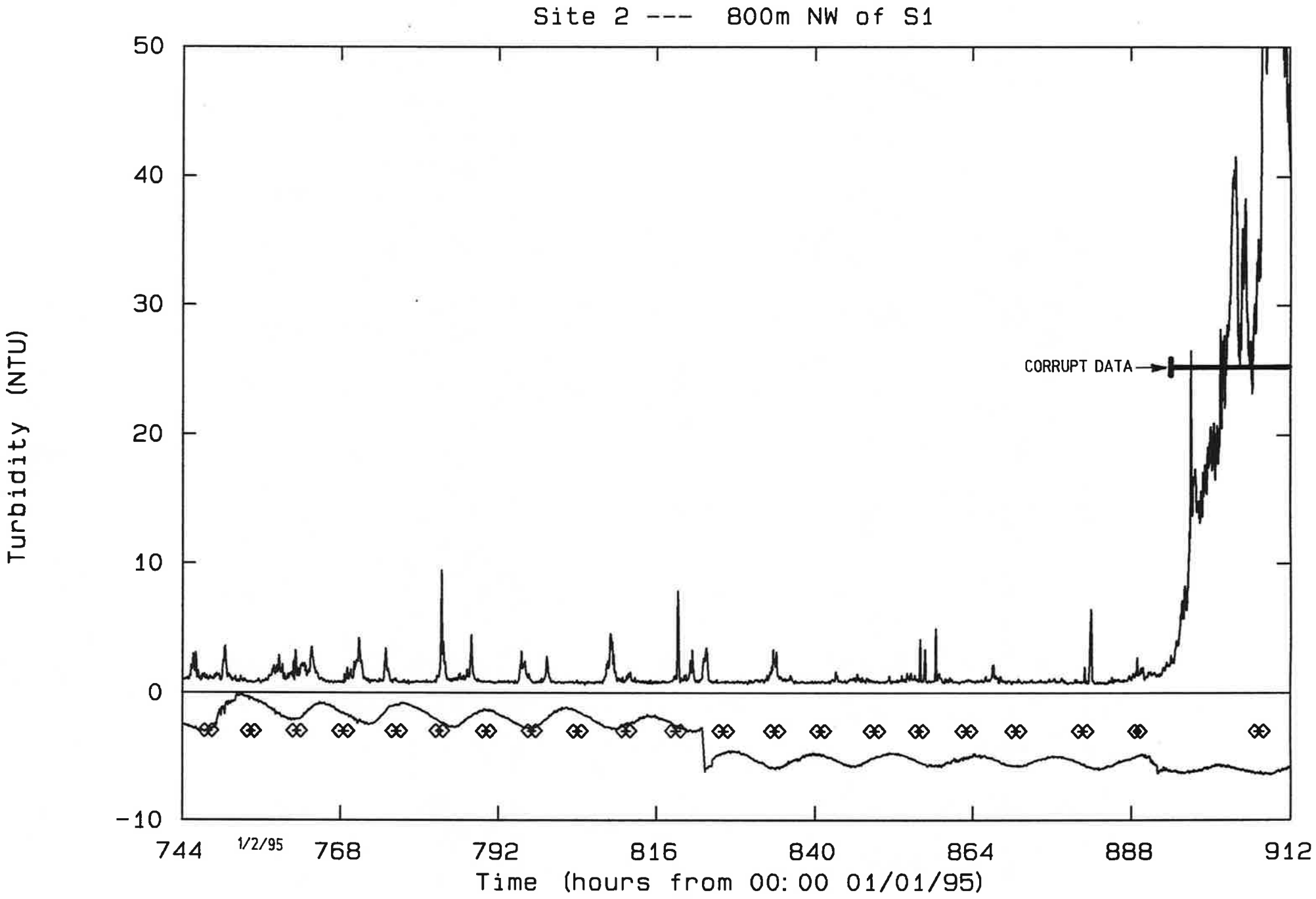
624
648
672
696
720
744
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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40
30
20
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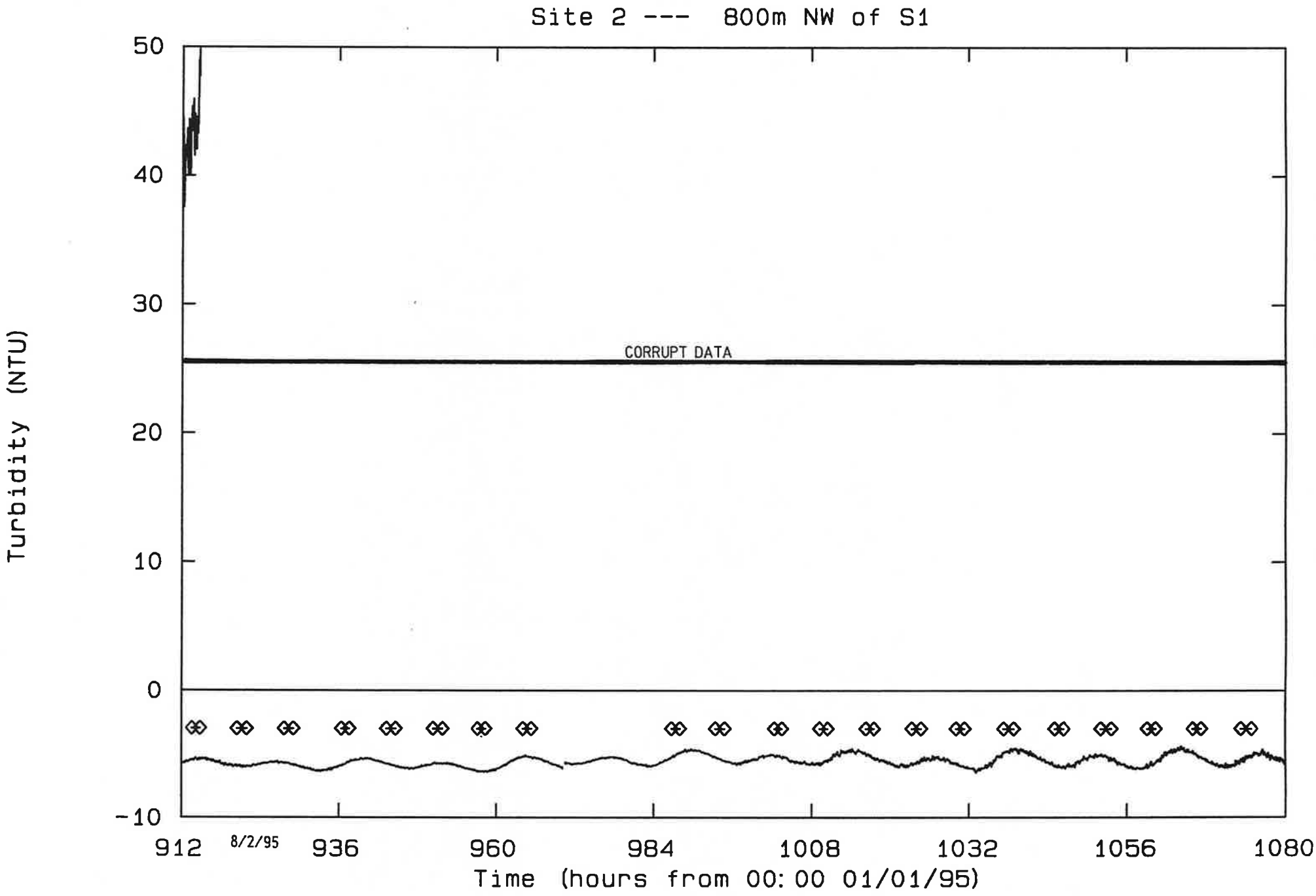
744
1/2/95
768
792
816
840
864
888
912
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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8/2/95
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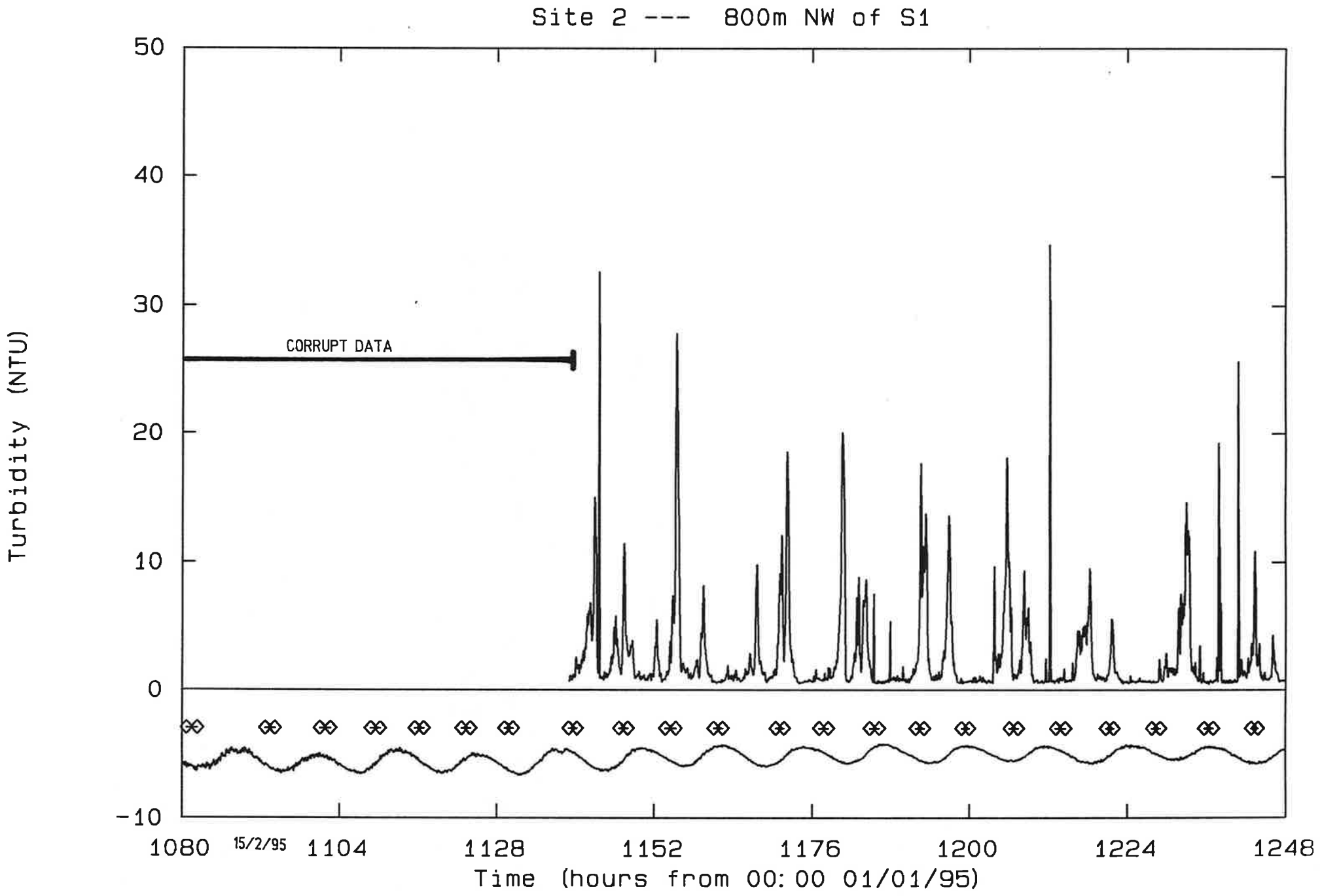
1056
1080
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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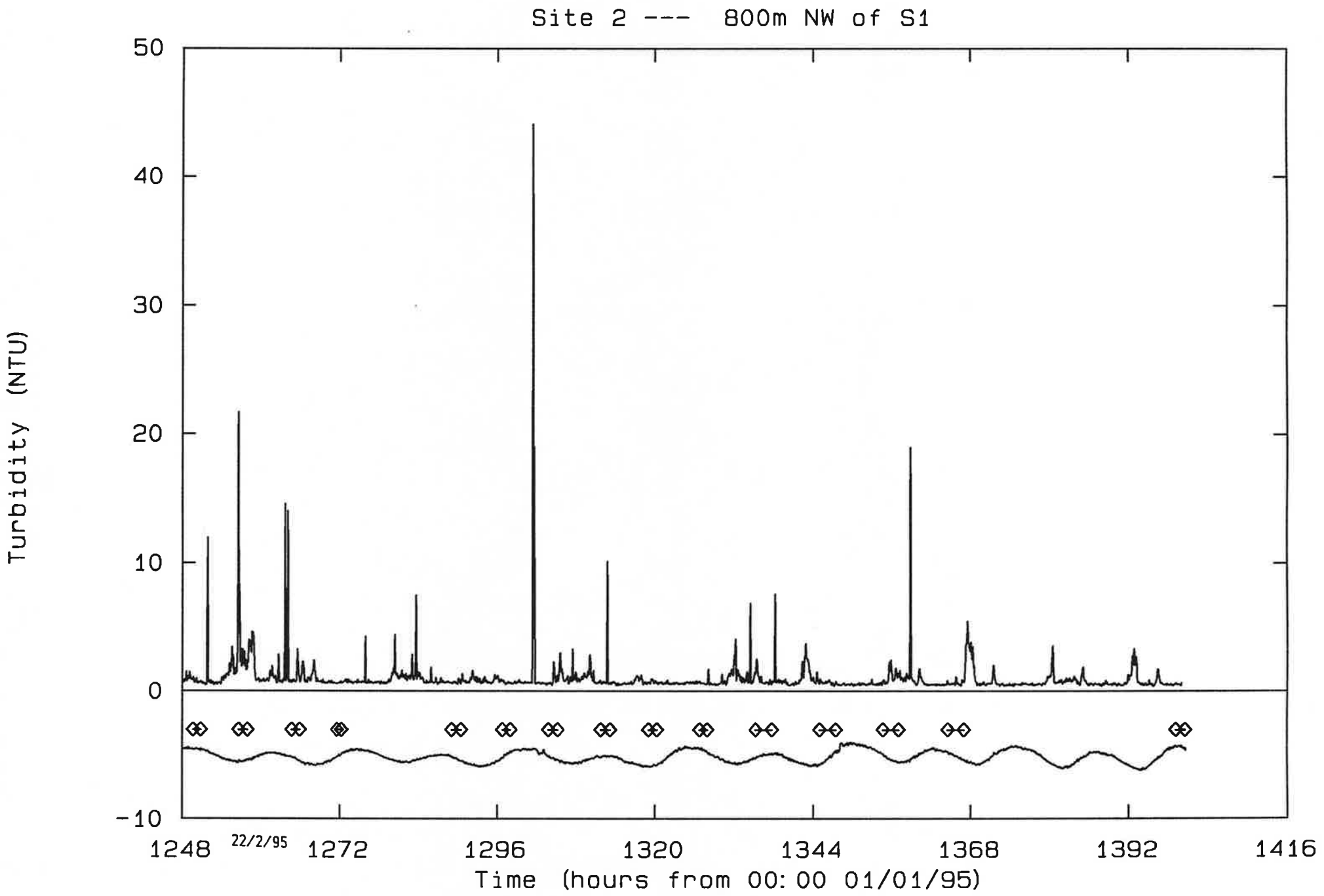
Time (hours from 00:00 01/01/95)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10
0
-10
1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

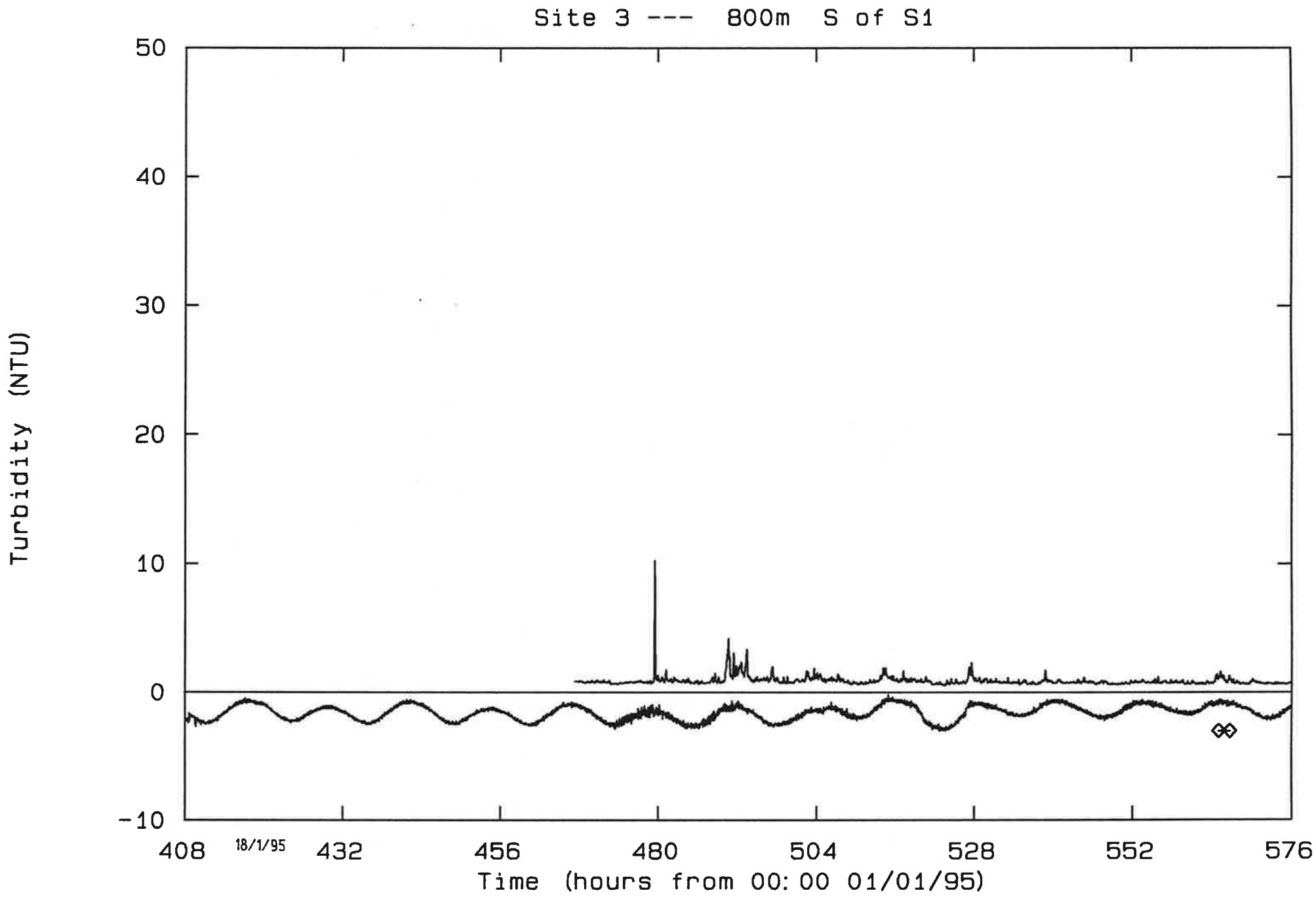
APPENDIX C

Site 3 - 800 m S of S1

Instrument : Nephelometer 325

Period of Deployment : 467.4 hrs - 1400.8 hrs
11:24 20/01/95 - 08:48 28/02/95

Periods of Fouling : 1377 hrs - 1400 hrs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40
30
20
10
0
-10
Turbidity (NTU)
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504
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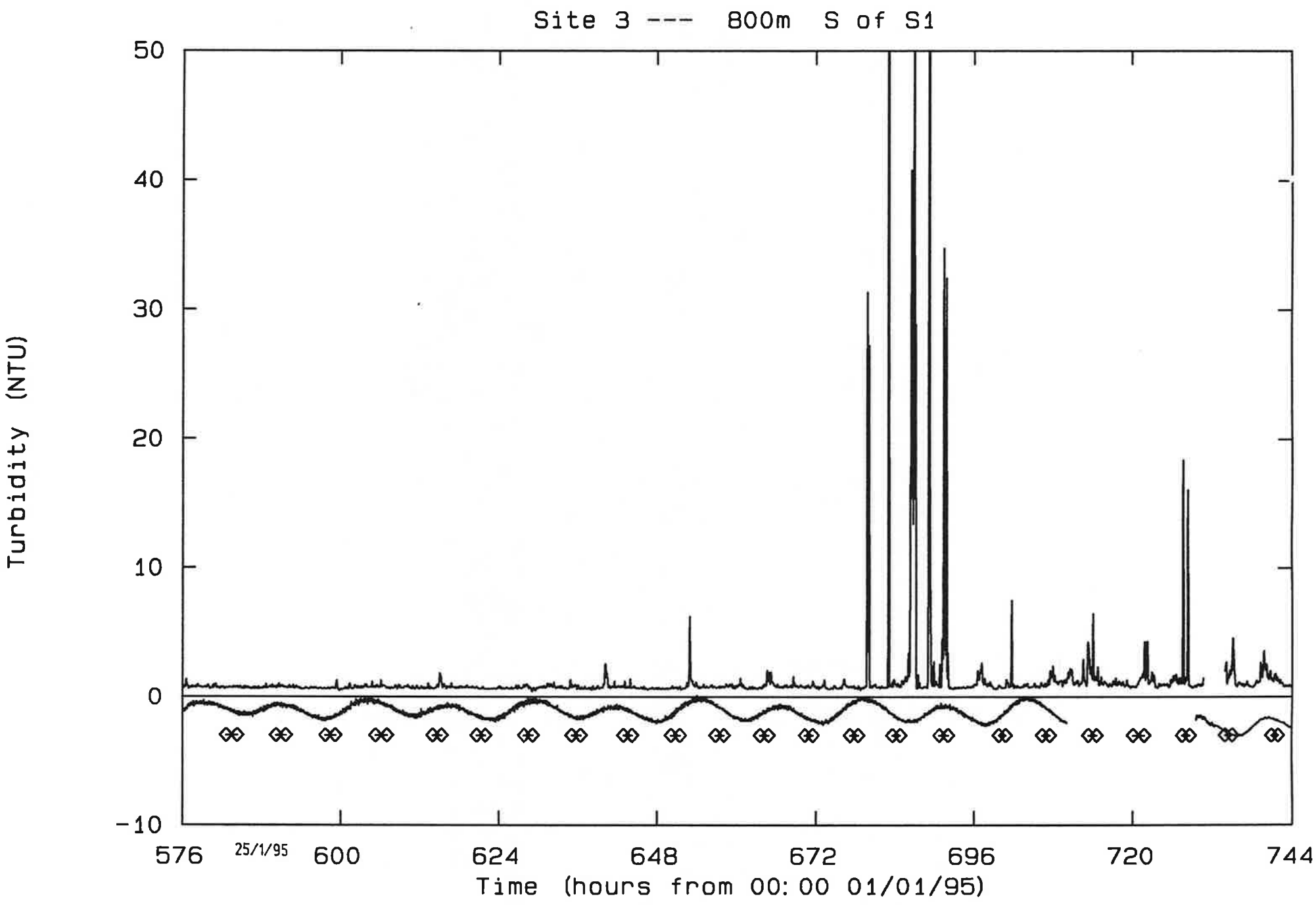
552
576
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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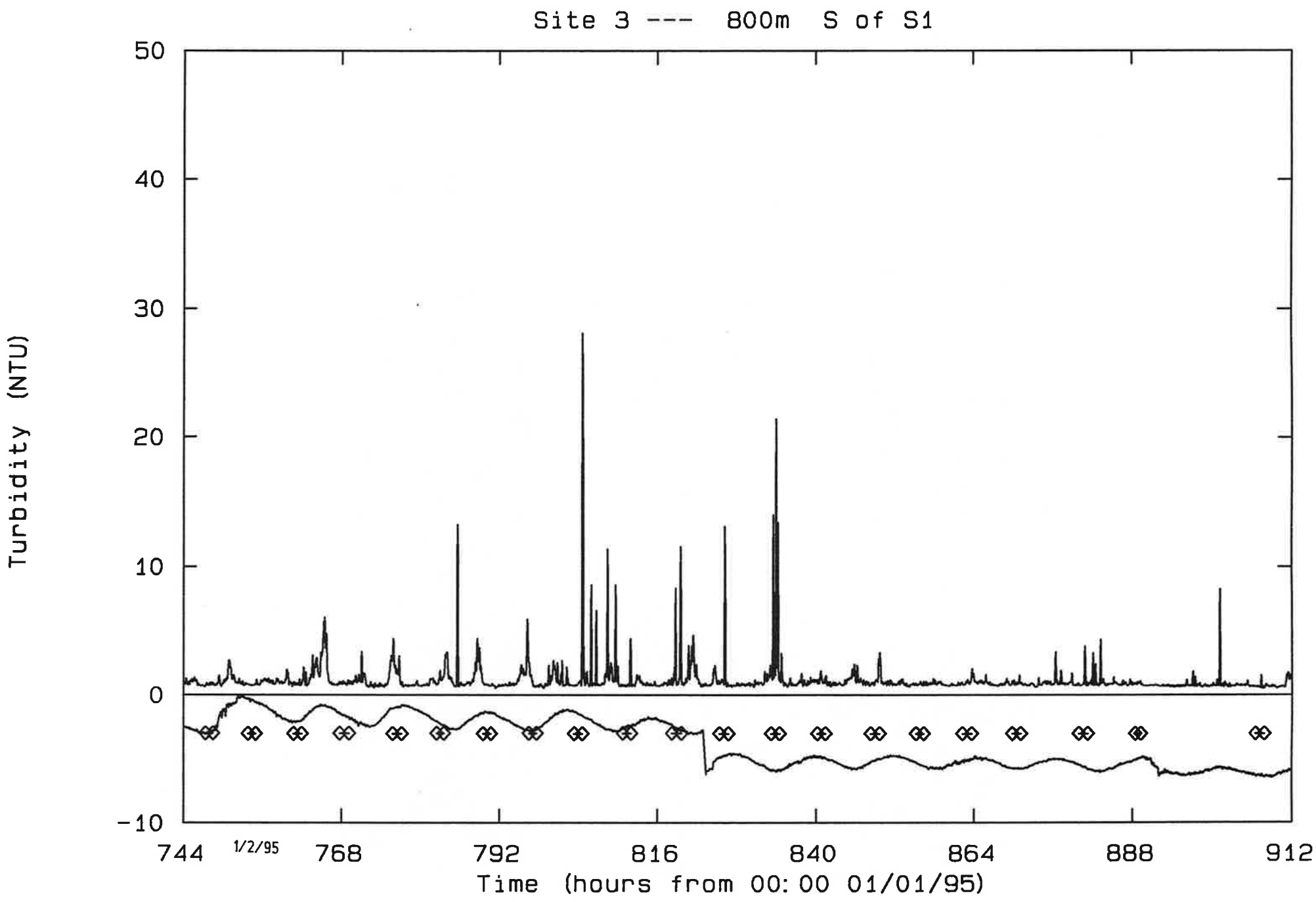
720
744
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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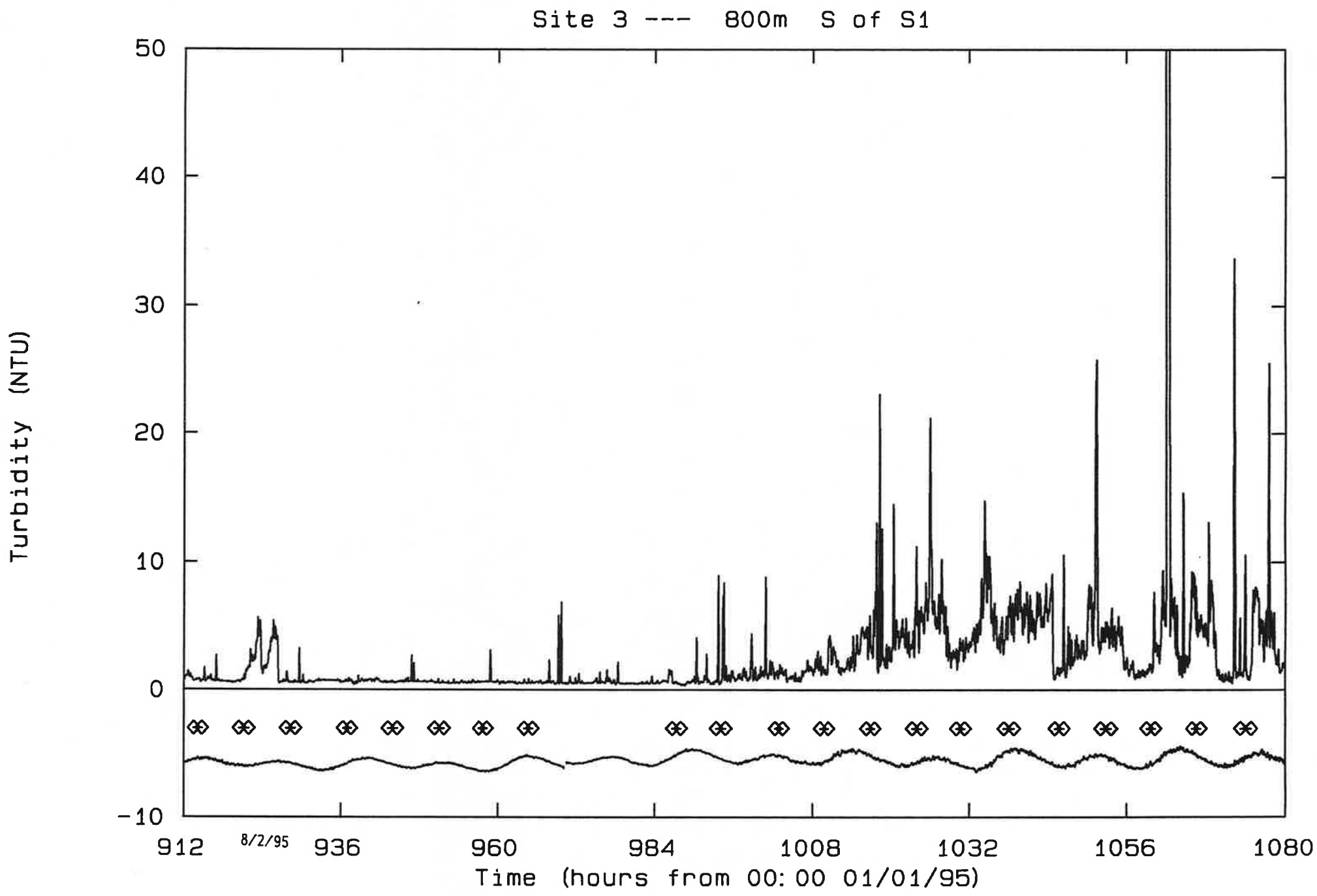
912
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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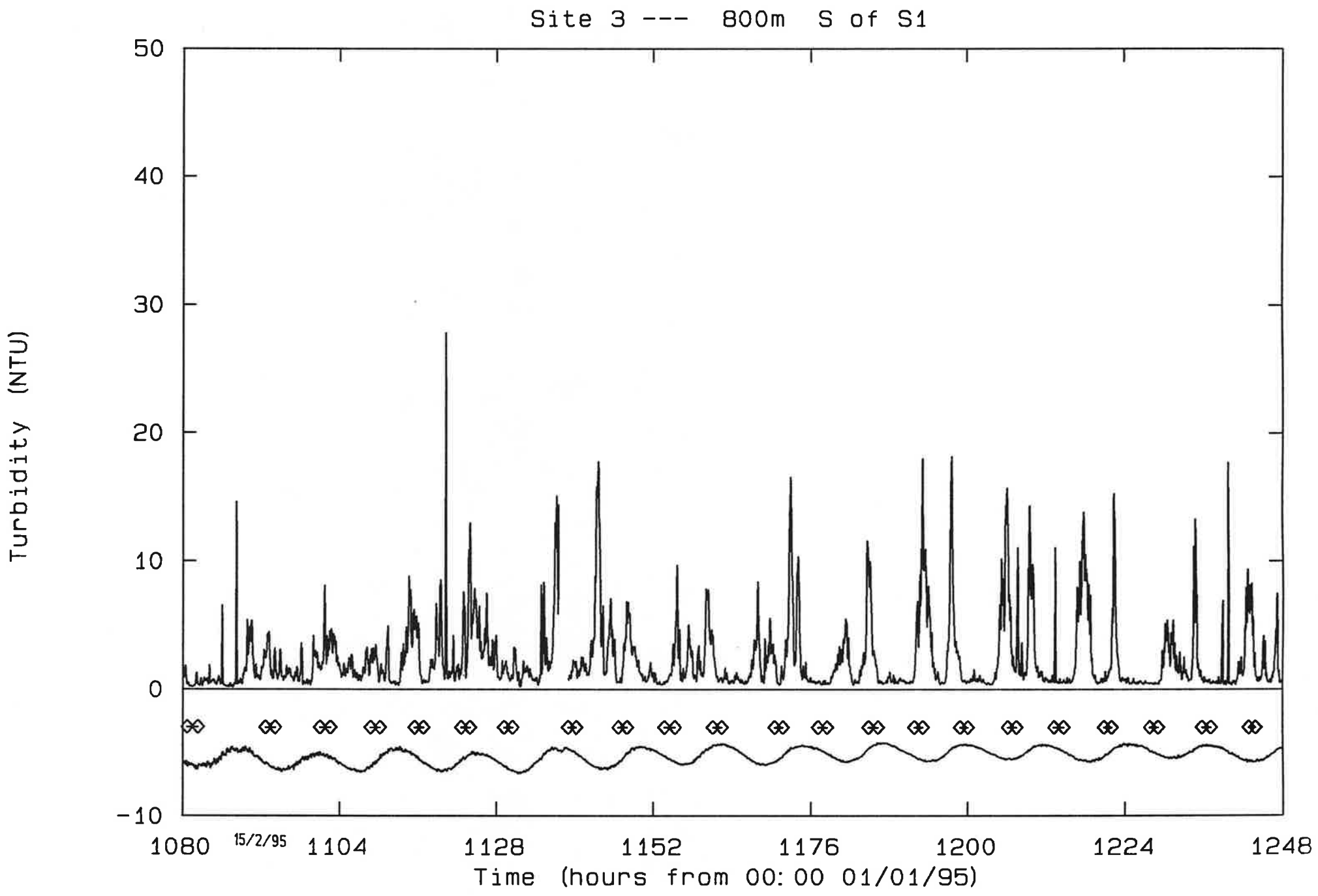
Time (hours from 00:00 01/01/95)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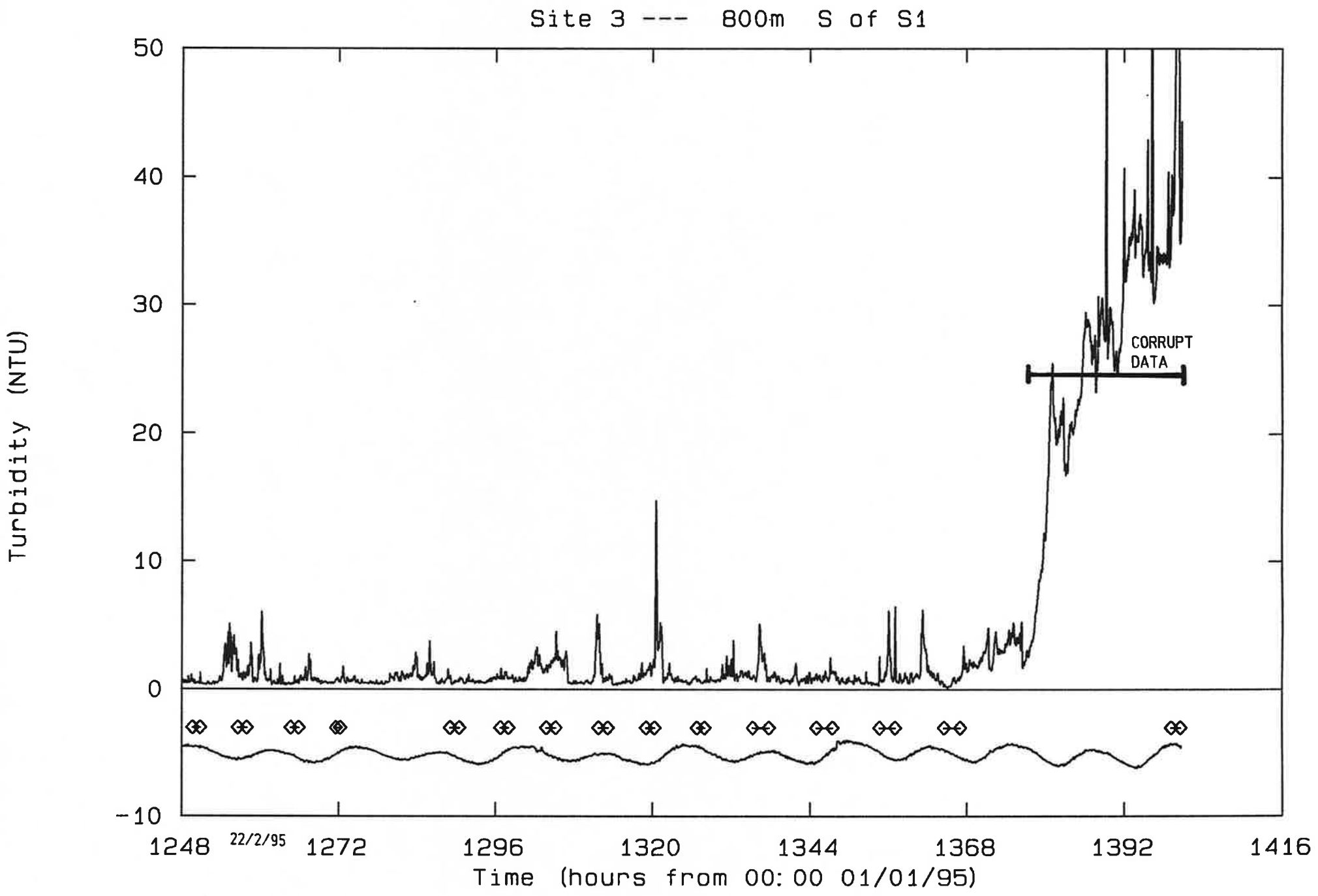
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1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

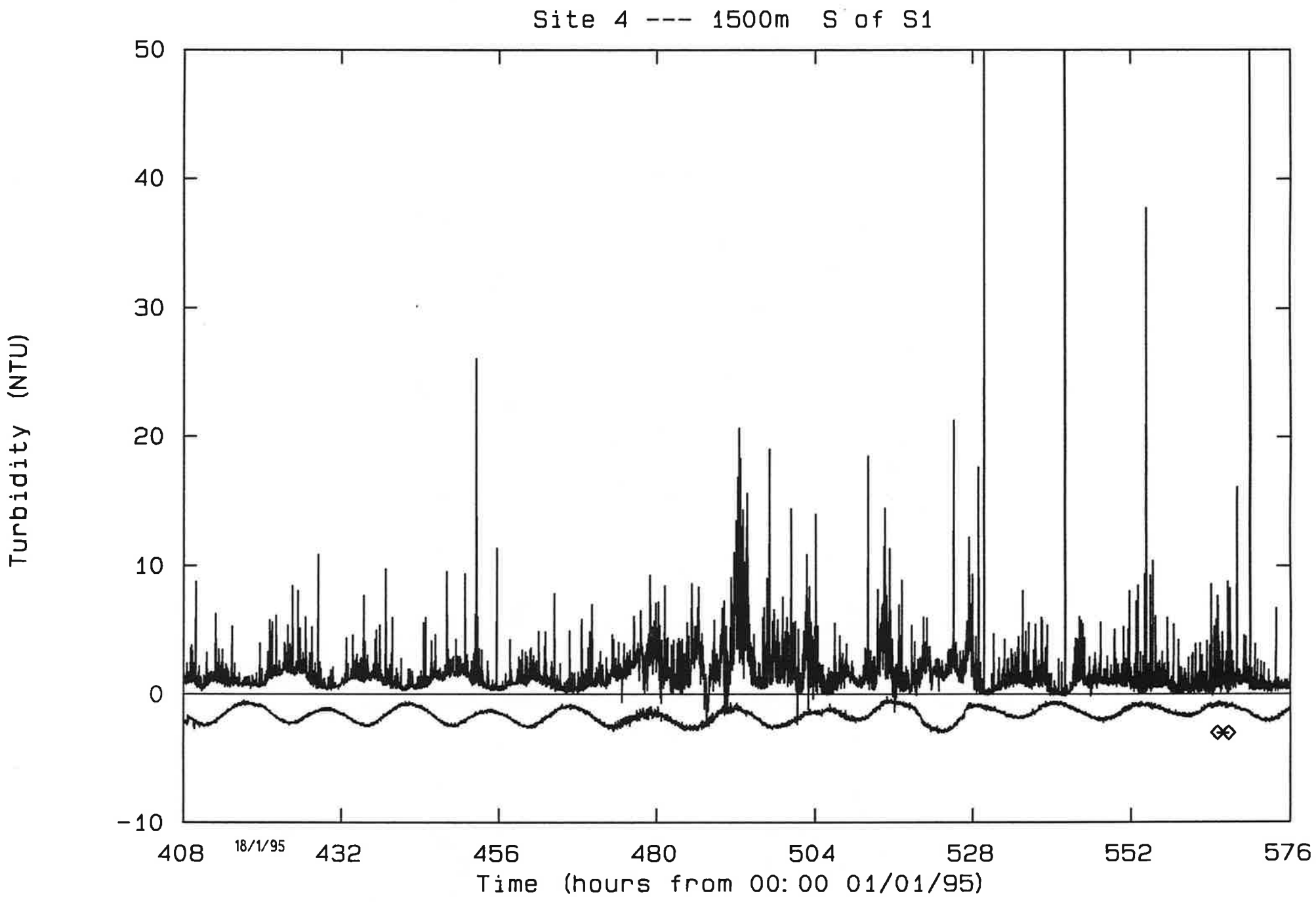
APPENDIX D

Site 4 - 1 500 m S of S1

Instrument : Yeokal SDL (398 hrs - 710 hrs)
Nephelometer 327 (710.5 hrs - 1402 hrs)

Period of Deployment : 398 hrs - 1402 hrs
14:24 17/01/95 - 10:00 28/02/95

Periods of Fouling : 1032 hrs - 1138 hrs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Turbidity (NTU)
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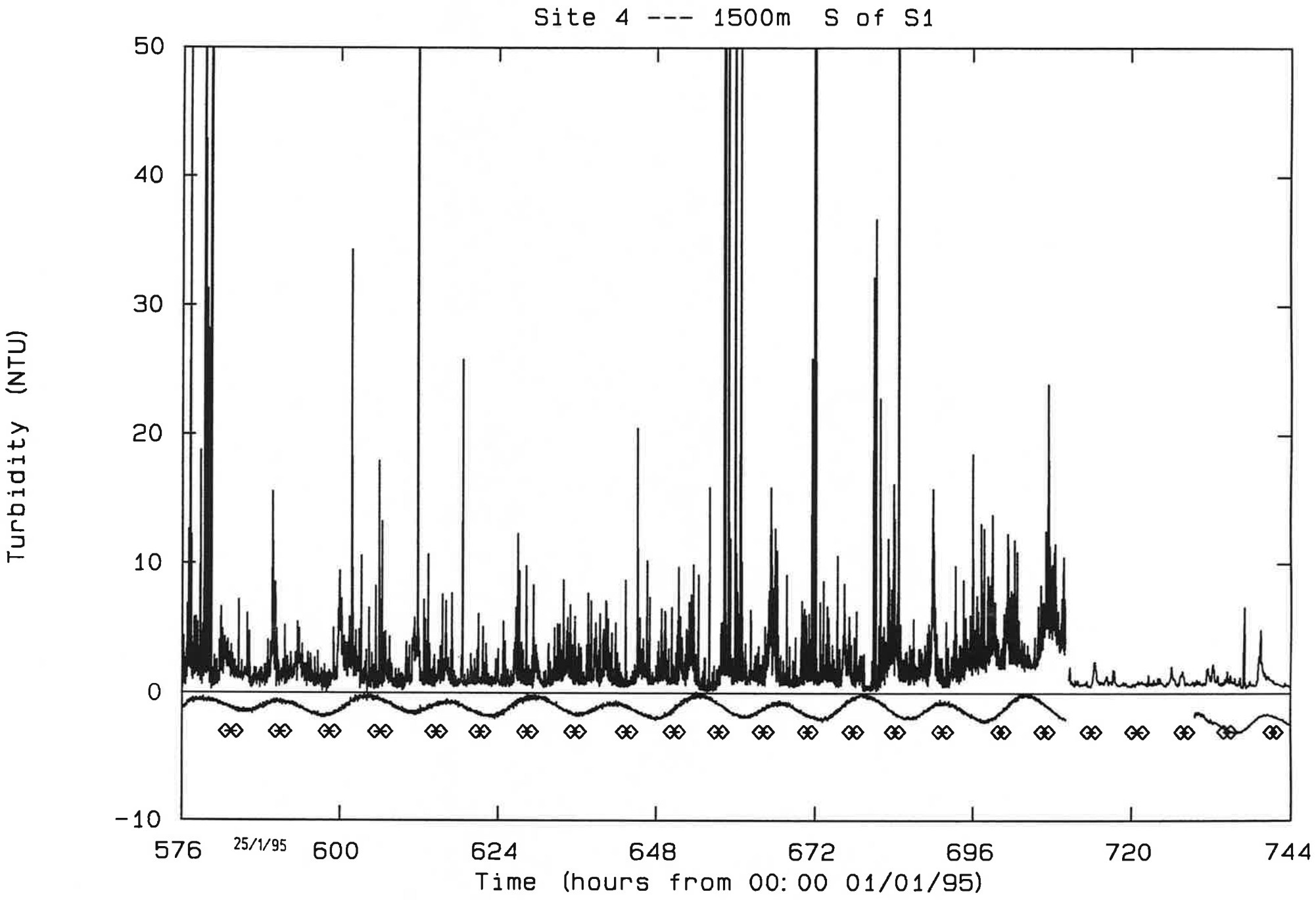
Time (hours from 00:00 01/01/95)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Turbidity (NTU)
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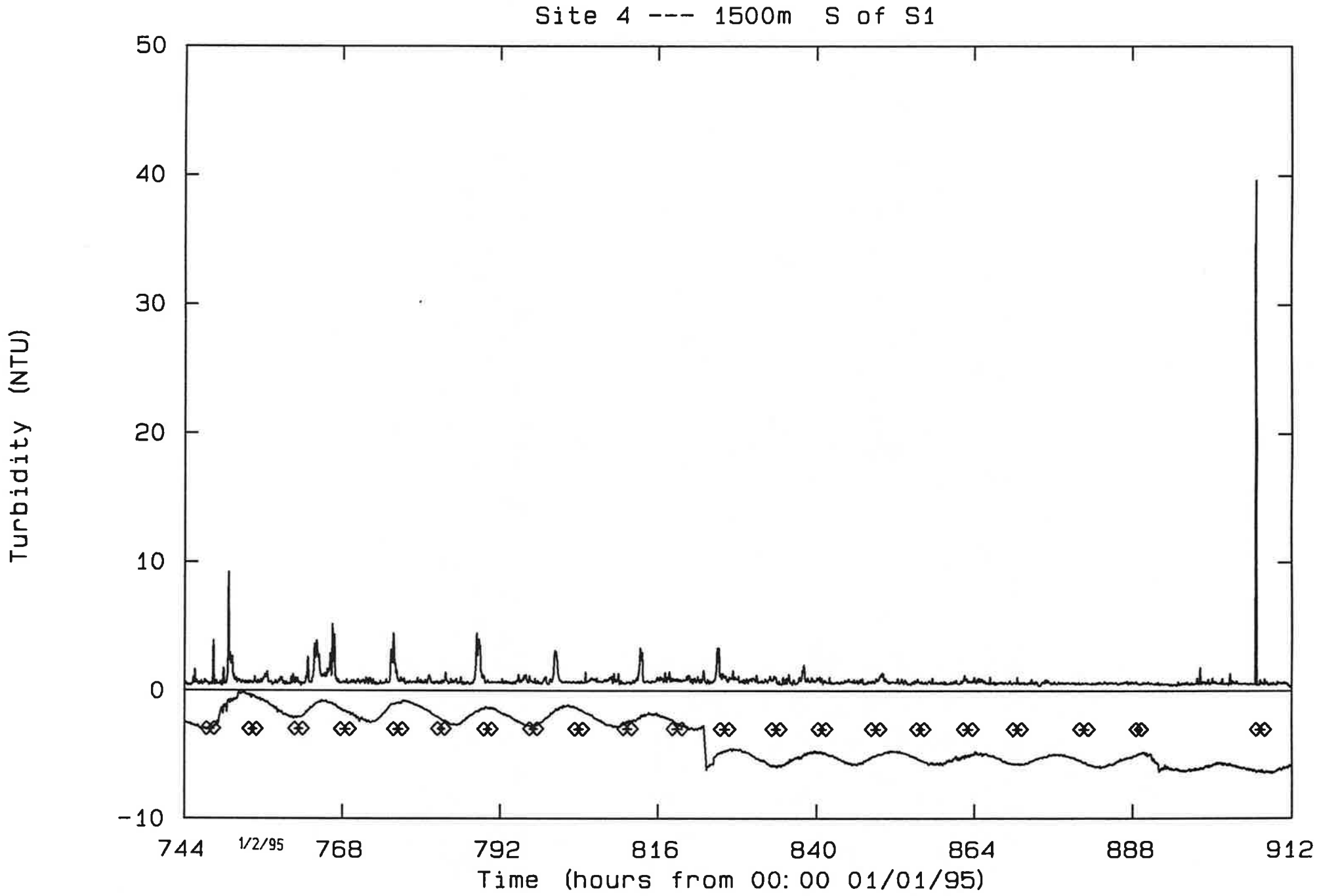
Time (hours from 00:00 01/01/95)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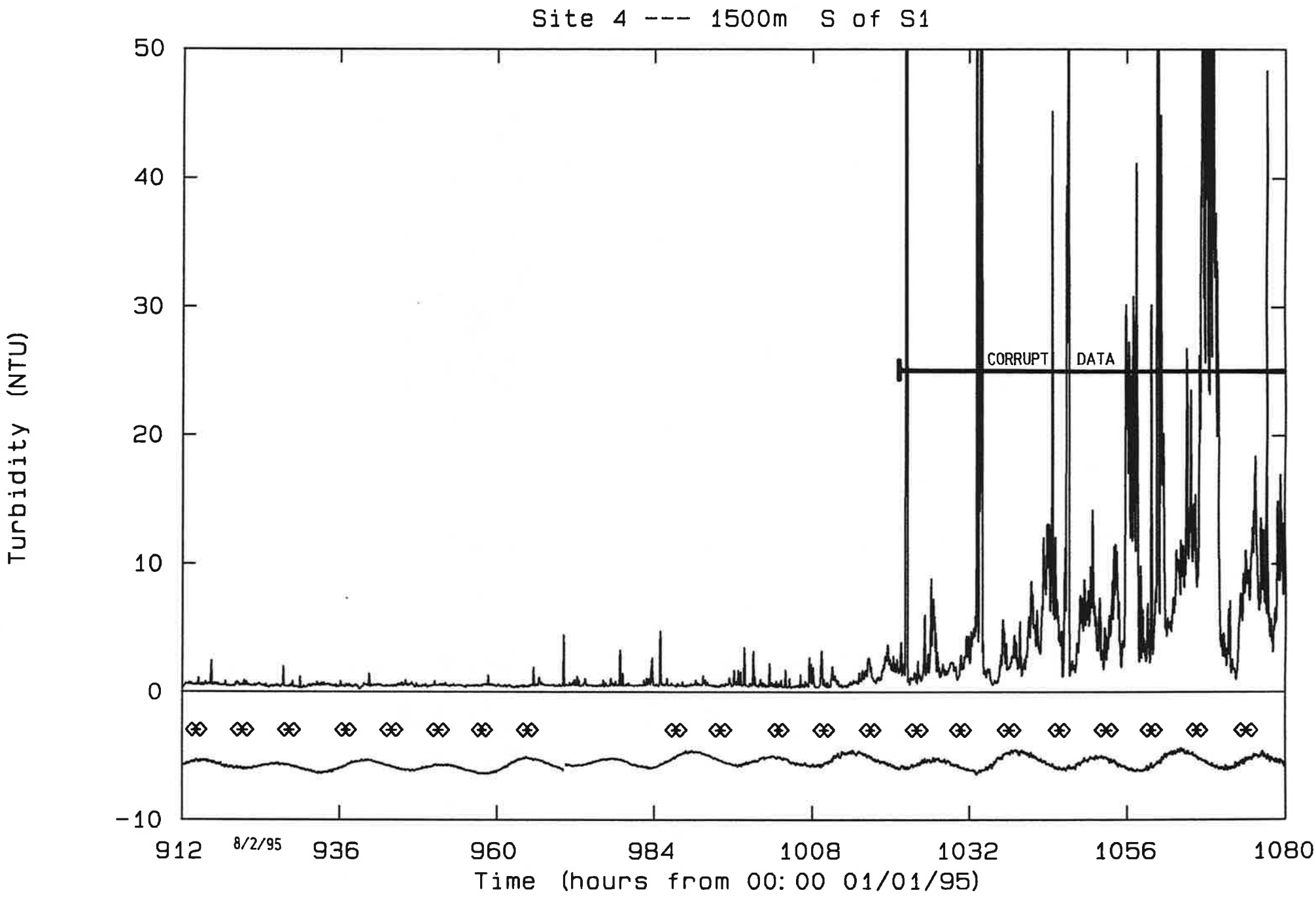
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Turbidity (NTU)
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40
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8/2/95
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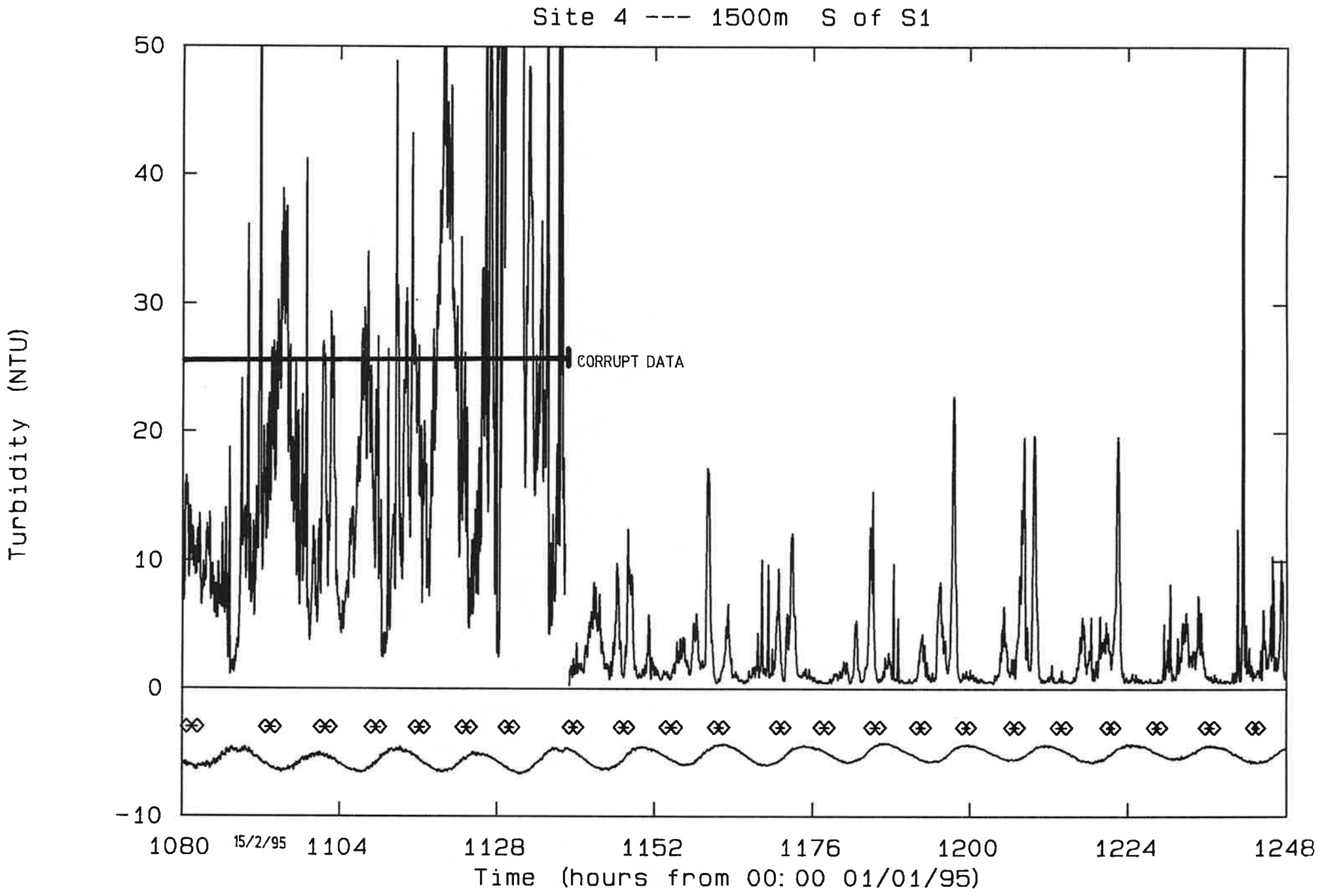
1080
Time (hours from 00:00 01/01/95)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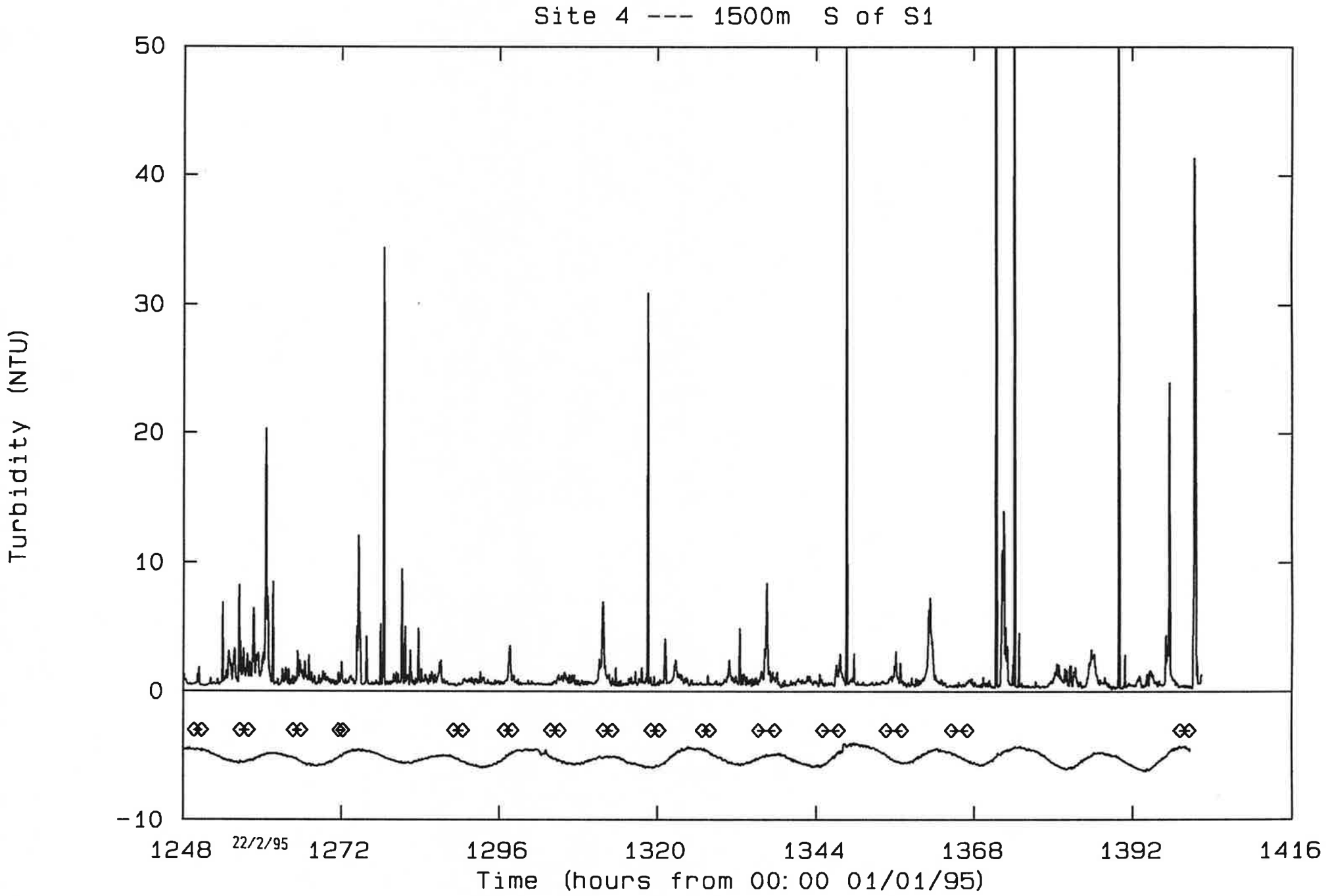
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Turbidity (NTU)
50
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-10
1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

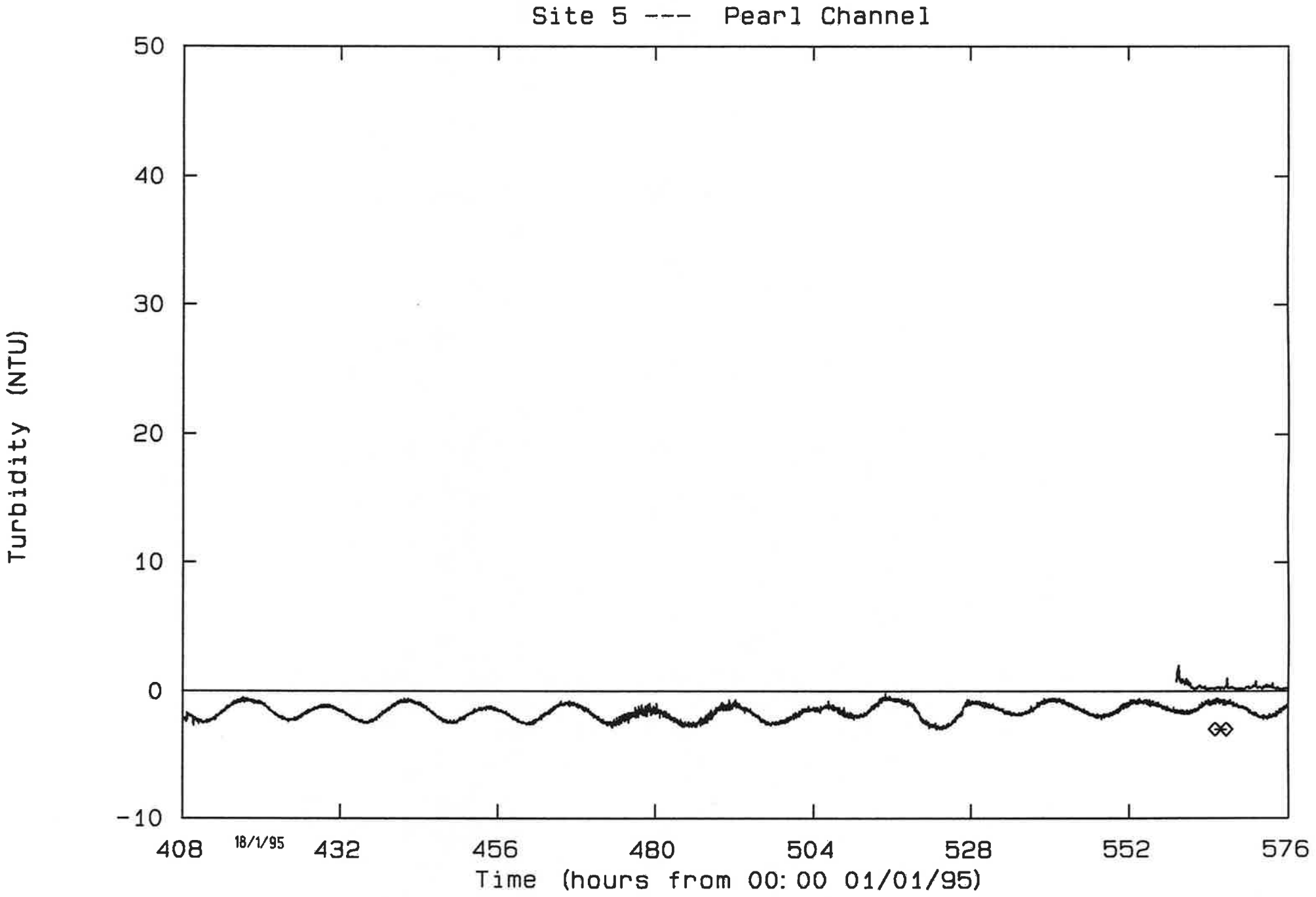
APPENDIX E

Site 5 - Pearl Channel

Instrument : Nephelometer 329

Period of Deployment : 559 hrs - 1 401.5 hrs
07:04 24/01/95 - 09:30 28/02/95

Periods of Fouling : 870 hrs - 1139 hrs
1350 hrs - 1401.5 hrs


Site 5 --- Pearl Channel
Turbidity (NTU)
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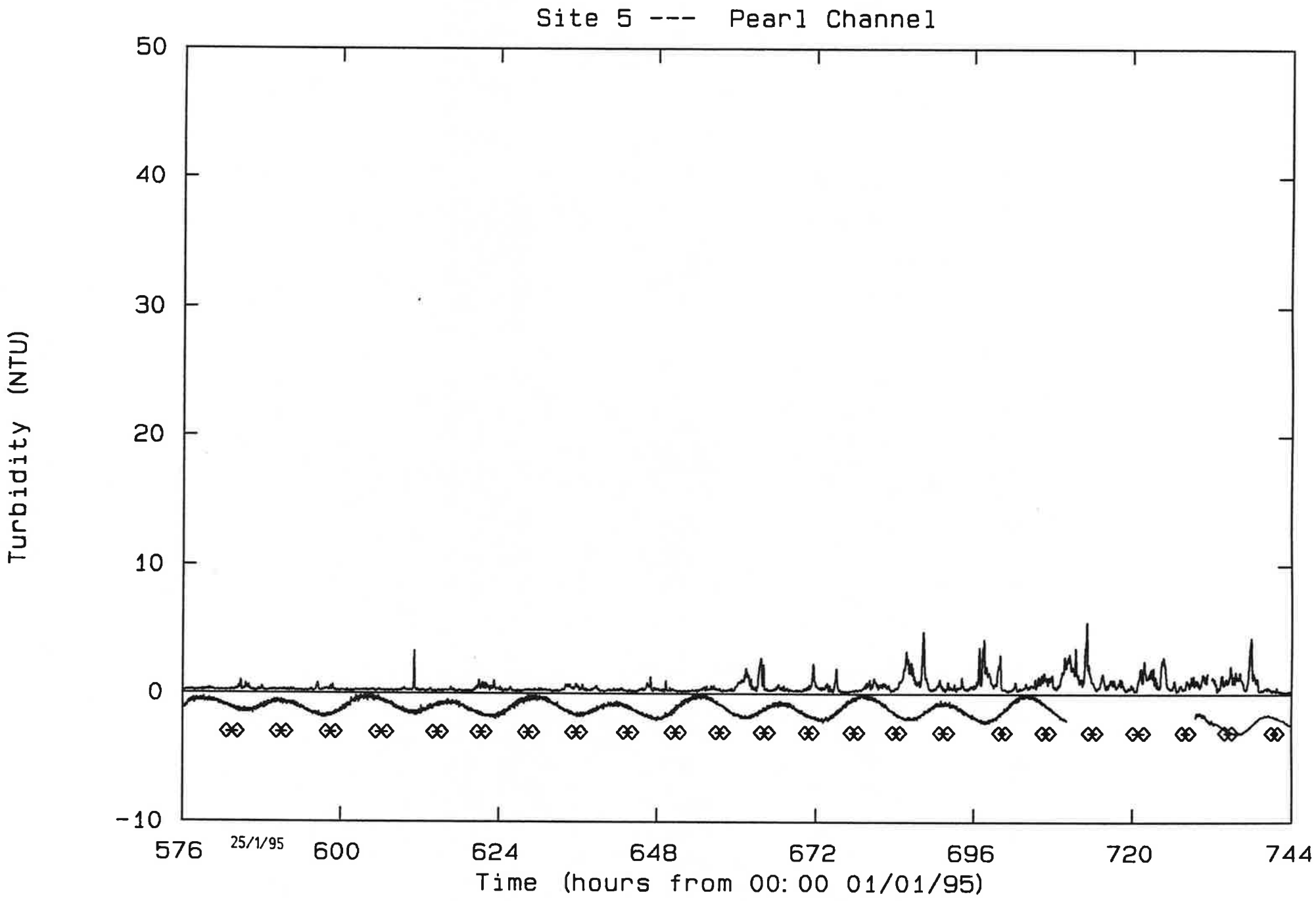
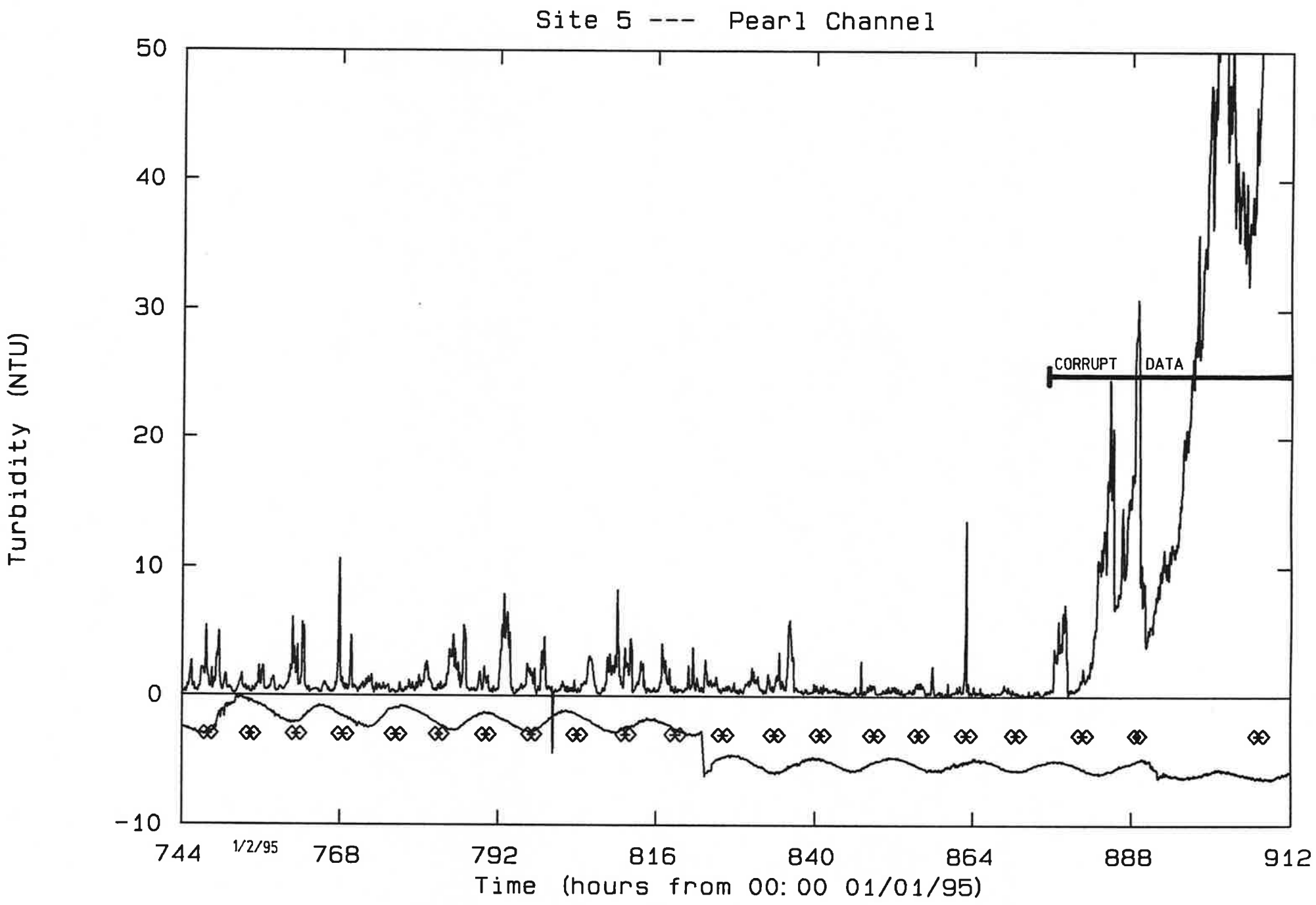
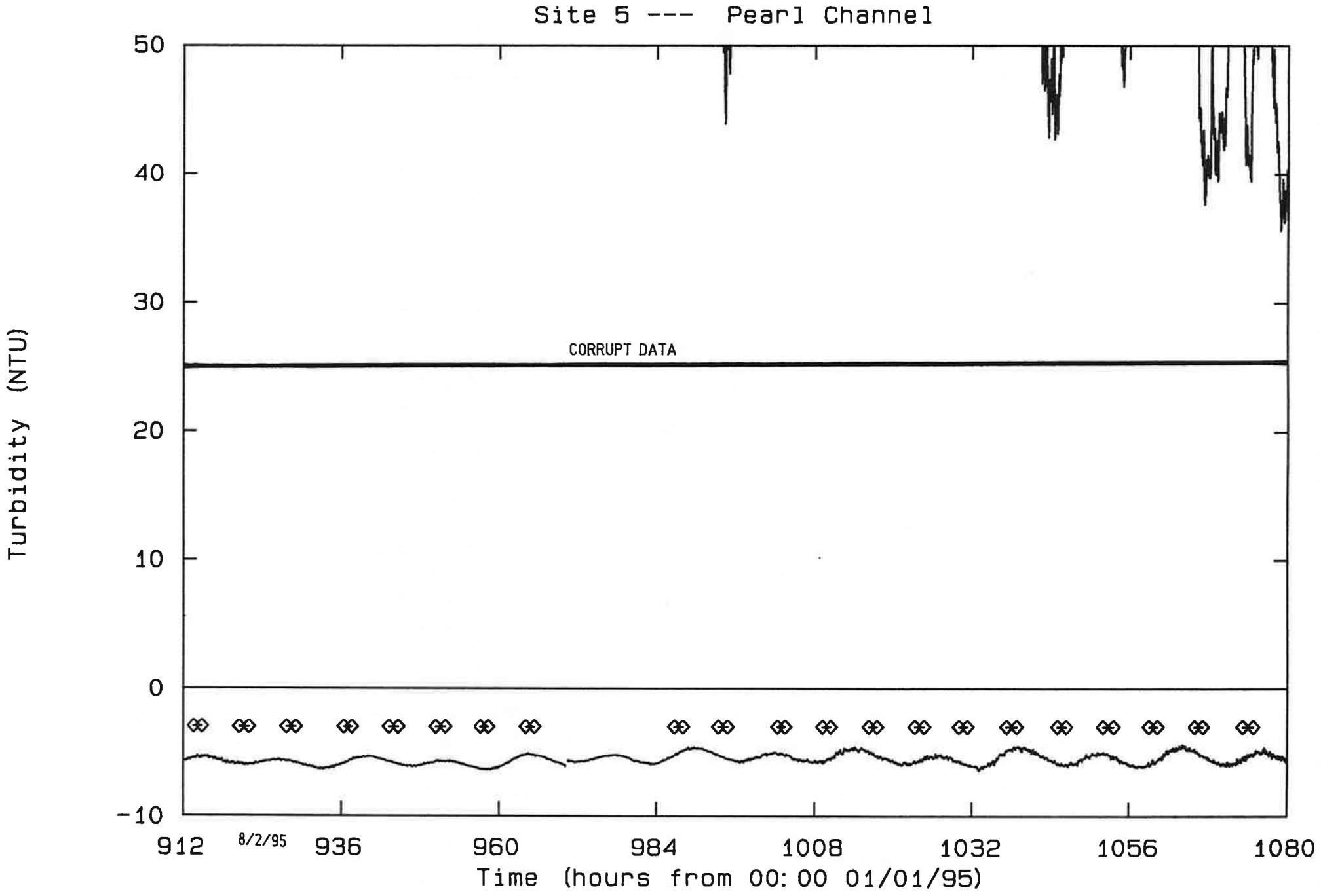
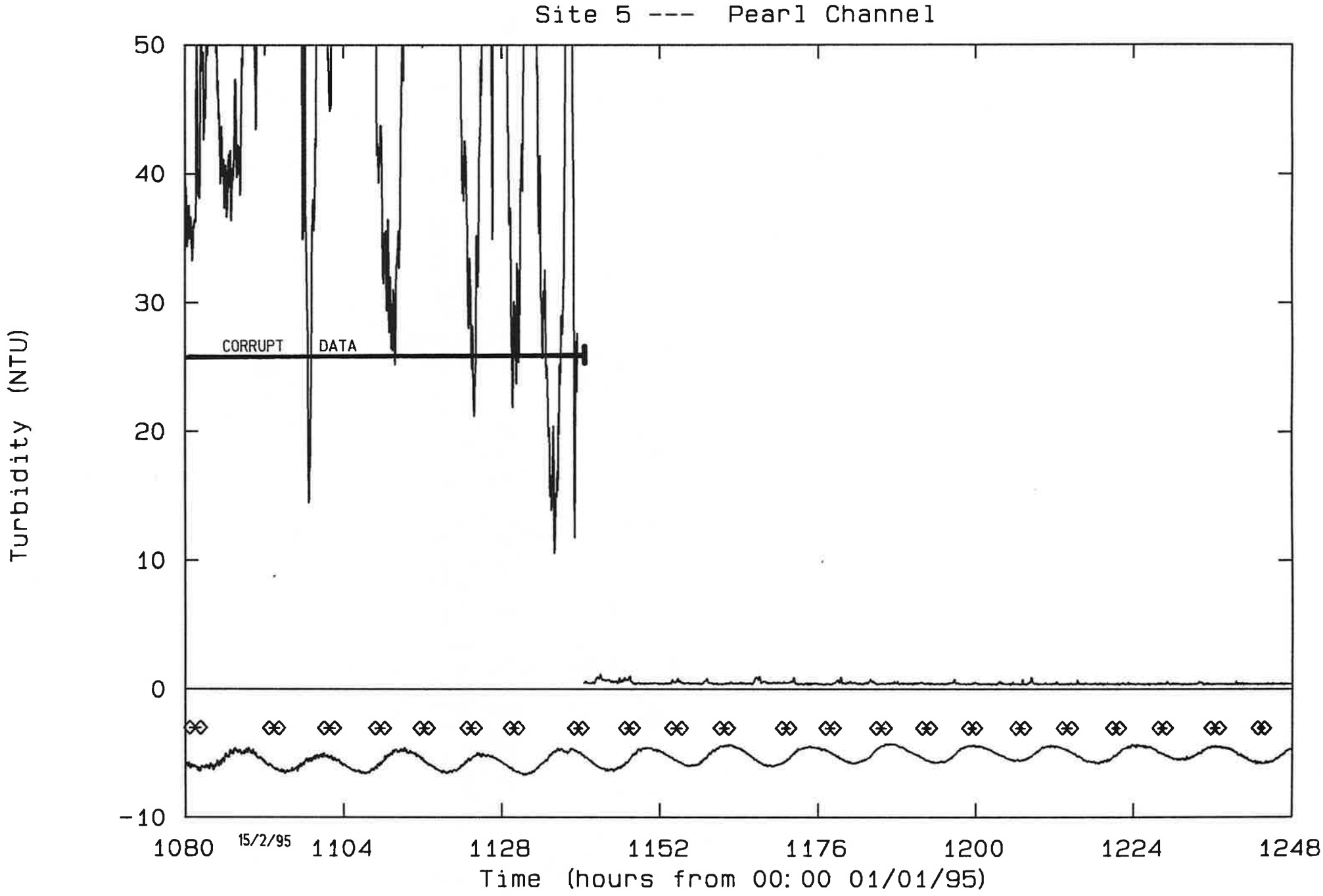
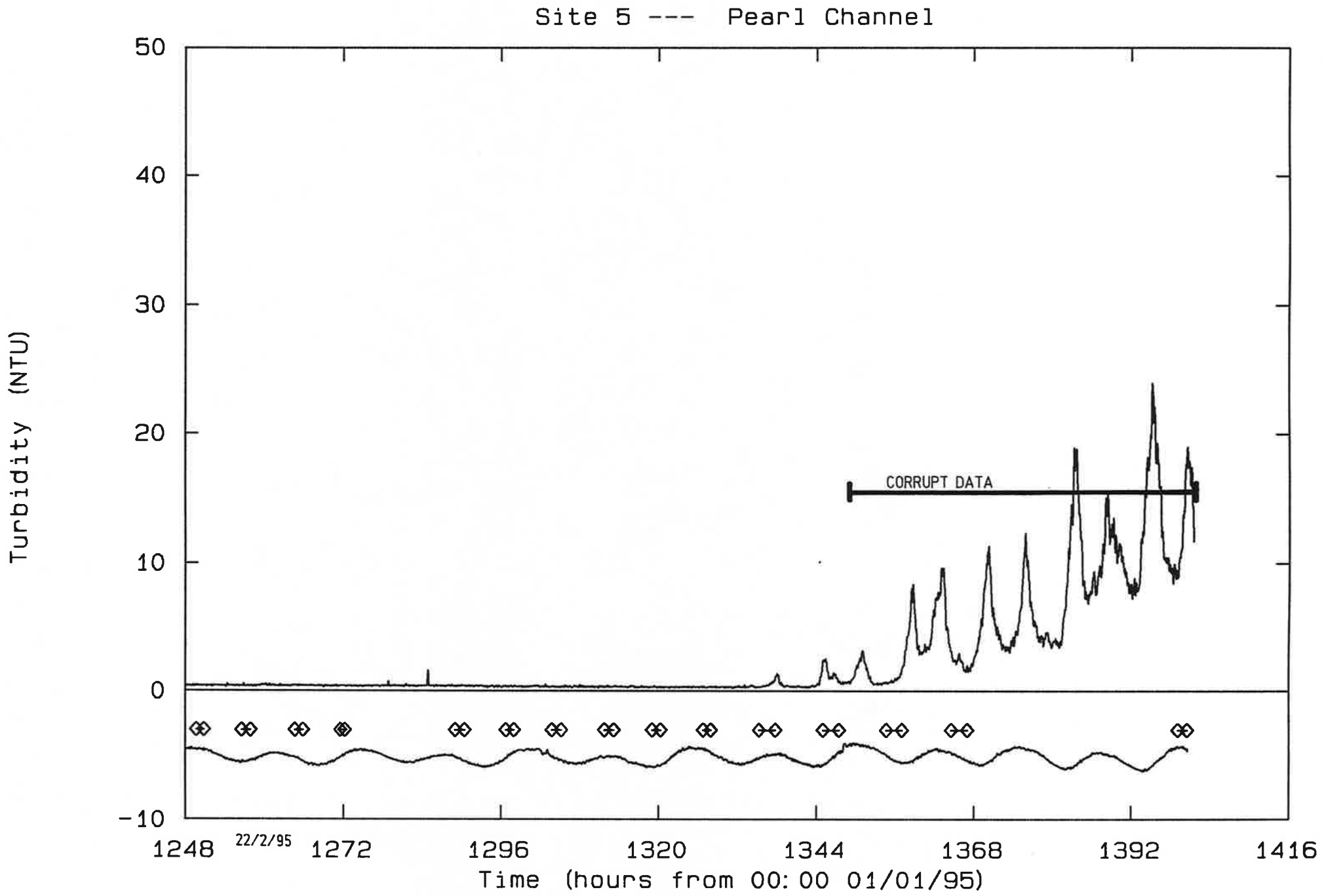
30
20
10
0
-10
408
18/1/95
432
456
480
504
528
552
576
Time (hours from 00:00 01/01/95)


Site 5 --- Pearl Channel
Turbidity (NTU)
50
40
30
20
10
0
-10
576
25/1/95
600
624
648
672
696
720
744
Time (hours from 00:00 01/01/95)


Site 5 --- Pearl Channel
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
744
1/2/95
768
792
816
840
864
888
912
Time (hours from 00:00 01/01/95)


Site 5 --- Pearl Channel
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
912
8/2/95
936
960
984
1008
1032
1056
1080
Time (hours from 00:00 01/01/95)


Site 5 --- Pearl Channel
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
1080
15/2/95
1104
1128
1152
1176
1200
1224
1248
Time (hours from 00:00 01/01/95)


Site 5 --- Pearl Channel
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

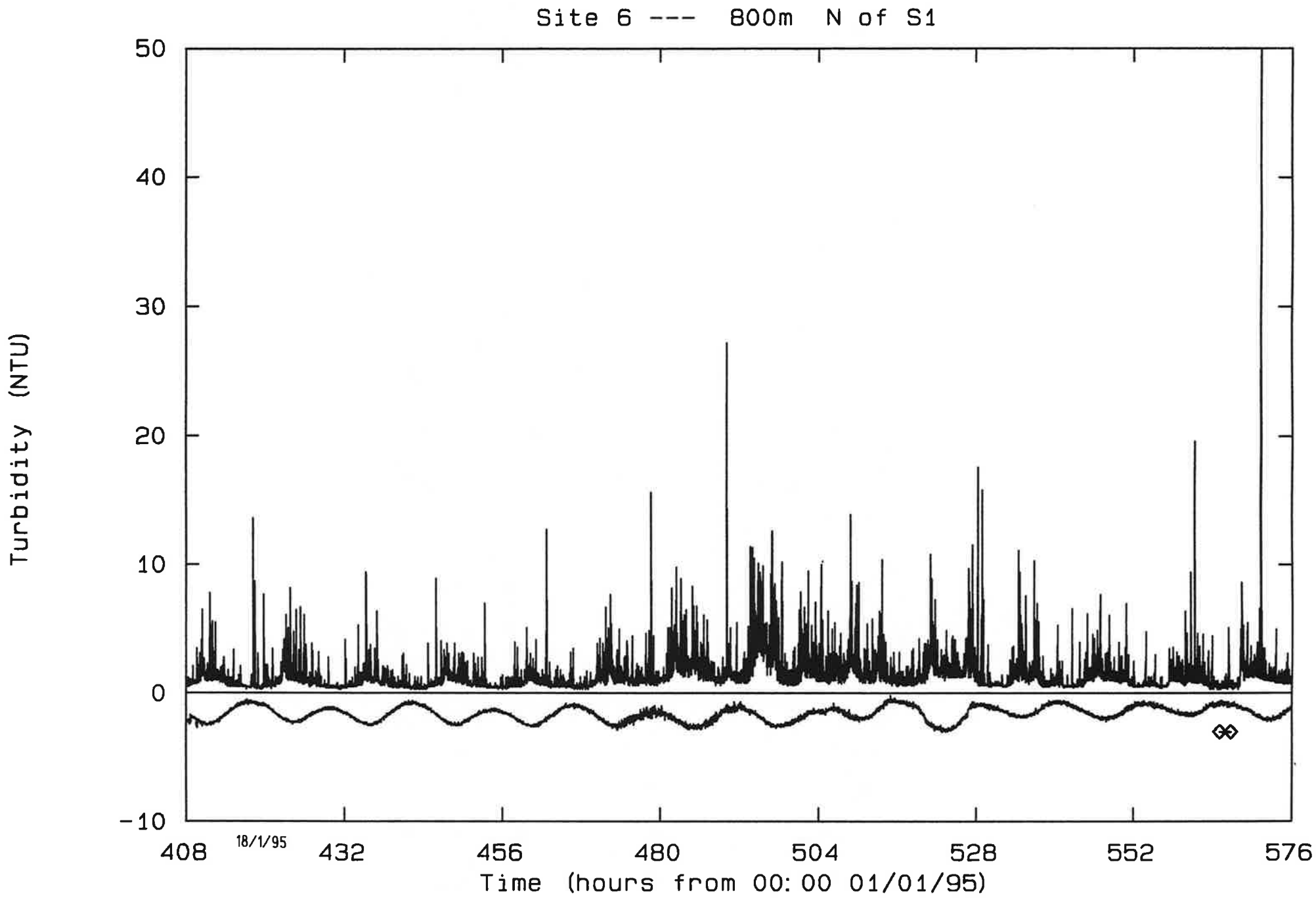
APPENDIX F

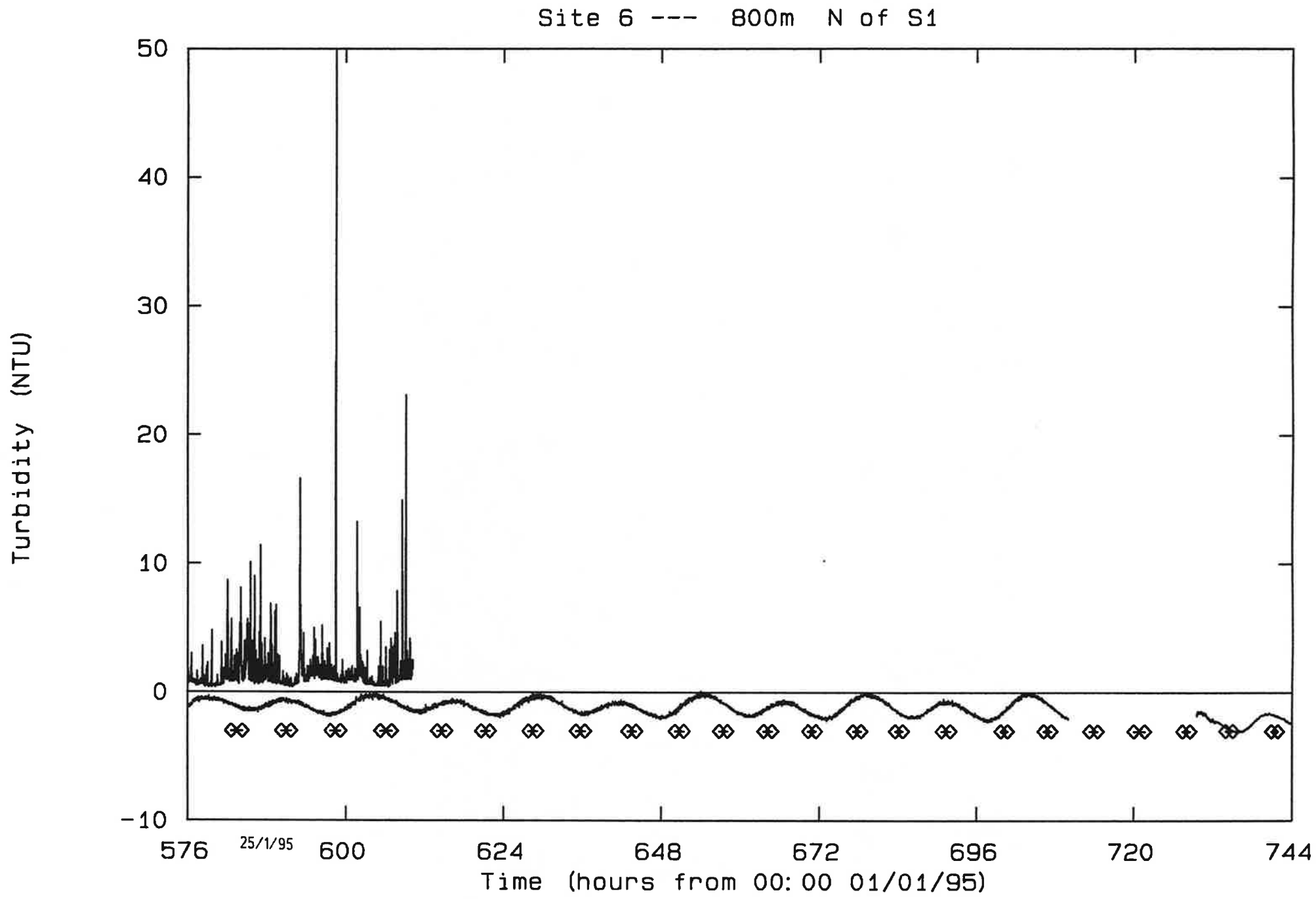
Site 6 - 800 m N of S1

Instrument : Yeokal SDL

Period of Deployment : 397 hrs - 610 hrs
13:00 17/01/95 - 10:00 26/01/95

Periods of Fouling:


Site 6 --- 800m N of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
408
18/1/95
432
456
480
504
528
552
576
Time (hours from 00:00 01/01/95)


Site 6 --- 800m N of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
576
25/1/95
600
624
648
672
696
720
744
Time (hours from 00:00 01/01/95)

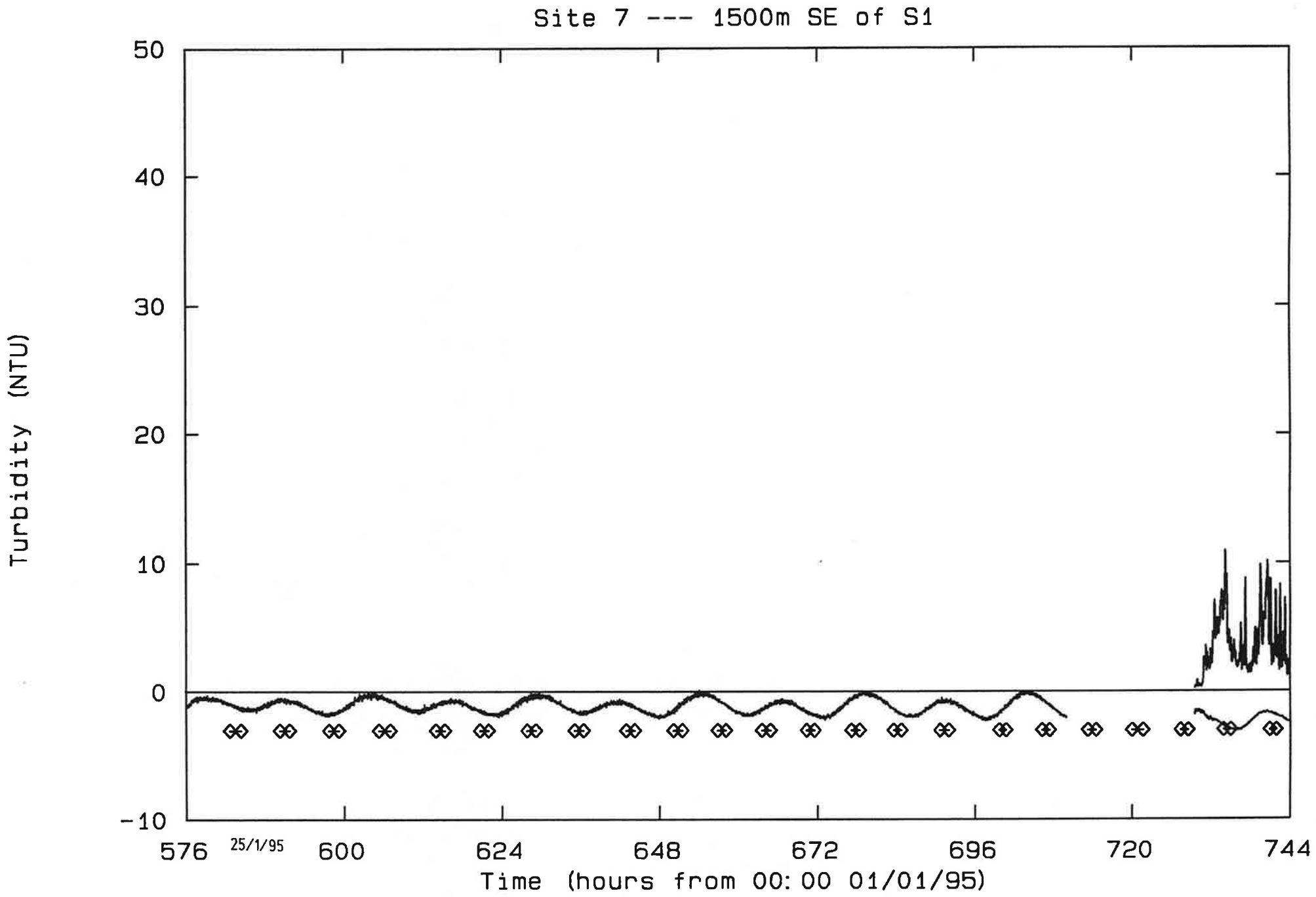
APPENDIX G

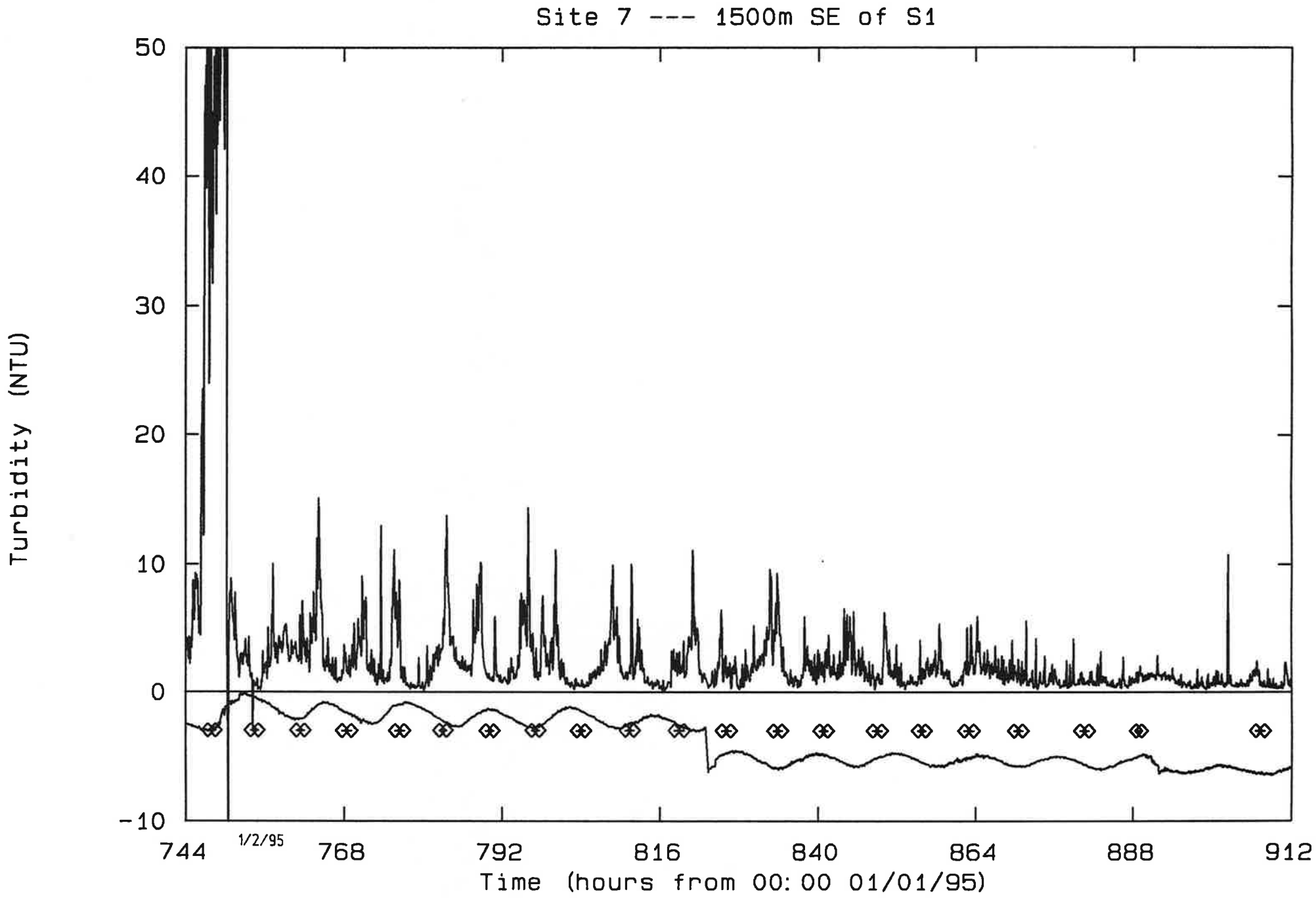
Site 7 - 1 500 m SE of S1

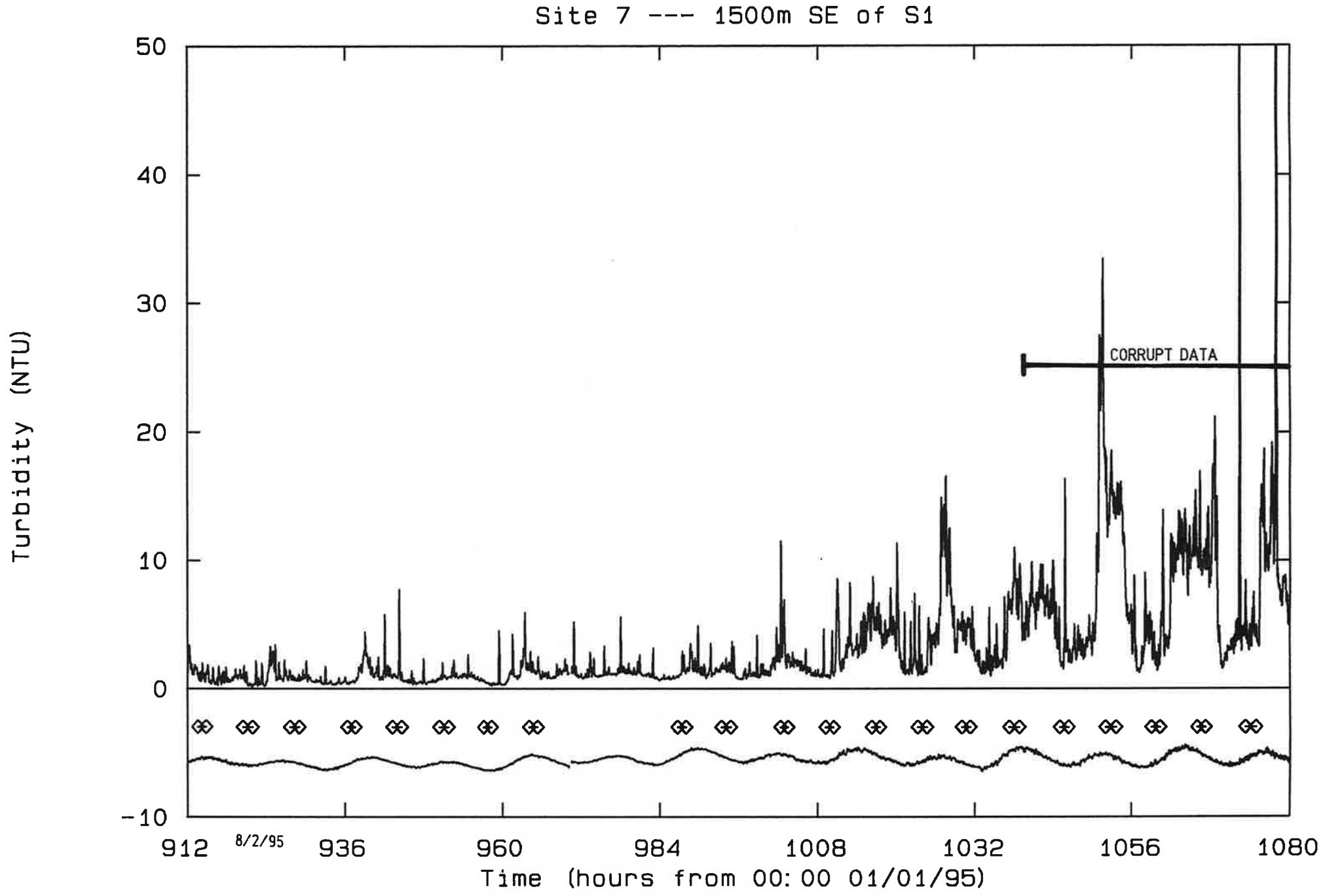
Instrument : Yeokal SDL

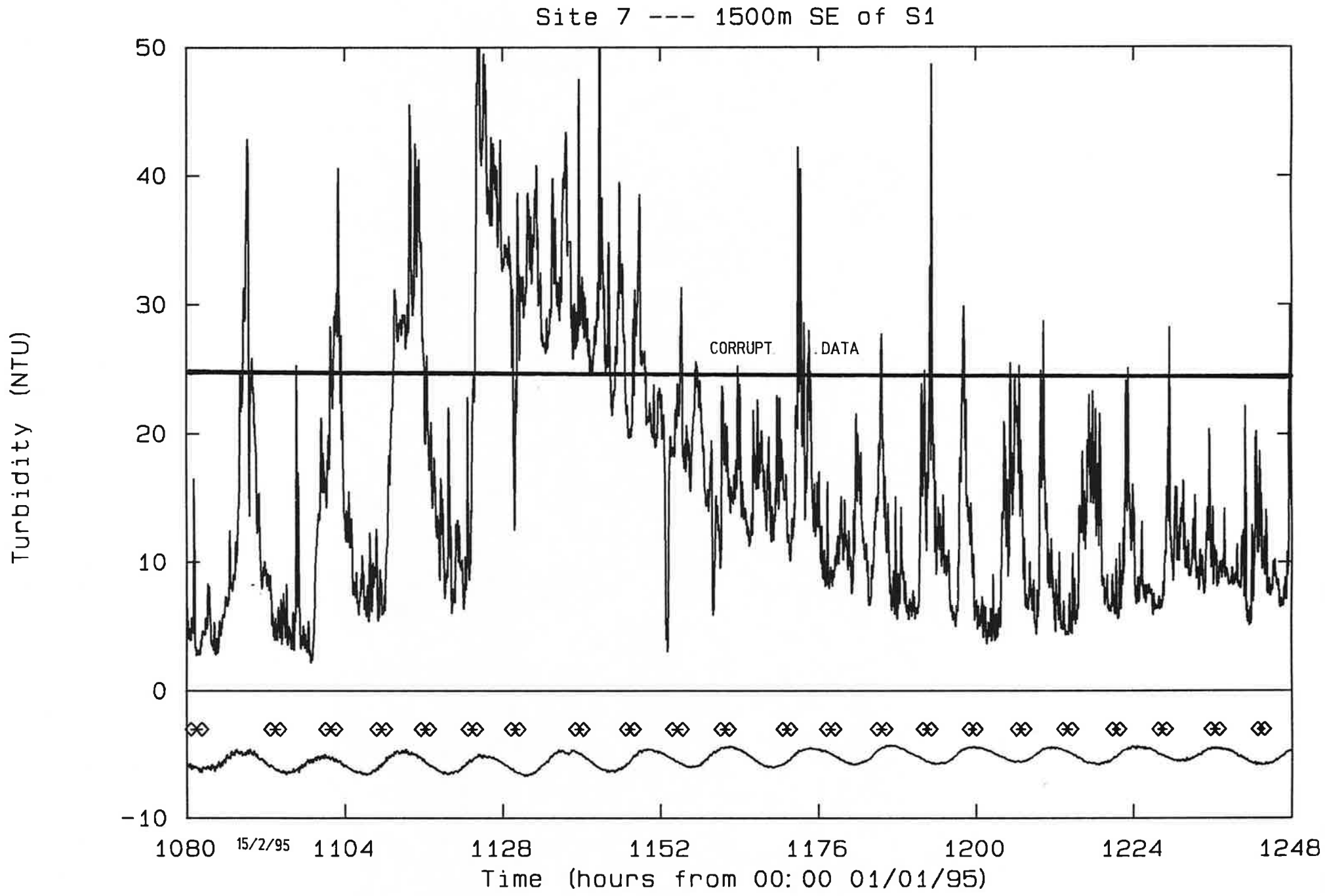
Period of Deployment : 729.5 hrs - 1400.5 hrs
09:30 31/01/95 - 08:30 28/02/95

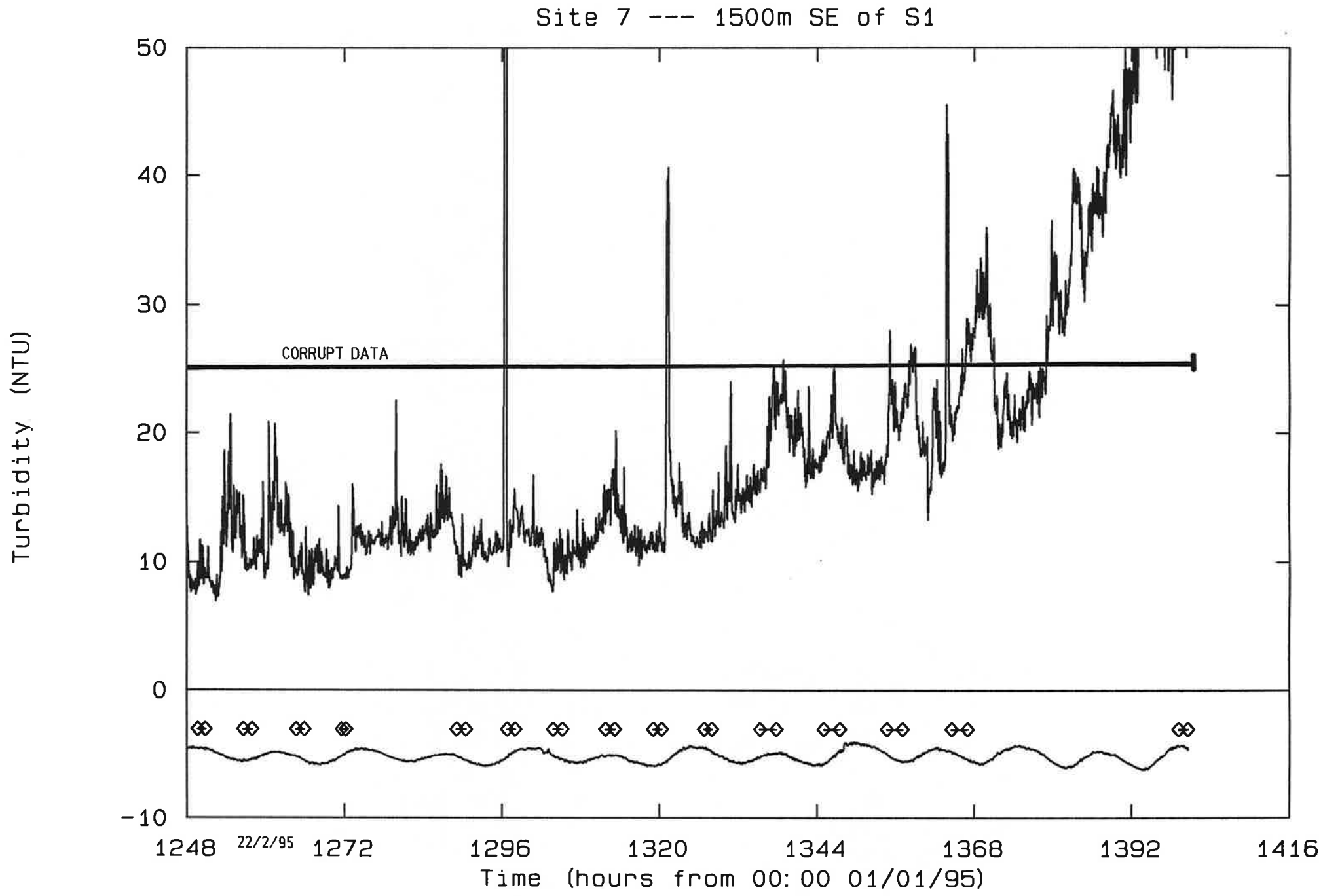
Periods of Fouling : 1040 hrs - 1400 hrs


Site 7 --- 1500m SE of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
576
25/1/95
600
624
648
672
696
720
744
Time (hours from 00:00 01/01/95)


Site 7 --- 1500m SE of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
744
1/2/95
768
792
816
840
864
888
912
Time (hours from 00:00 01/01/95)


Site 7 --- 1500m SE of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
912
8/2/95
936
960
984
1008
1032
1056
1080
Time (hours from 00:00 01/01/95)


Site 7 --- 1500m SE of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
1080
15/2/95
1104
1128
1152
1176
1200
1224
1248
Time (hours from 00:00 01/01/95)


Site 7 --- 1500m SE of S1
Turbidity (NTU)
50
40
30
20
10
0
-10
CORRUPT DATA
1248
22/2/95
1272
1296
1320
1344
1368
1392
1416
Time (hours from 00:00 01/01/95)

APPENDIX H

Slack Tide Turbidity Profiling 24/01/95

- aerial inspection and field notes
- turbidity profiles
- water sample results

SPITFIRE CHANNEL DREDGING - TURBIDITY MONITORING

Notes from Aerial Inspection and Turbidity Profiling 24/1/95

- An aerial inspection, coordinated with mobile turbidity measurements, of the first dredging pass was carried out on 24/1/95. The turbidity profiling log is attached together with plots of the turbidity profiles (Figure H.1) and the results of water sample analyses (Table H.1).

- The aerial inspection commenced on-site at approximately 1215 hrs with the dredge stationary in the channel to the southeast.

- Prior to dredging, a natural plume was observed on the western side of the bay and extending across the western end of Spitfire Channel. To the east of this, water was clear. In the shallower inshore (western) waters of the bay, high turbidities were observed.

- The northern turbidity meters were in the clear zone (0.0 NTU) while the southern meters were on the edge of the natural 'turbid' zone (0.3 to 0.9 NTU).

- Dredging operations commenced around 1230 hrs at the end of the flood tide with the dredge travelling east to west on the northern side of the channel.

- Initial dredging of the eastern end did not generate any visible plume (0.2 to 1.2 NTU).

- Once dredging commenced in the centre (on the western side of the deep section) only a slight plume was evident (2.2 to 4.4 NTU in the bottom half of the water column). The hoppers were not overflowing at this time.

- The dredge passed the yellow S1 beacon at approximately 1315 hrs. Soon after as it approached the interface with the natural turbid zone, hopper overflow became evident in the form of a more visible plume extending out from the sides of the vessels and trailing behind (6.5 to 12.0 NTU mixed throughout the water column at 1333 hrs).

- Dredging continued to the western end of the channel with a visible plume. The plume drifted slowly southeast with the slight flood current and slowly dispersed.

- The dredge turned at about 1340 hrs at which time the yellow S1 beacon was in about the centre of the plume. The plume was about 150 m to 200 m wide.

- The first plume from the east-west pass continued to drift slowly southeast and become less visible (7.4 and 8.5 NTU at 1349 hrs). At this time the northern edge of the plume was near the S1 beacon.

- On its return west-east run, the dredge again passed along the northern side of the channel generating a second plume. The plume did not move very far as it was essentially slack water.

- The first plume had passed the yellow S1 beacon and effectively stopped. Its southern extremity was about 400 m south of the channel and did not reach the first southern turbidity meter (@ 500 m south). Intensity continued to drop towards the natural background (4.0 to 5.7 NTU at 1411 hrs).

- At about 1411 hrs the dredge turned again some 600 m east of the S1 beacon and travelled west again virtually over the top of the previous pass and plume. This generated a more visible plume (15.0 to 21.8 NTU at 1426 hrs).

- As the tide was slack there was essentially no movement of the plumes although intensities appeared to reduce with time.

- At 1420 hrs the dredge turned again just west of the S1 beacon and dredged for a few hundred meters before pulling up the heads and steaming for port at approximately 1445 hrs.

- There were no visible plumes behind the fully laden dredge as she steamed away.

- The plumes were observed from the air for about another 20 minutes with only slight movement now towards the northwest with the beginning of the ebb tide.

- The initial plume, although still identifiable from the air, had markedly reduced in intensity towards background conditions (0.2 to 1.5 NTU at 1440 hrs). The drogue tracking this plume had moved about 1 km to the south-east over the 1 hour to this time.

- The plume from the later passes was still quite visible when the aerial inspection was terminated at approximately 1505 hrs (5.7 to 8.3 NTU).

- Turbidity profiling from the boat continued for about another 1.5 hrs. The later plume moved towards the north west (as tracked by drogue) and reduced in intensity (0.0 to 6.0 NTU at 1537 hrs; 0.0 to 3.6 NTU at 1600 hrs). The distance moved in the 1 hour to 1600 hours was about 750 m. Turbidity profiles were also taken adjacent to the bottom-mounted turbidity meters.

SPITFIRE CHANNEL DREDGING - TURBIDITY PROFILING LOG 24/01/95

ABC WRY JBD

0430 Start

0600 approx - Depart Bribie Island

0705 Deploy Neph 329 in Pearl Channel
27 07.314 S 153 16.496 E (Site 5)
Bribie Island Water Tower Bearing 300

0811 Site 1 (North neph on north side of channel)

profile	2	0
	4	0
	6	0.4
	8	0.5
	10	1.1
wind	15kt S	
sea	1m	
swell	1m	

0825 Site 2 (South neph on north side of channel)

profile	2	0
	4	0
	6	1.1
	8	0.8
	10	4.5
	11	tot

0837 Site 3 (Neph on South side of channel)

profile	2	0.4
	4	0.5
	6	0.8
	8	0.6
	10	0.7
	12	0.9
	12.5	tot
wind	15kt S	
sea	1m	
swell	1m	

0846 Site 4 (Yeokal on south side of channel)

profile	2	1.0
	4	0.7
	6	0.6
	8	0.6
	10	0.7
	12	1.1

Dredge not on site until 1130 approx
instructed to hold station until dredge arrives

1123 water sample 1A at 9m at yeokal on south side (site 4)

1130 Site 4

profile	2	0.0
	4	0.3
	6	0.4
	8	0.5
	10	0.6
	12	0.9

wind 10-15kt SSE
sea 0.7
swell 1m
flood tide

1138 Site 3

profile	2	0.2
	4	0.3
	6	0.3
	8	0.4
	10	0.4
	12	0.8

1150 Site 2
water sample 1B at 9m

profile	2	0.0
	4	0.0
	6	0.0
	8	0.0
	10	0.0

1157 Site 1

profile 2 0.0
4 0.0
6 0.0
8 0.0
10 0.0

1210 Centre channel opposite yellow beacon S1

27 02.605 S 153 16.218 E

profile 2 0.0
4 0.2
6 0.0
8 0.0
10 0.0
12 0.0
14 0.2
15.2 tot

Dredge coming on site on eastern end of spitfire channel

Proceeding to rendezvous at eastern end of spitfire

Dredge holding station in preparation ????

1230 Dredge moving into spitfire channel

1240 Port gear down

1250 Starboard gear down

profile in entrance to spitfire channel at start of dredge run

27 03.241 S 153 17.716 E

profile 2 0.2
4 0.3
6 0.3
8 0.3
10 0.3
12 0.6
14 1.2
15 0.9
16 0.6
17 0.8
18 0.4

sea 0.7m

swell 1.0m

wind 10 kt SE

1315 dredging fully under way
large standing waves in dredge wake
noticing lots of material stirred up by dredge propellers ??
profile in plug produced by propellers ??
27 02.880 S 153 16.528 E

profile	2	0.0
	4	0.0
	6	0.0
	8	2.2
	10	2.3
	12	3.0
	14	4.1
	15	4.4
	16	3.7

notice pieces of poly float/packing material in plume/wake (source???)

1333 deploy drogue in dredge plume
27 02.741 S 153 16.015 E

profile	2	8.8
	4	6.5
	6	6.7
	8	7.2
	10	7.1
	12	12.0
	14	8.7
	15	9.2

sea 0.5m
swell 1.0m
wind 10-15 kt SE

1341 drogue location
27 02.484 S 153 16.131 E
water samples collected (D1) (at 3,6,9m)

1349 drogue location
27 02.876 S 153 16.184 E

profile	2	7.7
	4	8.5
	6	7.4
	8	7.7
	10	7.8
	12	7.8

1358 drogue location
27 02.940 S 153 16.288 E

1406 profile 2 3.8
4 2.2
6 1.7
8 1.7
10 1.6
12 1.2
drifted out of main plume
dredge on third pass in a westerly direction

1411 drogue location
27 03.026 S 153 16.393 E
profile 2 4.0
4 4.1
6 4.7
8 4.8
10 5.4
12 5.7
13.3 5.7
water samples collected (D2) (at 3,6,9m)

1426 plume created by third pass of dredge
27 02.875 S 153 16.567 E
profile 2 17.4
4 18.3
6 17.8
8 21.8
10 18.3
12 19.2
14 21.1
15 17.7
16 15.0
water samples collected (S1) (at 3,6,9m)

1440 drogue location
27 03.073 S 153 16.616 E
profile 2 1.3
4 1.5
6 0.9
8 0.4
10 0.2
12 0.2
14 0.2
16 0.4

1444 dredge discontinues work
hauls up gear
approximate location 1km east of yellow beacon (S1)
ETA berth at fishermans 1715
ETD from fishermans 1915

1450 drogue location
27 03.024 S 153 16.700 E
drogue out, moved to ...

1453 drogue location
27 02.953 S 153 16.675 E
profile 2 10
4 6.8
6 6.7
8 6.6
10 6.5
12 6.5
14 7.8
16 9.1
17 8.6
drogue out, moved to ...

1507 drogue location

27 02.753 S 153 16.147 E

profile 2	5.7
4	7.2
6	7.7
8	8.2
10	8.3
12	7.8
14	6.6
16	7.8

water samples collected (D3) (3,6,9m)

1537 drogue location

27 02.523 S 153 16.211 E

profile 2	0.0
4	0.0
6	6.0
8	5.8
10	5.9
12	5.8
14	5.0

1600 drogue location

27 02.342 S 153 16.214 E

profile 2	0.0
4	3.6
6	3.3
8	3.0
10	2.2
12	0.8

1627 Site 1

profile 2	5.8
4	5.7
6	6.1
8	6.2

1638 Site 2

profile 2 1.0
4 1.0
6 0.9
8 1.2
10 1.8

sea 2m

swell -

wind 15-20 kt ESE

Head back to Bribie Island

1745 arrive at bribie

clean up

depart for stafford

1930 Finish

Turbidity Profiles
Plumes Tracked 24/01/95

FIGURE

H. 1

WBM OCEANICS AUSTRALIA

TABLE H.1

Water Sample Results 24/01/95

Time (hrs)	Location	Description	Depth (m)	Turbidity (NTU)	Suspended Solids (mg/L)
1123	Site 4	Background	9	0.5	<1.
1150	Site 2	Background	9	0.1	<1.
1341	D1	1st Plume	3 6 9	3.0 1.3 3.2	4 5 7
1411	D2	2nd Plume	3 6 9	2.7 1.1 0.9	5 2 3
1426	S1	2nd Plume	3 6 9	7.4 0.8 0.9	12 6 2
1507	D3	2nd Plume	3 6 9	2.5 4.3 5.6	5 8 8

APPENDIX I

Ebb Tide Turbidity Profiling 30/01/95

- aerial inspection and field notes
- turbidity profiles
- water sample results

SPITFIRE CHANNEL DREDGING - TURBIDITY MONITORING

Notes from Aerial Inspection and Turbidity Profiling 30/1/95

- An aerial inspection, coordinated with mobile turbidity measurements, was carried out on 30/1/95 during a dredging pass which coincided with the peak ebb flow of a large spring tide. The turbidity profiling log is attached, together with plots of the turbidity profiles (Figure I.1) and the results of water sample analyses (Table I.1).

- The aerial inspection commenced on-site at approximately 1100 hrs with the dredge having completed an east-west pass of the western end of the channel and was then passing the NW12 beacon on a return west-east pass. At this stage a visible plume from the east-west pass was evident moving quickly to the north across Spitfire Banks and the dredge was generating a second plume on its return pass.

- At 1116 hrs the first plume was over the northern most nephelometer. Background turbidities to the north of this were around 3 to 4 NTU. General background conditions observed showed widespread 'boils' of sediment in suspension generating a mottled appearance. This was presumably being generated by the high currents. The occurrence and intensity of these were greater towards the western end of the channel (2 to 3 NTU near surface and 4 to 5 NTU near bed).

- At 1125 hrs a drogue was released behind the dredge in the second plume as she approached the S1 beacon on the west-east pass. Turbidity profiles indicated 8 to 14 NTU throughout the water column and 21 NTU near the bed.

- The plumes continued to travel quickly to the northwest with the strong ebb current and reduce in intensity. At 1130 hrs the edge of the second plume was reaching the first nephelometer to the north Site 2). The dredge completed dredging and headed for Port.

- A larger ship passed through the channel generating a visible plume, although not as intensive as the dredges.

- The plumes continued to move northwest and visibly reduce in intensity. At 1143 hrs the turbidities in the second plume had reduced to 5 to 7 NTU.

- At 1150 hrs the edge of the second plume was approaching the northern most nephelometer Site 1). Background conditions adjacent to the plume were 1 to 2 NTU while in the plume turbidities were 2 to 5 NTU.

- The plume passed over the northwestern edge of the Spitfire Banks and into the deeper water. The plume itself while still visible, markedly reduced in intensity towards the background 'mottled' conditions.

- At 1202 hrs turbidity levels of 4 to 6 NTU were measured in the second plume in the deeper water to the north. The northern most nephelometer Site 1) was still in the tail of the plume.

- By 1225 hrs the second plume was in a zone of high background turbidity (mottled) and through still visible, appeared to be less intense than the background conditions. The first plume was also still visible but markedly dispersed in clearer water further to the east.

- The aerial inspection was terminated at about 1240 hrs. Turbidity profiling of the second plume as tracked by drogue continued until 1340 hrs with levels typically being in the range 2 to 7 NTU (the higher values towards the bottom). By this time (approximately 2.25 hours after the initial measurements), the drogue tracking the plume had travelled approximately 6 km towards the northwest. The observations and consistency of the measurements indicate that these measurements were generally reflecting background conditions.

SPITFIRE CHANNEL DREDGING - TURBIDITY PROFILING LOG 30/01/95

ABC JBD WRY

0530 Start

0800 Instructed to hold at Bribie till Dredge comes on site

1100 On site

1116 150m N of Site 1 (Neph 1 in plume)

profile	2	3.7
	4	3.7
	6	3.9
	8	tot

1119 Main part of plumes past Site 1

1125 Drogue track
27 02.588 S 153 16.099 E

profile	2	13.9
	4	8.6
	6	12.9
	8	12.0
	10	14.5
	12	21.1

1128 Dredge gear starboard up

1130 Plume reaches Site 2

1135 Drogue location
27 02.176 S 153 15.865 E
Water samples collected (D1)

1143

profile	2	5.7
	4	5.2
	6	5.0
	8	6.8

1150 Edge of plume at Site 1 (background)

profile	2	0.6
	4	0.3
	6	1.7
	8	1.6

1154 Plume fully at Site 1

profile	2	3.0
	4	2.6
	6	4.4
	8	5.5

1202 Drogue location

27 01.682 S 153 15.545 E

profile	2	4.2
	4	6.1
	6	4.3
	8	4.3
	10	4.0
	12	4.0
	14	5.9
	16	4.7
	18	6.4
wind	10kt NE	
sea	0.5	
swell	0.7	

1208 Water samples collected (D2)

27 01.450 S 153 15.461 È

1225 Drogue location

27 01.088 S 153 15.391 E

profile	2	3.6
	4	3.5
	6	3.9
	8	4.1
	10	4.4
	12	6.4
	14	4.2
	16	4.9

1237 1km W of drogue (background)

27 00.806 S 153 15.080 E

profile	2	2.0
	4	2.4
	6	2.4
	8	3.4
	10	2.5
	12	2.8
	14	5.3
	16	4.7
	18	4.3

1248 Drogue location

27 00.501 S 153 15.333 E

profile	2	0.0
	4	5.7
	6	3.3
	8	4.0
	10	3.0
	12	6.5
	14	4.2

1307 Drogue location

27 00.064 S 153 15.251 E

Pearl River passing entrance leads

profile	2	2.1
	4	2.3
	6	5.6
	8	3.5
	10	3.1
	12	7.1
	14	6.1

1322 Drogue location
26 59.731 S 153 15.255 E
profile 2 3.5
4 3.2
6 3.1
8 4.4
10 7.2
12 6.1
wind 15kt NE
sea 1.0m
swell 0.7m

1330 Water samples collected (D3)

1346 Drogue location
26 59.234 S 153 15.173 E
profile 2 3.2
4 2.9
6 3.5
8 4.4

1430 Logger 327 deployed
27 03.404 S 153 16.060 E
Retrieve Yeokal s (109)

1530 Pearl River depart Fishermans
ETA @ Spitfire 1715

1730 Finish

Turbidity Profiles
Plume Tracked 30/01/95

FIGURE

1. 1

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TABLE I.1

Water Sample Results 30/01/05

Time (hrs)	Location	Description	Depth (m)	Turbidity (NTU)	Suspended Solids (mg/L)
1135	D1	2nd Plume	3	5.9	9
			6	3.5	8
			9	4.8	8
1208	D2	2nd Plume	3	0.6	3
			6	2.1	5
			9	2.2	6
1330	D3	2nd Plume	3	2.5	9
			6	2.8	7
			9	1.2	8

APPENDIX J
Flood Tide Turbidity Profiling 12/04/95

- aerial inspection and field notes
- turbidity profiles

SPITFIRE CHANNEL DREDGING - TURBIDITY MONITORING

Notes from Aerial Inspection and Turbidity Profiling 12/4/95

- An aerial inspection, coordinated with mobile turbidity measurements, was carried out on 12/4/95 during a dredging pass which coincided with a flood tide. The turbidity profiling log is attached, together with plots of the turbidity profiles (Figure J.1).

- The aerial inspection commenced on-site at 1520 hrs with the dredge travelling east to west with its heads down but no visible plume.

- Background measurements prior to the commencement of dredging indicated turbidities in the range 4.9 to 6.4 NTU.

- A visible plume presumably coinciding with hopper overflow commenced at 1525 hrs.

- At 1545 the dredge passed to the north of the S1 beacon on its east-west pass with a visible plume extending out behind. A turbidity profile in the plume soon after (1555 hrs) indicated turbidity levels between 11.7 and 16.8 NTU.

- The dredge completed its east-west pass at about 1605. The plume was drifting towards the south with the flood tide and at this time was to the south of the S1 beacon.

- The dredge took some time to turn and continue dredging on a west-east pass. The original plume continued to move towards the south and by 1624 hrs turbidity levels had reduced to between 12.7 and 14.2 NTU.

- The dredge completed dredging at about 1630 hrs near the S1 beacon on the return west-east pass.

- The plume continued to move towards the south and reduce in intensity. By 1636 hrs turbidity levels had dropped to between 9.7 and 10.7 NTU.

- The aerial inspection and turbidity profiling were terminated at about 1645 hrs due to adverse weather conditions. In the 1 hour since it had been released, the drogue tracking the plume had moved about 1 km to the southeast.

SPITFIRE CHANNEL DREDGING - TURBIDITY PROFILING LOG 12/04/95

1400 On Station

SEA 1.2-1.5

SWELL 1.0 - 1.2

WIND 20-25 kt SSE

1500 Hrs BACKGROUND 800 m SOUTH OF S1	
Depth (m)	Turbidity (NTU)
1	4.9
2	5.2
3	5.2
4	5.5
6	5.8
8	6.0
10	5.9
1515 Hrs BACKGROUND AT S1	
Depth (m)	Turbidity (NTU)
1	5.2
2	5.1
4	5.5
6	5.5
8	5.9
10	6.3
12	6.4

Pearl River makes first dredging run.

SEA 1.2 - 1.5

SWELL 1.0 - 1.2 m

WIND 20 - 25 kt SSE

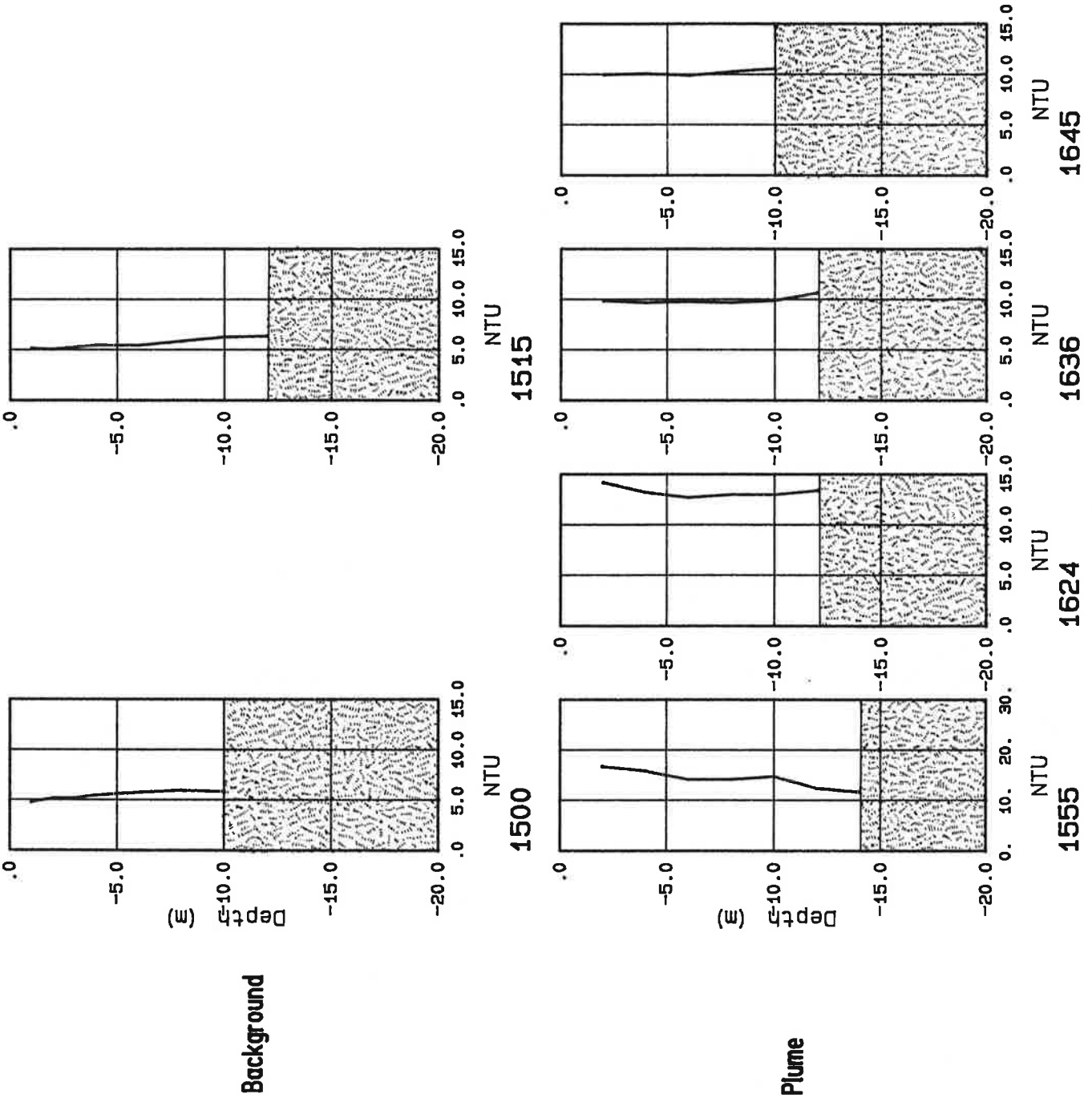
1555 Hrs PROFILE IN PLUME 27 02 51.1 S; 153 16 16.6 E	
Depth (m)	Turbidity (NTU)
2	16.8
4	15.9
6	14.2
8	14.2
10	14.8
12	12.5
14	11.7
1624 Hrs PROFILE IN PLUME 27 03 04.5 S; 153 16 21.8 E	
Depth (m)	Turbidity (NTU)
2	14.2
4	13.2
6	12.7
8	13.0
10	13.0
12	13.4

SEA 1.5 - 1.8 m

SWELL 1.0 - 1.2 m

WIND 20 - 25 kt SSE

1636 Hrs PROFILE IN PLUME 27 03 16.7 S; 153 16 30.1 E	
Depth (m)	Turbidity (NTU)
2	9.9
4	9.7
6	9.8
8	9.7
10	9.9
12	10.7
1645 Hrs PROFILE IN PLUME 27 03 20.9 S; 153 16 34.1 E	
Depth (m)	Turbidity (NTU)
2	10.0
4	10.1
6	9.9
8	10.3
10	10.6



Turbidity Profiles
Plume Tracked 12/04/95

FIGURE

J. 1

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APPENDIX K

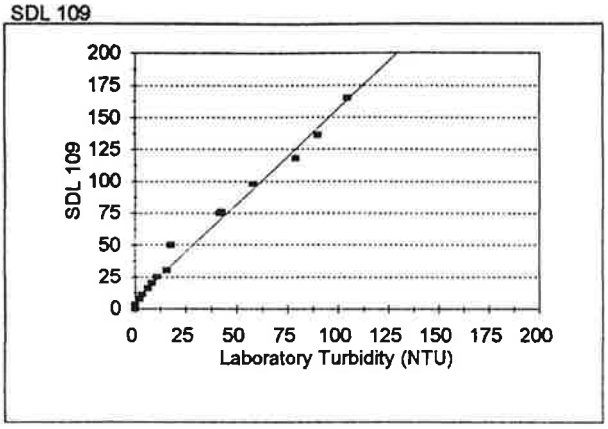
Instrument Calibration

Spitfire Channel Dredging - Instrument Calibration

All instruments used in this study have been calibrated to laboratory values of turbidity from samples of spoil wash diluted with clean sea water. Calibration relationships are shown in Figure K.1.

The relationship between suspended solid concentrations and laboratory turbidity is illustrated in Figure K.2. This relationship can be used to convert measured turbidity levels to suspended solid concentrations.

SDL 109



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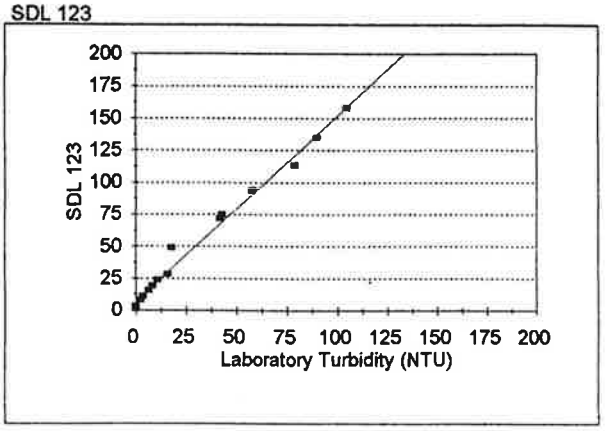

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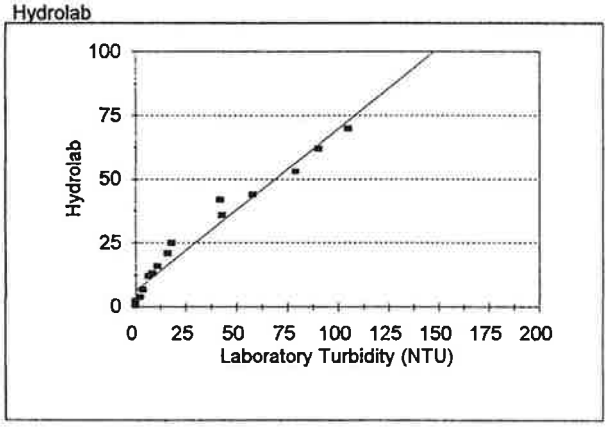

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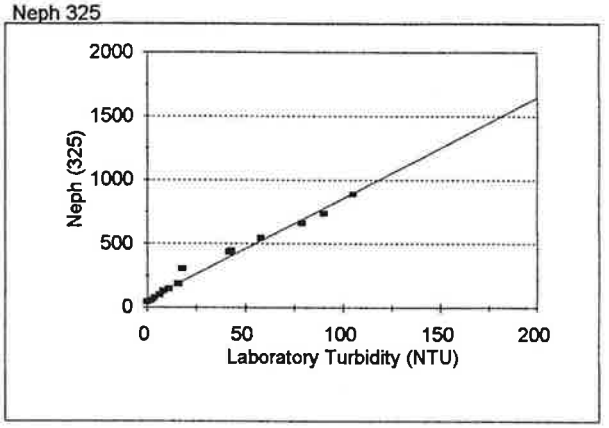

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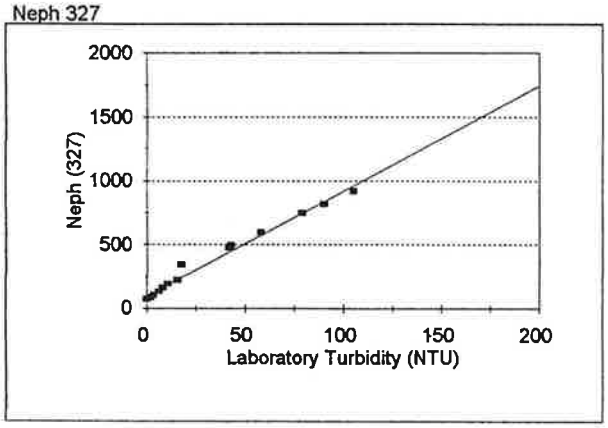

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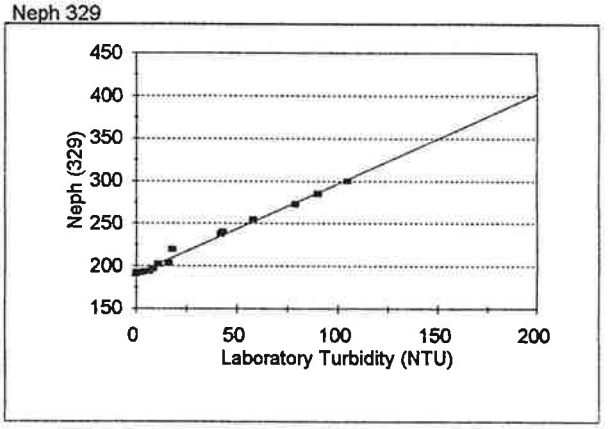

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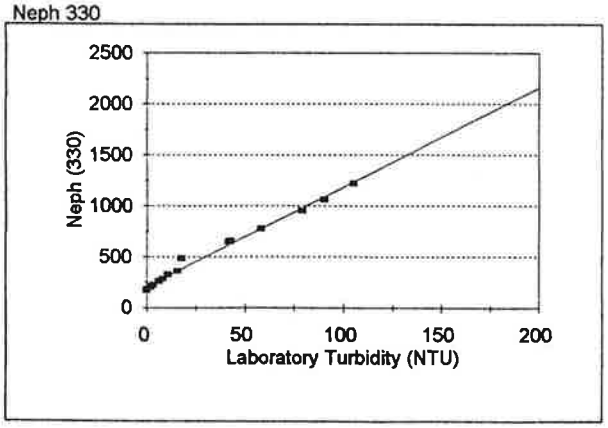

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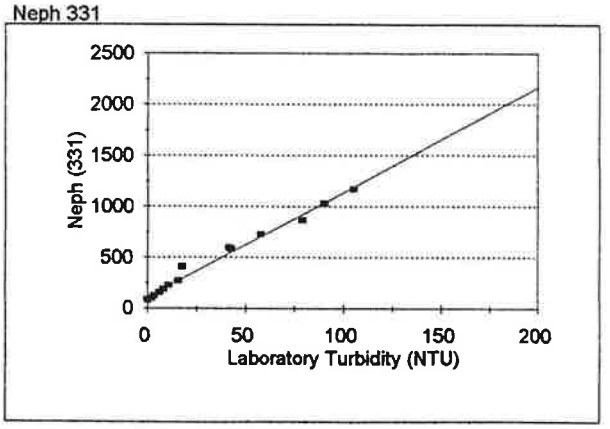

NEPHLOMETRIC CALIBRATION CURVES

FIGURE

K. 1

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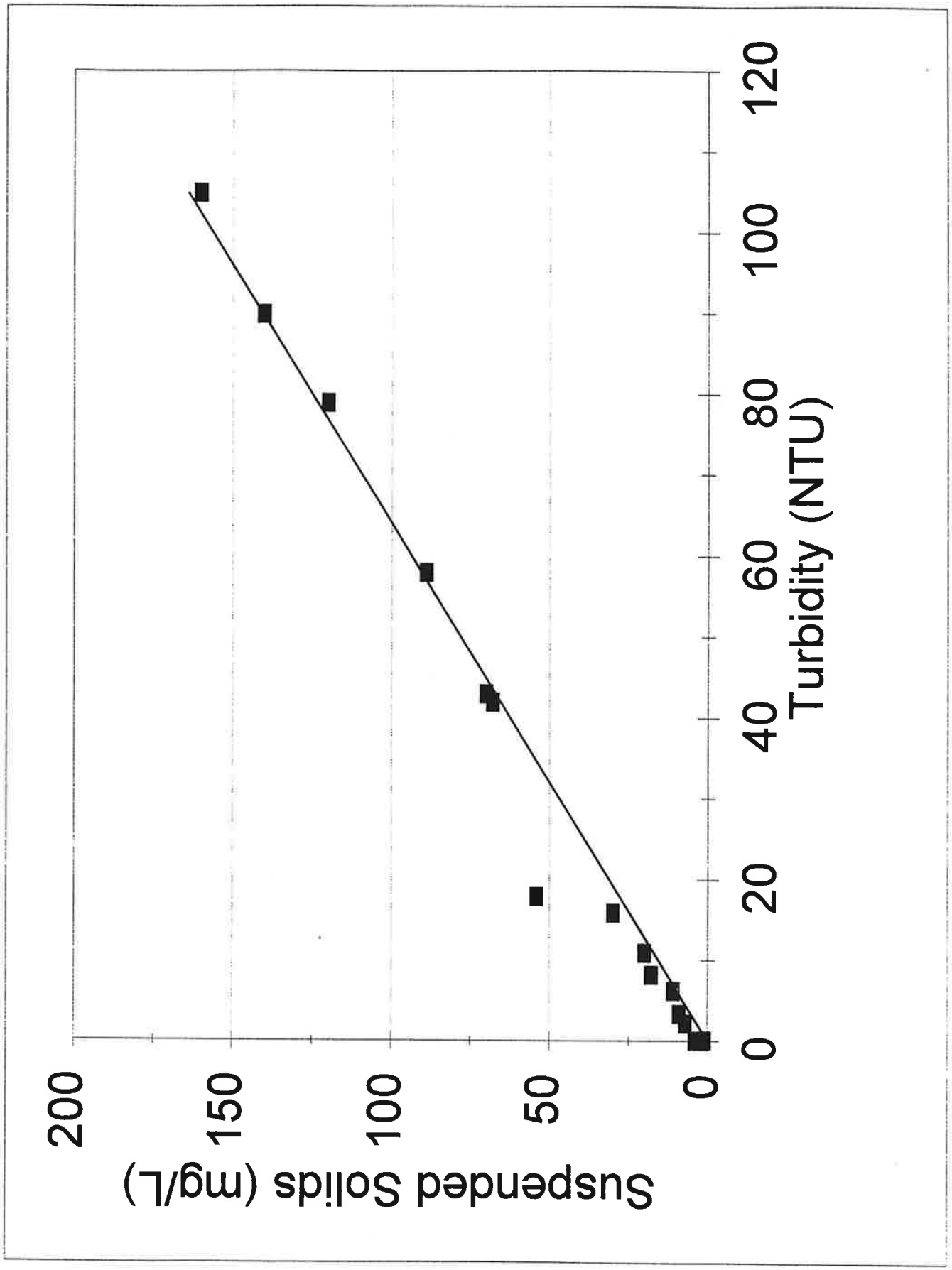

RELATIONSHIP BETWEEN
SUSPENDED SOLIDS & LABORATORY TURBIDITY

FIGURE

K. 2

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