19. NATURAL CONDITIONS

19.1 Natural Conditions Survey

As part of planning of this Study, the Natural Condition Survey at Jambi as described below has been implemented by subcontracting with local consultants in Indonesia. To grasp the natural conditions of the Study sites, the survey items have been executed in both dry season and rainy season as shown in Table 19.1.1.

Table 19.1.1 Natural Condition Survey Items and Execution Period at Jambi

Survey Items	Location	Survey in dry season	Survey in rainy season
		July – Aug. 2001	Nov. – Dec. 2001
1. Topographic survey (1:1,000)	Talang Duku	●	
	Muara Sabak	●	
2. Sounding survey (1:1,000)	Muara Sabak	●	
3. Sounding survey (1:10,000) Including dual frequency sounding	Navigation channel	●	●
	Outer Bar	●	●
4. Current observation	Muara Sabak	●	●
	No. 4 Buoy		●
	No. 3 Buoy		●
	Outer Bar	●	
5. Wave observation	Outer Bar	●	●
6. Tide observation	Muara Sabak	●	
7. Soil investigation and laboratory test	Talang Duku	●	
	Muara Sabak	●	
8. Seabed soil sampling and laboratory test	Navigation channel	●	
9. Existing wind data correction and analysis	Singkep Island	●	

19.2 Topographic condition

19.2.1 Talang Duku Port

Talang Duku Port is located on the right bank of Batang Hari River at about 10 km in a straight line to the northeast from the center of Jambi City. A paved road leads from Jambi City to Talang Duku Port and it takes about 15 minutes by car.

Talang Duku Port is located on the flat land, at the lower reaches of Jambi, on the left bank of Batang Hari River at about 15 km upstream from the river mouth. Batang Hari River has large water-level variation at its midstream (about 5 m, but it is different from year to year). Particularly in the dry season, the elevation differences from the banks to the water level are high. The elevation within the Talang Duku Port is approximately +7.5 m above NLLW and approximately +5.0 m above Mean Sea Level (MSL).

19.2.2 Muara Sabak

Muara Sabak is located on the left bank of Batang Hari River in a straight distance of about 60 km north-northeast from the center of Jambi City. About one-third of the road from Jambi City to Muara Sabak is paved, and the remaining two-third is unpaved. It takes about 3 hours by car from Jambi City to Muara Sabak.

In Muara Sabak, a pier was constructed with OECF funds in 1998. The hinterland has a land reclamation area of 200×260 m. The project site is located at about 25 km upstream from the mouth of Batang Hari River in the low swampy land stretching on its left bank downstream. The land reclamation area at the project site has an elevation of about +5.0 m above NLLW and about +2.6 m above MSL.

The surrounding area of the project site is the flat land covered with low bushes and tall grasses and has a water channel for drainage running at right angle with the Batang Hari River. Muara Sabak village lies somewhat upstream on the opposite (right) bank of the project site and Kampung Laut village is located at about 13 km downstream on the left bank. There is no road connecting the project site to these two villages and the main transport facilities that people can use are small craft such as speedboats.

19.2.3 Topographic survey

For the planning and designing of the port facilities, 1:1,000 scale topographic maps at Talang Duku and Muara Sabak were prepared by terrestrial survey method.

The survey elements for this topographic survey are as follows:

1) Projection — UTM (Universal Transverse Mercator) Zone No. 48
2) Spheroid — WGS 84
3) Datum elevation — NLLW (Nearly Lowest Low Water) decided by tide observation and harmonic analysis for Muara Sabak and existing benchmarks for Talang Duku Port

The existing benchmarks in the Talang Duku Port were used as the datum points of the horizontal coordinates and elevation for the topographic mapping. The horizontal coordinates and elevations that were used for this topographic mapping are shown in Table 19.2.1.

Table 19.2.1 Horizontal Coordinates and Elevations of the Existing Benchmarks at Talang Duku

Point No.	Horizontal coordinates (UTM)		Elevation (m)
	E (m)	N (m)	
PDC.1	351,081.299	9,830,165.993	7.719
TLD.03	351,230.846	9,830,174.099	7.717
TLD.04	351,204.702	9,830,076.608	7.008

Source: Results of natural condition survey by JICA

The horizontal coordinates and elevations of newly established benchmarks in the topographic survey area at Muara Sabak are shown in Table 19.2.2.

Table 19.2.2 Horizontal Coordinates and Elevations of Benchmarks at Muara Sabak

Point No.	Horizontal coordinates (UTM)		Elevation (m)
	E (m)	N (m)	
MSB 01	371,290.666	9,875,881.662	4.011
MSB 02	371,277.782	9,876,743.28	3.961

Source: Results of natural condition survey by JICA

19.2.4 Sounding survey

For the planning and designing of port facilities at the proposed port site and also for the study and planning of dredging at channel on Batang Hari River, 1:1,000 scale bathymetric maps covering water area in front of proposed port site and 1:10,000 scale bathymetric maps covering Batang Hari River and channel from Muara Sabak to Outer Bar were prepared.

The survey elements for this sounding survey are as follows:

1) Projection — UTM (Universal Transverse Mercator) Zone No. 48
2) Spheroid — WGS 84
3) Datum elevation — NLLW (Nearly Lowest Low Water) decided by tide observation

19.2.5 Sounding survey by dual frequency

The sounding survey at Batang Hari River and channel was carried out using two different frequency waves (namely, 210 kHz and 33kHz). The results of dual frequency sounding and visual observation of soil samples are shown in Table 19.2.3.

From these results, it is presumed that the upper most part of riverbed in Batang Hari River and seabed at the channel of Outer Bar has a relatively soft clay or sand layer of approximately 70 cm to 90 cm thickness. The thickness of soft layer is approximately 70 cm between Muara Sabak and Majelis. However, the thickness of soft layer from Tg Solok to downstream is presumed to be approximately 90 cm.

Table 19.2.3 Dual-Frequencies Sounding and Visual Observation Result of Riverbed Soil Samples

Cross section No.	Sampling point No.	Depth by 210 kHz	Depth by 33 kHz	Width of soft layer	Length of core sample	Visual observation of soil samples
LS-01	GS-01	-5.01 m	-5.94 m	0.93 m	----	Soft silty **clay**
LS-06	GS-02	-3.88 m	-4.80 m	0.92 m	----	Very soft silty **clay**
LS-10	GS-03	-3.90 m	-4.82 m	0.92 m	----	Slightly silty clayey fine **sand** with shell fragments
LS-14	GS-04	-4.02 m	-4.97 m	0.95 m	0.92 m	Fine to medium **sand** with shell fragments
LS-18	GS-05	-3.93 m	-4.88 m	0.95 m	0.98 m	Slightly silty **clay** with organic fragments
LS-22	GS-06	-5.42 m	-6.15 m	0.73 m	0.92 m	Slightly silty clayey fine to medium **sand**
LS-27	GS-07	-2.37 m	-3.15 m	0.78 m	0.54 m	Fine to medium **sand** with organic fragments
LS-31	GS-08	-3.64 m	-4.62 m	0.98 m	1.01 m	Silty fine **sand** with organic fragments
LS-35	GS-09	-8.28 m	-9.25 m	0.97 m	0.94 m	Silty fine to medium **sand** with organic fragments
LS-39	GS-10	-4.42 m	-5.17 m	0.75 m	0.55 m	Very soft silty **clay**
LS-43	GS-11	-3.25 m	-3.92 m	0.70 m	0.66 m	Slightly silty fine to medium **sand** with organic fragments
LS-47	GS-12	-4.45 m	-5.13 m	0.68 m	0.66 m	Slightly silty fine **sand** with organic fragments
LS-51	GS-13	-4.98 m	-5.67 m	0.69 m	0.69 m	Medium **sand** with organic fragments
LS-56	GS-14	-5.70m	-6.40 m	0.70 m	----	Slightly clayey fine **sand**

Note: ---- : Sampling by grab sampler. Therefore, no data of core sample length

Source: Results of natural condition survey by JICA

19.3 Subsoil Condition

19.3.1 Soil Investigation

To grasp the soil condition of the proposed port sites, offshore and onshore boring were executed at Talang Duku and Muara Sabak. Soil laboratory tests, consisting of water content, gain size analysis, unit weight test, unconfined compression test and consolidation test, were executed using obtained disturbed and undisturbed soil samples.

19.3.2 Talang Duku

The locations of new and existing boring points are shown in Figure 19.3.1 “Location of Boring Point at Talang Duku” and the results of the existing and new boring surveys are shown in Figure 19.3.2 “Soil Profile at Talang Duku”.

As seen from the existing onshore boring results, there is a relatively soft silt or clay layer at –11 m deep (NLLW) below the surface layer, but a hard sand layer with the N-Value of 50 or more lies at approximately –14 m depth (NLLW).

According to the offshore boring results that have been obtained in this survey, the surface layer consists of silt and clay, but a fine sand layer with N-Value of 50 or more lies at approximately –17 m depth (NLLW).

19.3.3 Muara Sabak

The boring locations at Muara Sabak are shown in Figure 19.3.3 and the results of the new boring surveys are shown in Figure 19.3.4.

As seen from the onshore boring results, there is a very soft silt layer from the surface layer down to approximately –9 m depth (NLLW) and a hard layer with a thickness of 4 m with N-Value of 50 or more lies at about –25 m depth (NLLW). However, a relatively soft clay layer lies below those layers again. A fine to medium sand layer with a thickness of 5 m or more and the N-Value of 50 or more lies at about –51 m depth (NLLW).

According to the offshore boring results, a very soft silt or clay layer lies from the surface layer down to approximately –6 m depth (NLLW) and a hard clay layer with a thickness of 6 m with the N-Value of 50 or more lies about –15 m depth (NLLW). However, a relatively soft clay layer is shown below these layers. A medium sand layer with a thickness of 5 m or more and with the N-Value of 50 or more lies underneath –46 m depth (NLLW).

19.4 River Channel and Sedimentation

19.4.1 Riverbed Soil Sampling and Analysis

To investigate the soil materials of riverbed on Batang Hari River and seabed on channel at Outer Bar, soil sampling was executed at the interval of approximately 2 km between Muara Sabak and Outer Bar. Soil laboratory test, consisting of water content, grain size analysis and unit weight, were executed using obtained soil samples.

The soil sampling locations are shown in Figure 19.4.1. Gravity Core sampler was used for riverbed and seabed soil sampling at an approximately 2 km interval. Table 19.4.1 shows the summary of soil sampling and visual observation of obtained soil samples.

From the investigation of the bottom soil samples, it was clarified that clay and clayish sand are distributed at the river mouth, while the bed materials contain less clay and more sand at the more upstream bottom of Batang Hari River. It is presumed that this phenomenon is attributed to the difference in the current velocity between river mouth and waterway.

Table 19.4.1 Results of Soil Sampling of Riverbed and Channel at Batang Hari River

Point No.	Location (U.T.M.)		Length of core sample	Material of river bed	
	E	N		Color	Soil condition
GS-01	364,480.9	9,899,757.3	----	Grey brown	Soft silty **clay**
GS-02	365,472.0	9,897,615.4	----	Grey brown	Very soft silty **clay**
GS-03	365,312.9	9,895,498.9	----	Grey brown	Slightly silty clayey fine **sand** with shell fragments
GS-04	366.523.5	9,893,538.5	----	Brown	Fine to medium **sand** with shell fragments
GS-05	367,053.0	9,891598.9	----	Blackish brown	Slightly silty **clay** with organic fragments
GS-06	367,572.4	9,889,666.0	----	Greyish brown	Slightly silty clayey fine to medium **sand**
GS-07	367,772.9	9,886,872.9	54 cm	Brown	Fine to medium **sand** with organic fragments
GS-08	368,033.8	9,885,011.7	101 cm	Grey brown	Silty fine **sand** with organic fragments
GS-09	367,752.9	9,883,039.8	94 cm	Grey brown	Silty fine to medium **sand** with organic fragments
GS-10	368,844.8	9,881,618.6	55 cm	Brownish grey	Very soft silty **clay**
GS-11	370, 344.5	9,880,503.6	66 cm	Brown	Slightly silty fine to medium **sand** with organic fragments
GS-12	371,424.3	9,878,786.7	66 cm	Brown	Slightly silty fine **sand** with organic fragments
GS-13	371,559.3	9,876,781.5	69 cm	Brown	Medium **sand** with organic fragments
GS-14	372,049.2	9,874,828.2	----	Greyish brown	Slightly clayey fine **sand**

19.4.2 Soil laboratory test

Figure 19.4.2 shows the results of soil laboratory test using soil samples obtained by gravity core sampler and dual frequencies sounding survey.

The characteristics of the riverbed and channel bottom materials are summarized as follows:

1) From the results of grain size analysis, percentage of sand was less than 40 %, except GS-07 (73 %) and GS-04 (54 %).
2) Grain size analysis shows that the riverbed materials between Muara Sabak and Majelis contains less sand and more clay, whereas, the bed materials between Majelis and Tg Solok contains more sand and less clay.
3) The density of riverbed materials at the condition of sedimentation in the river was estimated based on the soil laboratory test. The estimated densities of riverbed materials range between 1.3 g/cm^3 - 1.6 g/cm^3. It is presumed that the riverbed materials of upper layer of Batang Hari River were relatively soft and loose.
4) The Thickness of this soft and loose upper layer of riverbed materials at Batang Hari River was estimated as approximately 70 cm - 90 cm from the results of dual

frequencies sounding survey and obtained core length.

5) The fluid mud on the top of riverbed was not detected. It is presumed it had flowed away due to the high speed current (Maxim velocity is more than 1.0 m/sec and average velocity is more than 0.3 m/sec).

19.4.3 Relation between sounding survey and maintenance dredging

Since Batang Hari River has a large volume of sediment at its river mouth, the river mouth has been divided into three survey zones for yearly sounding surveys and for eventual maintenance dredging by IPC2. For this Study, existing sounding survey data was very useful for the estimation of riverbed change. Furthermore, for this study, new sounding surveys were executed in July and November 2001.

The locations of sounding survey by IPC2 and maintenance dredging area are shown in Figure 19.4.3. The sounding surveys and maintenance dredging executed by IPC2 from 1998 to 2001 are shown in Table 19.4.2. It is possible to estimate the riverbed change comparing the sounding survey results before and after maintenance dredging.

Table 19.4.2 Sounding and Maintenance Dredging from 1998 to 2001 at Jambi

Year	Month	Sounding／Dredging	Area-I	Area-II	Area-III
1998	Feb.～May	Pre-dredge sounding	●	●	●
	April～June	Maintenance dredging			●
	June	Final sounding	●	●	●
1999	Aug.	Pre-dredge sounding	●	●	●
2000	May～June	Check sounding	●	●	●
2001	July	Pre-dredge sounding	●	●	●

Source: Information from PT. Pelabuhan Indonesia II

19.4.4 Estimation of Riverbed Variation by the Existing Sounding Survey Data

Using the existing sounding survey data, the cross sections of each Spot and the longitudinal profiles of the channel were prepared. The water depths at the same Spot were compared to estimate the riverbed variation. As a result, the following features were verified.

1) In each maintenance dredging area, the riverbed had risen approximately 20 cm per year at the channel center.
2) In each maintenance dredging area, the riverbed had risen less since the distance from the channel center is larger. The riverbed rise at the point 100 m away from the channel center was estimated to be 10 cm or less per year.

The estimated riverbed rise per year is shown in Table 19.4.3.

Table 19.4.3 Estimation of Yearly Riverbed Variation at Batang Hari River by the Existing Sounding Survey Data

Sounding Area	100 m left from canal center	25 m left from canal center	Canal center	25 m right from canal center	100 m right from canal center
Area I	+ 6 cm	+ 11 cm	+ 19 cm	+ 32 cm	-----
Area II	+ 9 cm	+ 23 cm	+ 22 cm	+ 19 cm	0 cm
Area III	- 6 cm	+ 12 cm	+ 16 cm	+ 15 cm	- 4 cm

Source: Analysis by JICA Study Team based on the results of sounding survey by PT Pelabuhan Indonesia II

19.4.5 Estimation of riverbed variation by the new sounding survey data

Using the new sounding survey data, the cross sections at 500 m intervals and the longitudinal profiles of Batang Hari River between Muara Sabak and Outer Bar were prepared. The water depths at the same cross section lines were compared to estimate the riverbed variation. As a result, the following features were verified.

1) In each maintenance dredging area, the riverbed had risen about 30 cm – 50 cm per year at the channel center and 50 m left and right side from channel center.
2) In non-dredging area, the riverbed rise is very small. The estimated riverbed rise per year in non-dredging area is almost zero or minus.

The estimated riverbed variation per year is shown in Table 19.4.4.

Table 19.4.4 Estimation of Yearly Riverbed Variation at Batang Hari River

Sounding Area	100 m left from canal center	50 m left from canal center	Canal center	50 m right from canal center	100 m right from canal center
Area I	+ 26 cm	+ 33 cm	+ 12 cm	+ 20 cm	+ 15 cm
Area II	+ 43 cm	+ 53 cm	+ 35 cm	+ 60 cm	+ 58 cm
Area III	- 6 cm	+ 30 cm	+ 36 cm	- 6 cm	- 18 cm
Other area	- 2 cm	- 5 cm	- 16 cm	+ 32 cm	- 25 cm

Source: Natural condition survey by JICA

19.5 Tide and Current

19.5.1 Current Observation

To determine the characteristics of current in Batang Hari River and channel in Outer Bar, current observations were executed in both dry season and rainy season at similar.

The current observation points are shown in Figure 19.5.1 and Figure 19.5.2.

19.5.2 Relation between prevailing current direction and tide

The relations of prevailing current direction with the rise and fall of the tide as obtained from the observations are shown in Table 19.5.1.

Table 19.5.1 Relation between Tide and Prevailing Current Direction

Location	Current observation depth	Prevailing direction			
		Dry season (July 2001)		Rainy season (Nov. 2001)	
		Low⇒High	High⇒Low	Low⇒High	High⇒Low
Muara Sabak	3.5 m above river bed	165 degrees	345 degrees	----	----
	1.5 m above river bed	165 degrees	345 degrees	170 degrees	350 degrees
No.4 buoy	3.5 m above river bed	----	----	170 degrees	350 degrees
	1.5 m above river bed	----	----	170 degrees	Not clear
No.3 buoy	1.5 m above river bed	----	----	155 degrees	330 degrees
Outer bar	3.5 m above river bed	240 degrees	60 degrees	----	----
	1.5 m above river bed	240 degrees	60 degrees	----	----

Source: Results of natural condition survey by JICA

The prevailing current direction at Muara Sabak was the same as the flow line of Batang Hari River in both dry and rainy season, and the current direction reversed between the low tide to high tide and the high tide to low tide. However, the prevailing current direction at Outer Bar was not so clear, but usually parallel to the coastline.

The prevailing current direction of the upper layer (3.5 m above riverbed) at Buoy 4 was the same as the channel direction. However, the prevailing current direction of lower layer (1.5 m above riverbed) was not so clear, especially the current direction during the period from the high tide to low tide.

19.5.3 Current velocity

Table 19.5.2 shows the average current velocity in scalar and maximum current velocity during the observation period.

Table 19.5.2 Average and Maximum Velocity of Current

Location	Current observation depth	Velocity (m/sec)			
		Average velocity (m/sec)		Maximum velocity (m/sec)	
		Dry season	Rainy season	Dry season	Rainy season
Muara Sabak	3.5 m above river bed	0.25 m/sec	----	1.12 m/sec	----
	1.5 m above river bed	0.34 m/sec	0.38 m/sec	1.14 m/sec	0.91 m/sec
No.4 buoy	3.5 m above river bed	----	0.38 m/sec	----	1.25 m/sec
	1.5 m above river bed	----	0.24 m/sec	----	0.92 m/sec
No.3 buoy	1.5 m above river bed	----	0.31 m/sec	----	1.17 m/sec
Outer bar	3.5 m above river bed	0.25 m/sec	----	0.67 m/sec	----
	1.5 m above river bed	0.08 m/sec	----	0.64 m/sec	----

Source: Results of natural condition survey by JICA

Note: An average current velocity is a scalar average velocity.

The characteristics of current in the study area are summarized as follows:

1) The average current velocity of the upper layer (3.5 m above riverbed) was higher than the lower layer (1.5 m above riverbed), especially at Outer Bar.
2) The maximum current velocity of upper layer is higher than lower layer.

3) The maximum current velocity occurred during the middle period from high tide to low tide and from low tide to high tide.
4) The prevailing current direction is the same direction of river flow of Batang Hari River or channel
5) The average value and maximum value of the current velocity at Muara Sabak are higher than at Outer Bar. It is supposed that this phenomenon is mainly attributed to the fact that Muara Sabak is located within the Batang Hari River.

19.5.4 Harmonic analysis of current

The harmonic analysis of current at Outer Bar was executed to determine the characteristic of current at Outer Bar of Batang Hari River. The result of harmonic analysis are shown in Table 19.5.3.

Table 19.5.3 Results of Harmonic Analysis of Current at Outer Bar

Type	M2	S2	K1	O1	P1	N2	K2	M4	MS4
V (m/sec)	0.355	0.112	0.405	0.151	0.289	0.077	0.030	0.015	0.006
Phase Lag (deg)	134.1	210.2	303.7	197.2	27.0	263.6	210.2	145.3	279.1

Source: Results of natural condition survey by JICA

19.5.5 Tide Observation and harmonic analysis

A tide gauge was installed at the existing pier in Muara Sabak village to make a tide observations. To decide the datum elevation for topographic survey and sounding survey, tide observations over a period of 30 days were executed at Muara Sabak.

Based on the observed tidal data, harmonic analysis was executed to calculate the tidal constituents. Nearly Lowest Low Water (NLLW) as a datum elevation for topographic survey and sounding survey was decided based on the calculated tidal constituents. The calculated values of tidal constituents at Muara Sabak are shown in Table 19.5.4. The calculated value of Z_o (the difference between the Mean Sea Level and NLLW) by the harmonic analysis was 2.358 m.

Table 19.5.4 Results of Harmonic Analysis of Tide at Muara Sabak

Type	M2	S2	K1	O1	P1	N2	K2	M4	MS4
Amplitude (m)	0.728	0.587	0.684	0.523	0.188	0.191	0.599	0.059	0.044
Phase Lag (degree)	85.9	101.0	183.0	108.0	130.3	60.3	147.3	141.8	192.0

Source: Results of natural condition survey by JICA

19.5.6 Datum Level for sounding survey

According to the information of IPC2, the datum level for sounding survey was –2.50 m below LWS. The value of Z_o shown in the tide table issued by the Government of Indonesia was also 2.5 m. However, the value of Z_o calculated by the harmonic analysis was 2.36 m. It is presumed that the reason of this difference was caused by the following:

1) Difference of the location of tide observation
   The tide observation point by this Study was at Muara Sabak. However, tide observation point at tide table was located near estuary.
2) Difference of the tide observation period and season
   Due to the short Study period, the tide observation period of this Study is one month. However, tide observation period for tide table issued by the Government of Indonesia maybe be more than 1 year. Furthermore, the tide observation of this Study was executed in dry season (July – August).

Figure 19.5.3 shows the relation of datum level used for sounding survey by IPC2 and this Study.

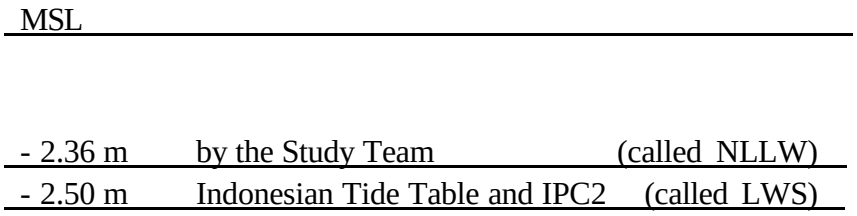


Figure 19.5.3 Relation of Datum Level for Sounding Survey

19.6 Wave

19.6.1 Wave observation

A wave gauge was installed at the mouth of Batang Hari River and 30 days continuous measurements of wave height and wave direction were made to obtain the basic data for the siltation modeling. The wave observation was carried out at the dry season (July - August 2001) and the rainy season (November 2001).

19.6.2 Wave analysis

(1) Observed wave

The results of wave observation in dry season and rainy season are shown in Figure 19.6.1 and 19.6.2. As seen in the diagrams, the wave direction is nearly constant in the directions of NNE - ENE. The outline of wave height and wave period is shown in Table 19.6.1.

Maximum wave height sometimes reaches up to 0.5 – 0.8 m but its duration is rather short and is within 2 – 3 hours or shorter than a half day.

Table19.6.1 Results of Wave Observation at Outer Bar of Batanghari River

Item	Dry season		Rainy season	
	Wave height	Wave Period	Wave height	Wave Period
Maximum wave	0.53 m	4.3 sec	0.73 m	4.6 sec
Significant wave	0.17 m	4.7 sec	0.14 m	5.2 sec

(2) Wave hindcast

Wave hindcast at the offshore point of Batanghari River was carried out using the wind data at the island of Dabo Singkep for four years (1998 – 2001). The outline of the hindcast wave height and wave period is shown in Table 19.6.2.

The hindcast wave height is rather low and is generally less than 0.2 m. The wave period of hindcast wave is shorter than that of the observed wave. The MSB method used for the wave hindcast could not replicate the features of the observed wave period.

Table19.6.2 Results of Wave Hindcast for Jambi

Item	1998 - 2001	
	Wave height	Wave Period
Maximum wave	0.25 m	1.7 sec
Significant wave	0.21 m	1.6 sec

(3) Consideration of wave in siltation modeling

Average wave height at the Outer Bar area of Batanghari River is generally small and is seen as within 0.2 – 0.5 m. The observed orbital velocity of water by waves is within 0.05 – 0.1 m/s, while the average velocity of tidal current at the Outer Bar area reaches 0.25 – 0.65 m/s (see Table 19.5.2).

The shear stress by wave action over the sediment at the Outer Bar area of Batanghari River is very small and less than 10 % of that of tidal current. The contribution of the wave action to the sediment transport is negligibly small at the Batanghari River.

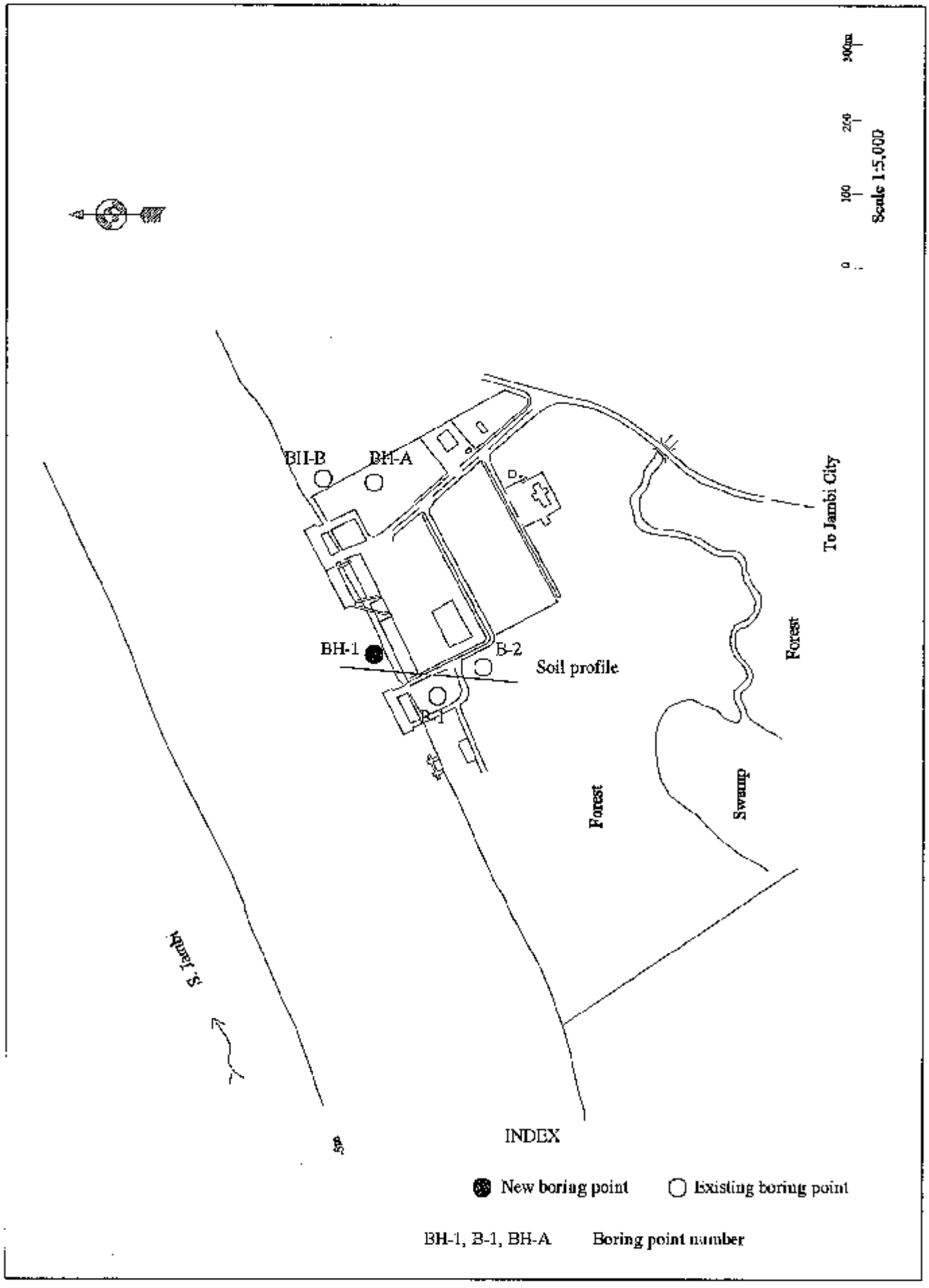


Figure 19.3.1 Location of Boring Point at Talang Duku

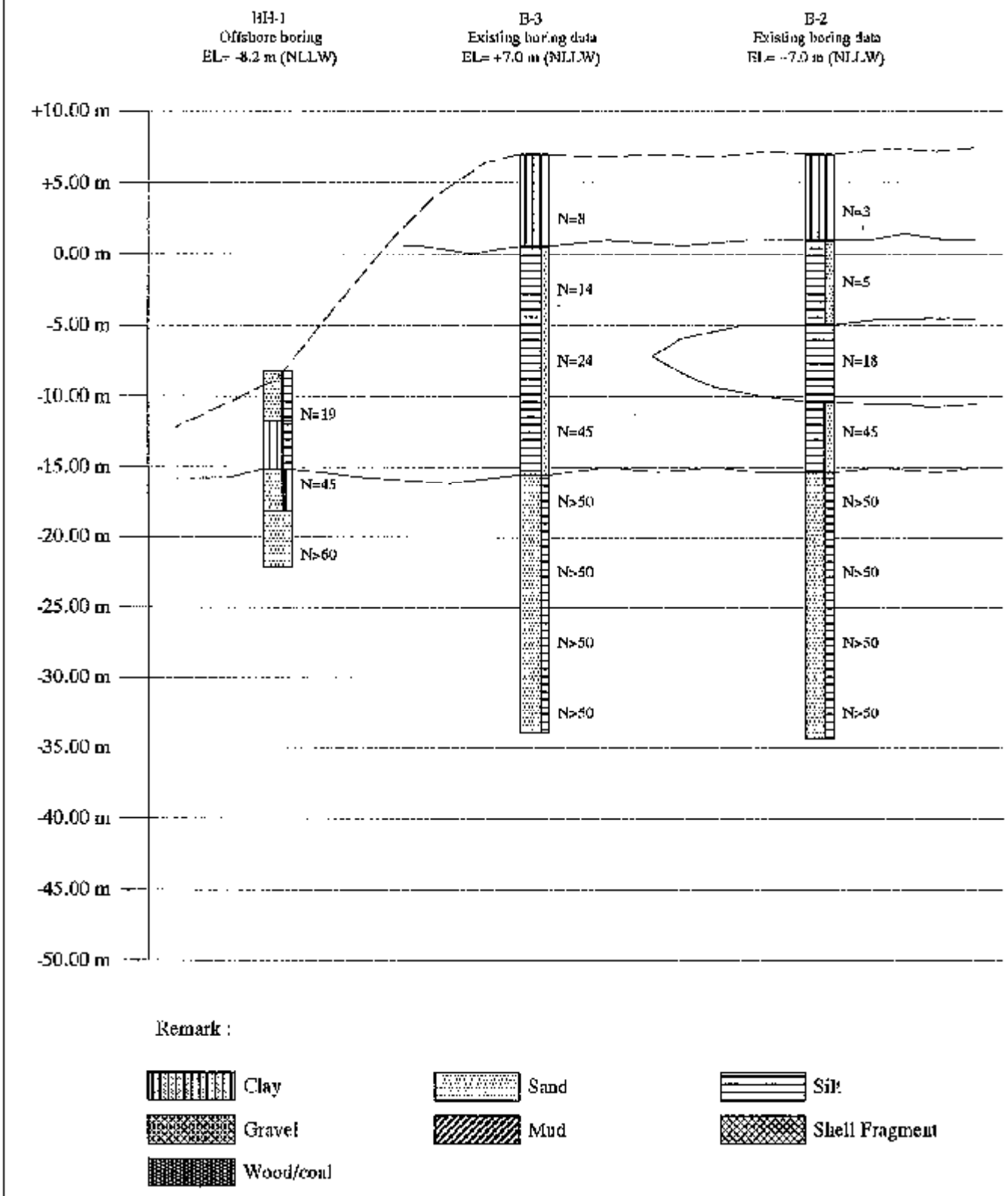


Figure 19.3.2 Soil Profile at Talang Duku

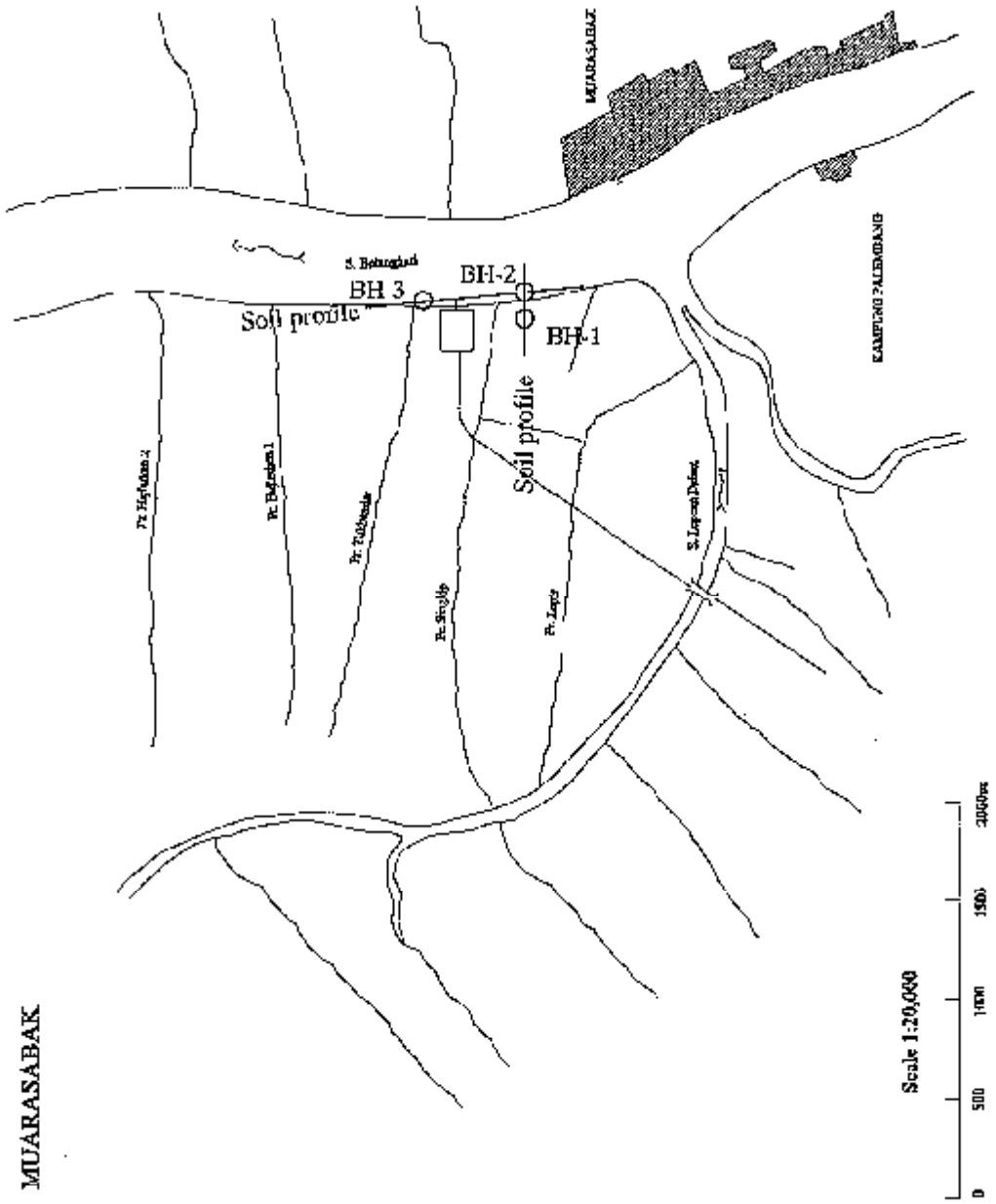


Figure 19.3.3 Location of Boring Point at Muara Sabak

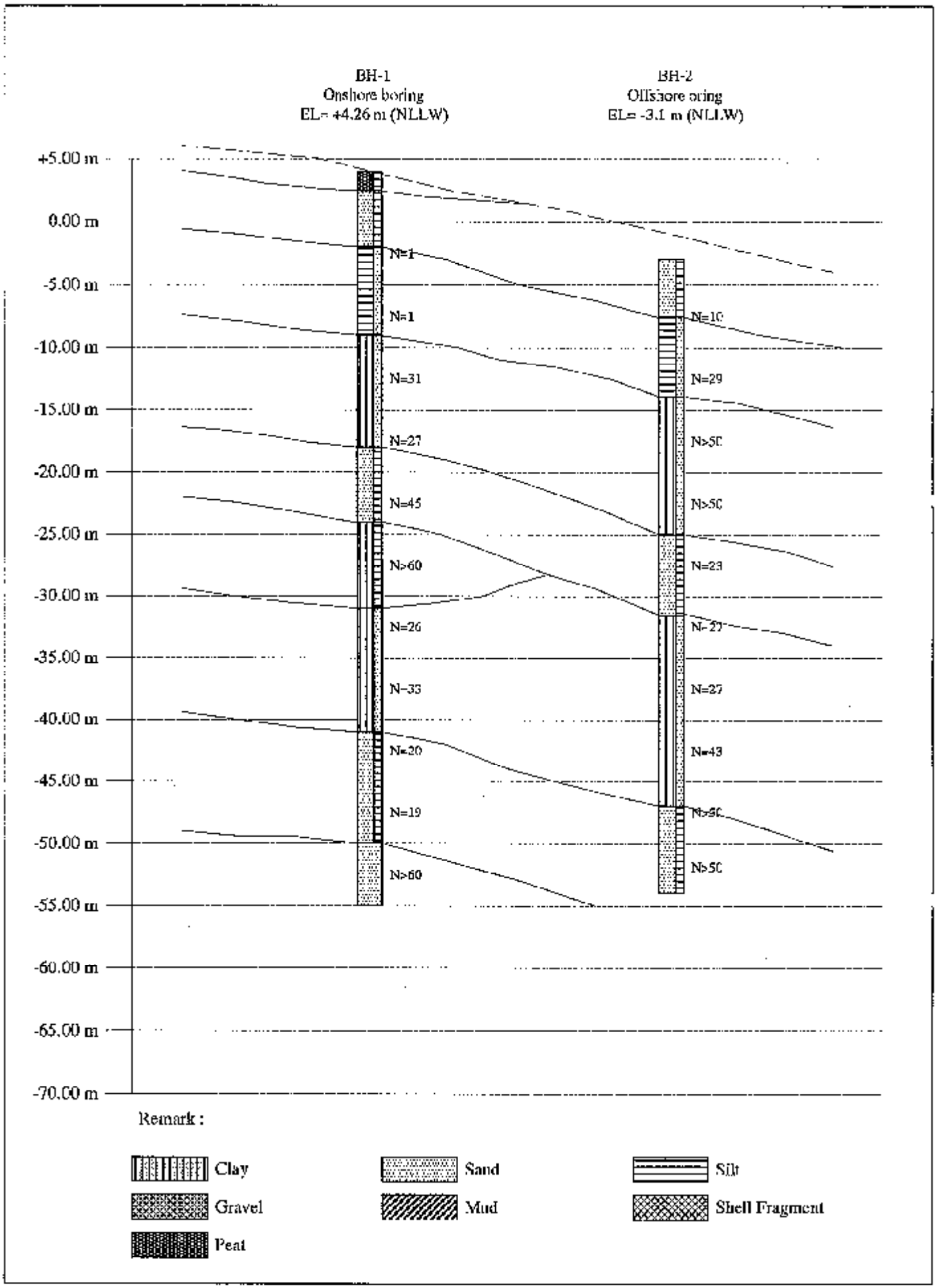


Figure 19.3.4 Soil Profile at Muara Sabak

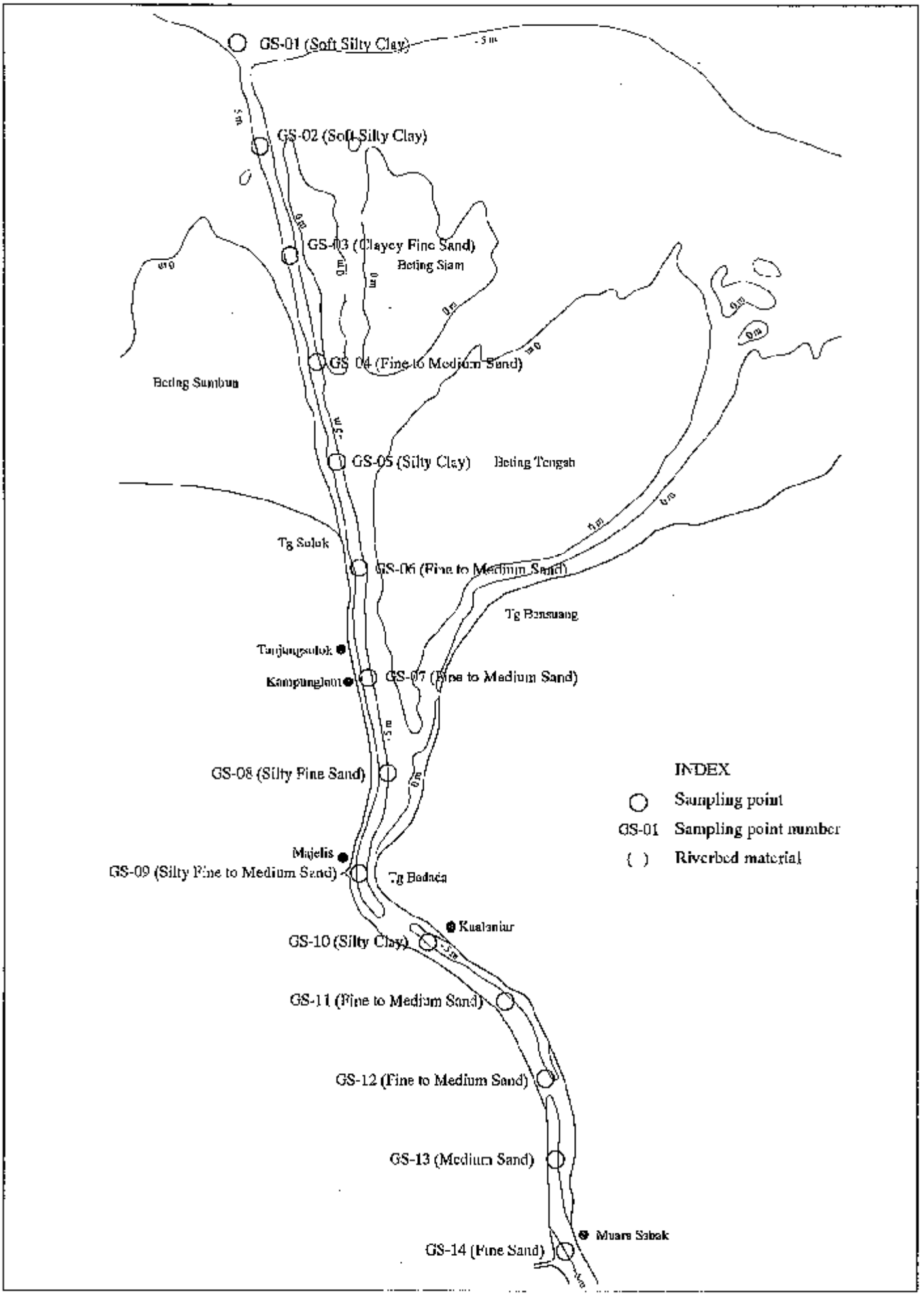
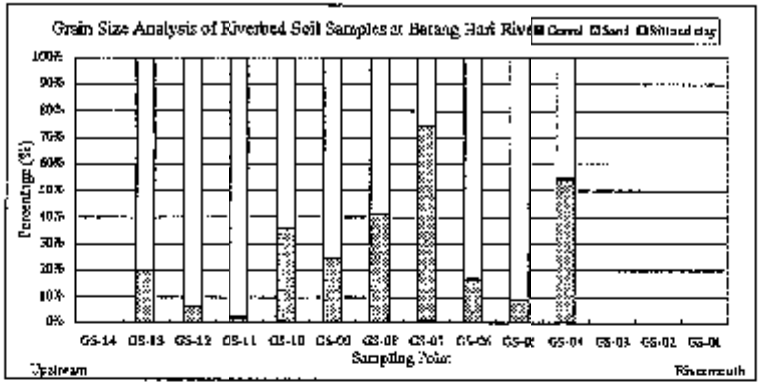
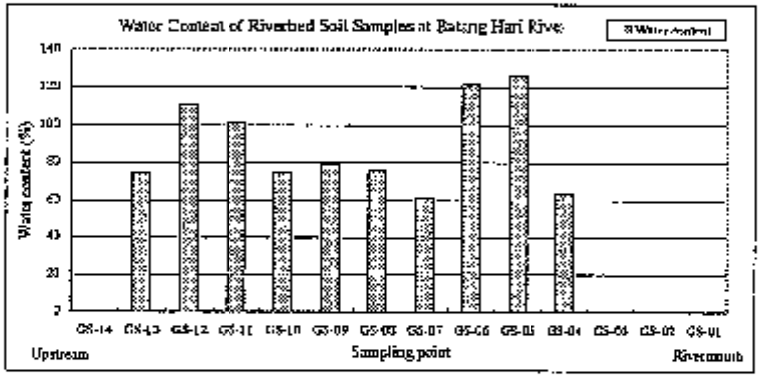


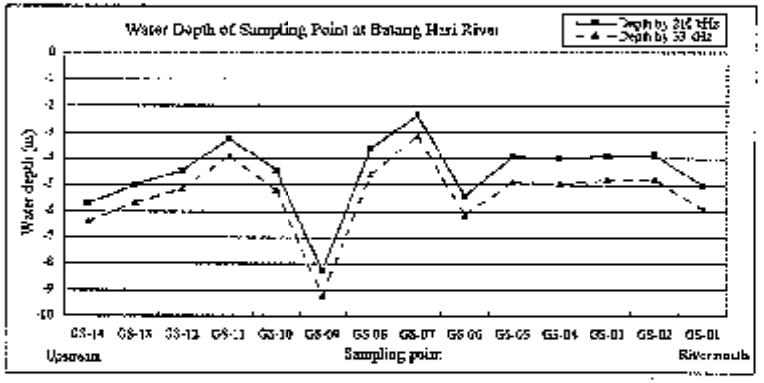
Figure 19.4.1 Location of Soil Sampling at Riverbed and Channel at Batang Hari River

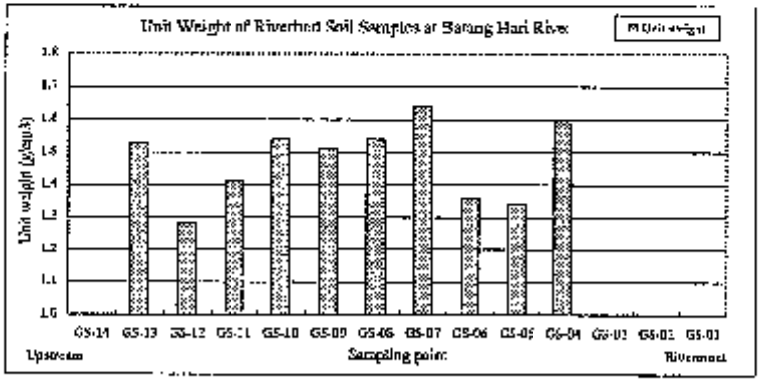


Soil Laboratory Test of Riverbed Soil Samples at Batang Hari River

Soil sampling point	Coordinate point	Depth by 210 KHz (m)	Depth by 33 KHz (m)	Thickness of top soil layer (m)	Grain size analysis (%)			Water content (%)	Unit weight (g/cm³)	Note
					Gravel	Sand	Silt & Clay			
GS-14	LS-14	-5.70	-6.40	0.70					0.00	Upstream
GS-13	LS-13	-4.90	-5.67	0.77	0.00	19.94	80.06	76.45	1.55	
GS-12	LS-12	-4.43	-5.13	0.70	0.00	6.20	93.80	111.28	1.25	
GS-11	LS-11	-5.25	-5.92	0.67	0.00	2.08	97.92	101.49	1.41	
GS-10	LS-10	-4.42	-5.17	0.75	0.00	18.20	81.80	75.81	1.54	
GS-09	LS-09	-3.26	-3.91	0.65	0.00	24.29	75.71	74.57	1.51	
GS-08	LS-08	-3.64	-4.62	0.98	0.00	40.84	59.16	71.44	1.54	
GS-07	LS-07	-2.37	-3.15	0.78	0.95	21.14	77.90	61.39	1.64	
GS-06	LS-06	-5.43	-6.15	0.72	0.10	18.36	81.54	111.13	1.39	
GS-05	LS-05	-3.98	-4.88	0.90	0.00	8.84	91.16	116.33	1.34	
GS-04	LS-04	-4.02	-4.97	0.95	0.10	54.4	45.52	65.73	1.60	
GS-03	LS-03	-3.89	-4.62	0.92					0.00	
GS-02	LS-02	-3.96	-4.60	0.63					0.00	
GS-01	LS-01	-5.51	-5.94	0.43					0.00	Rivermouth







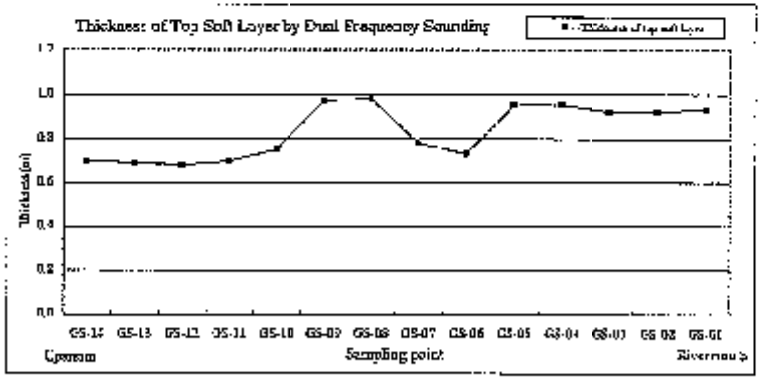


Figure 19.4.2 Results of Soil Laboratory Test for Soil Samples of Riverbed and Channel at Batang Hari River

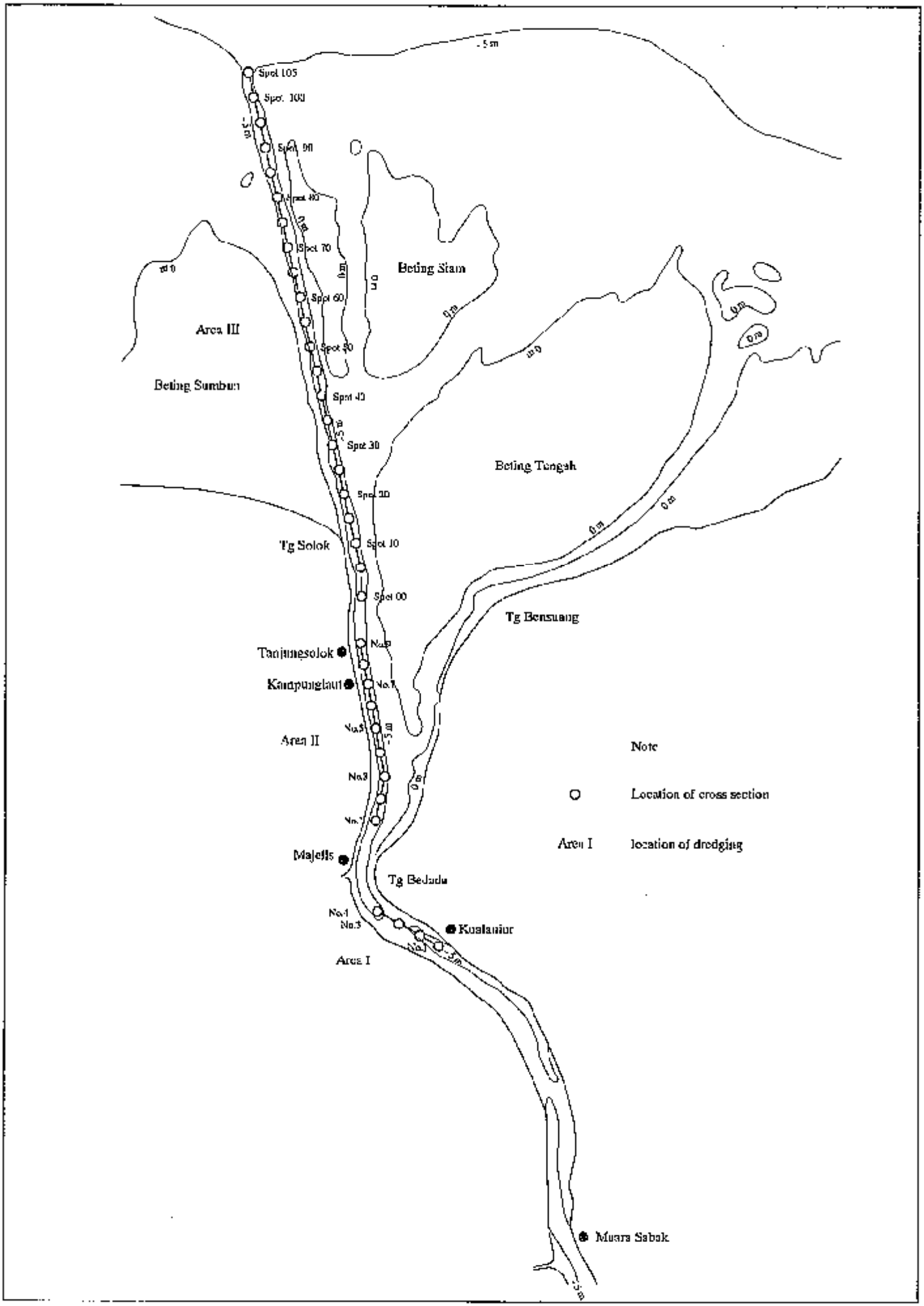


Figure 19.4.3 Location of Cross Section Points at Batang Hari River

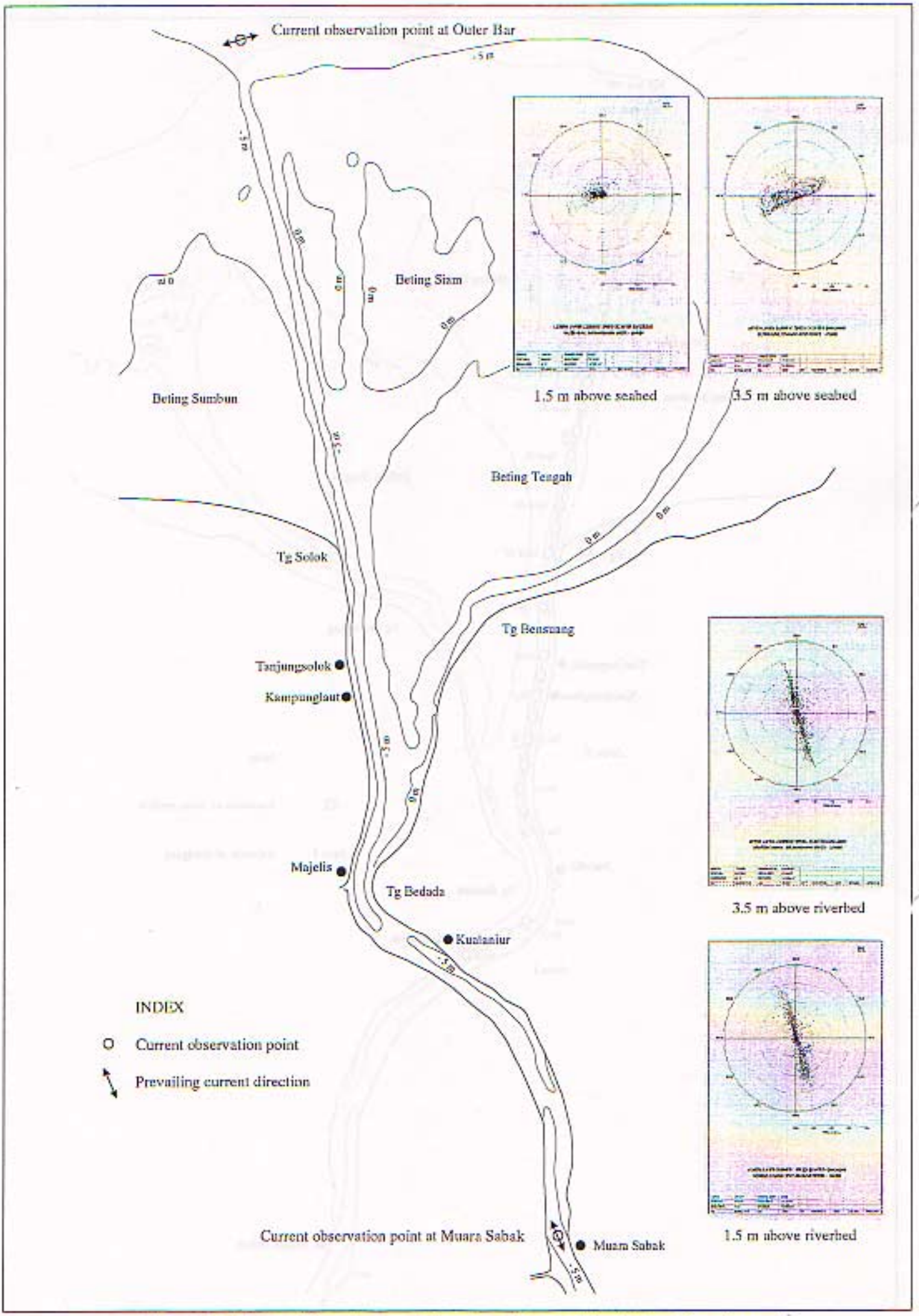


Figure 19.5.1 Prevailing Current Direction at Batang Hari River (Dry Season)

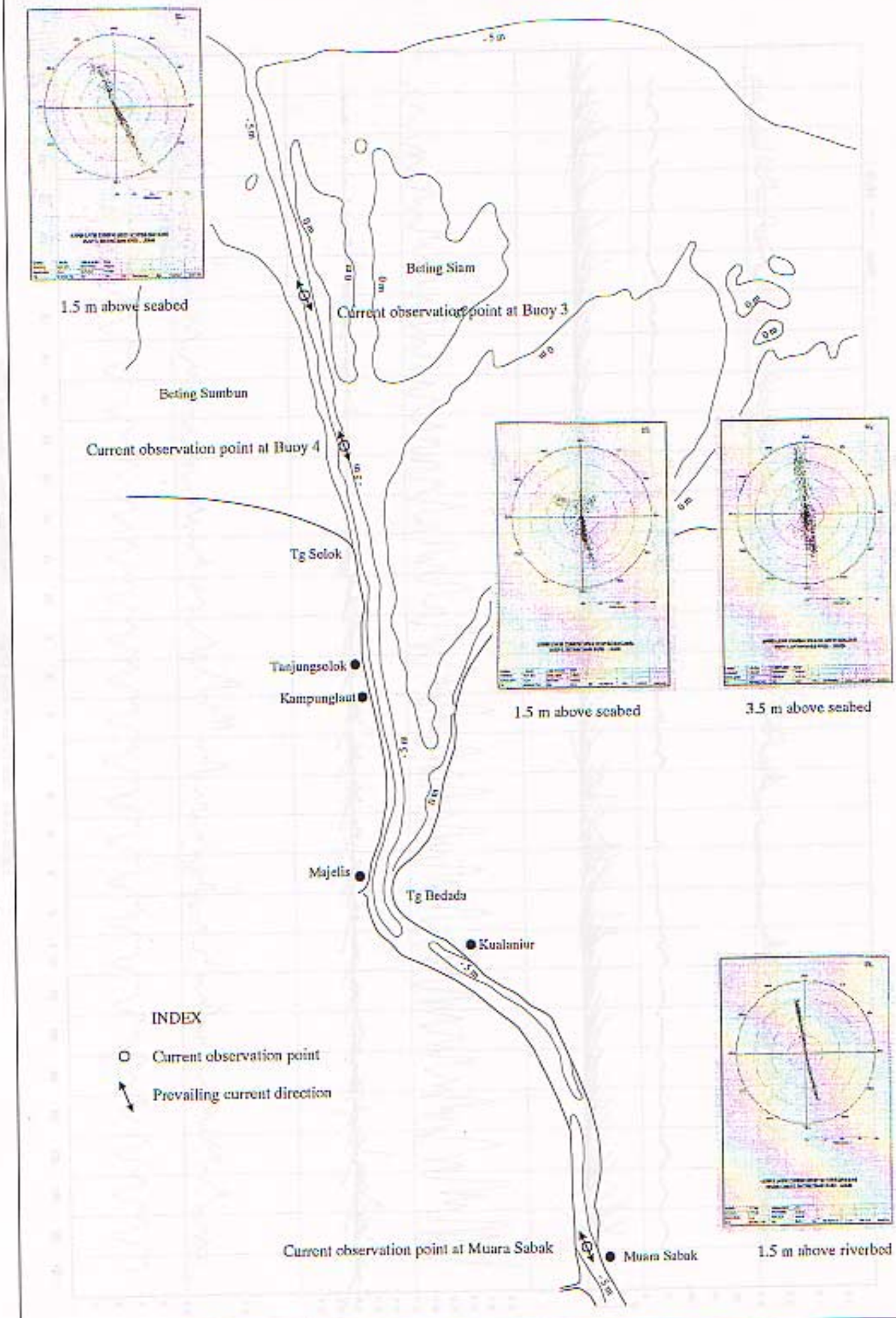


Figure 19.5.2 Prevailing Current Direction at Batang Hari River (Rainy Season)

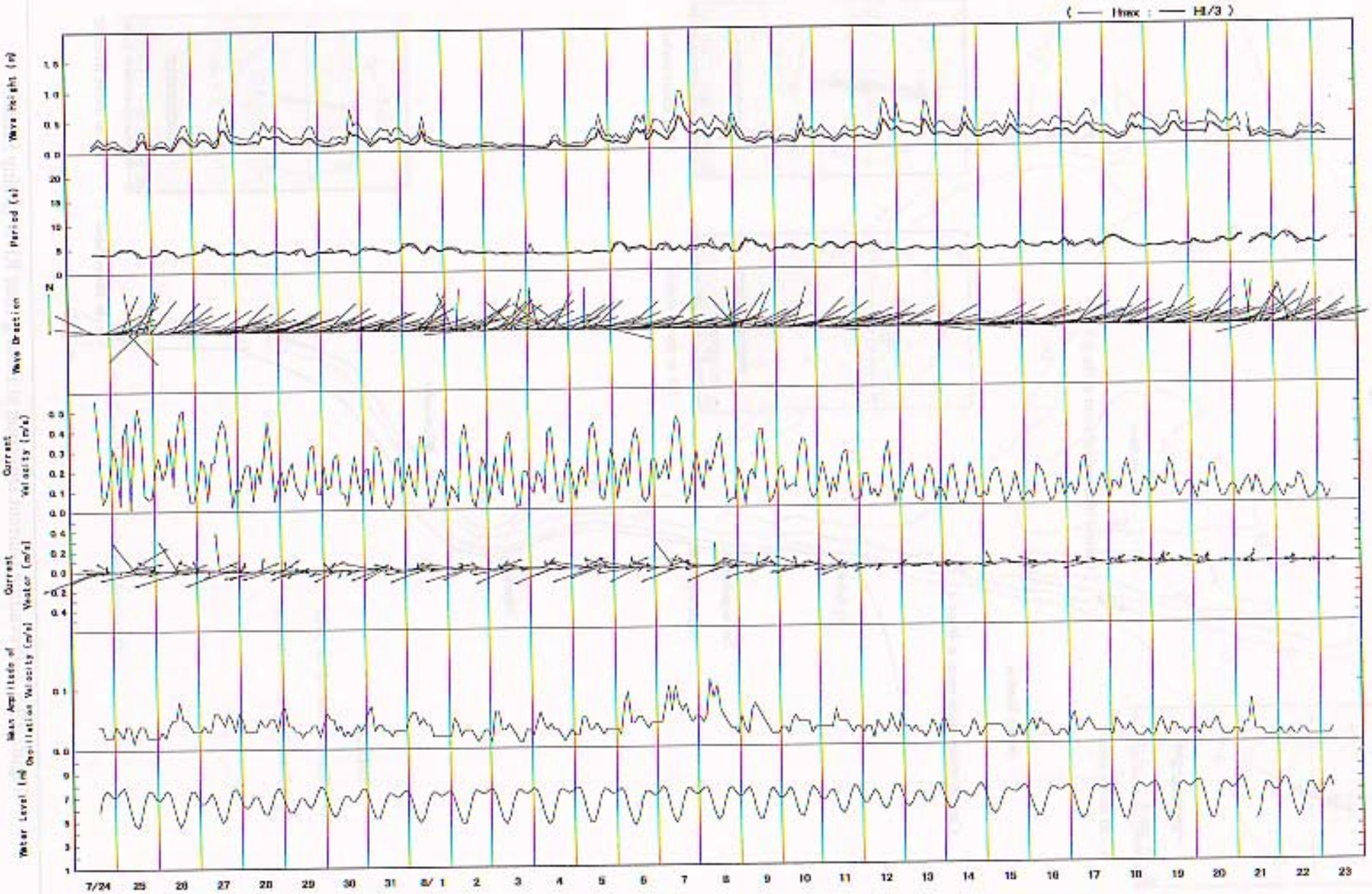


Figure 19.6.1 Time Series of Wave Height and Current (Muara Sabak, July-August 2001)

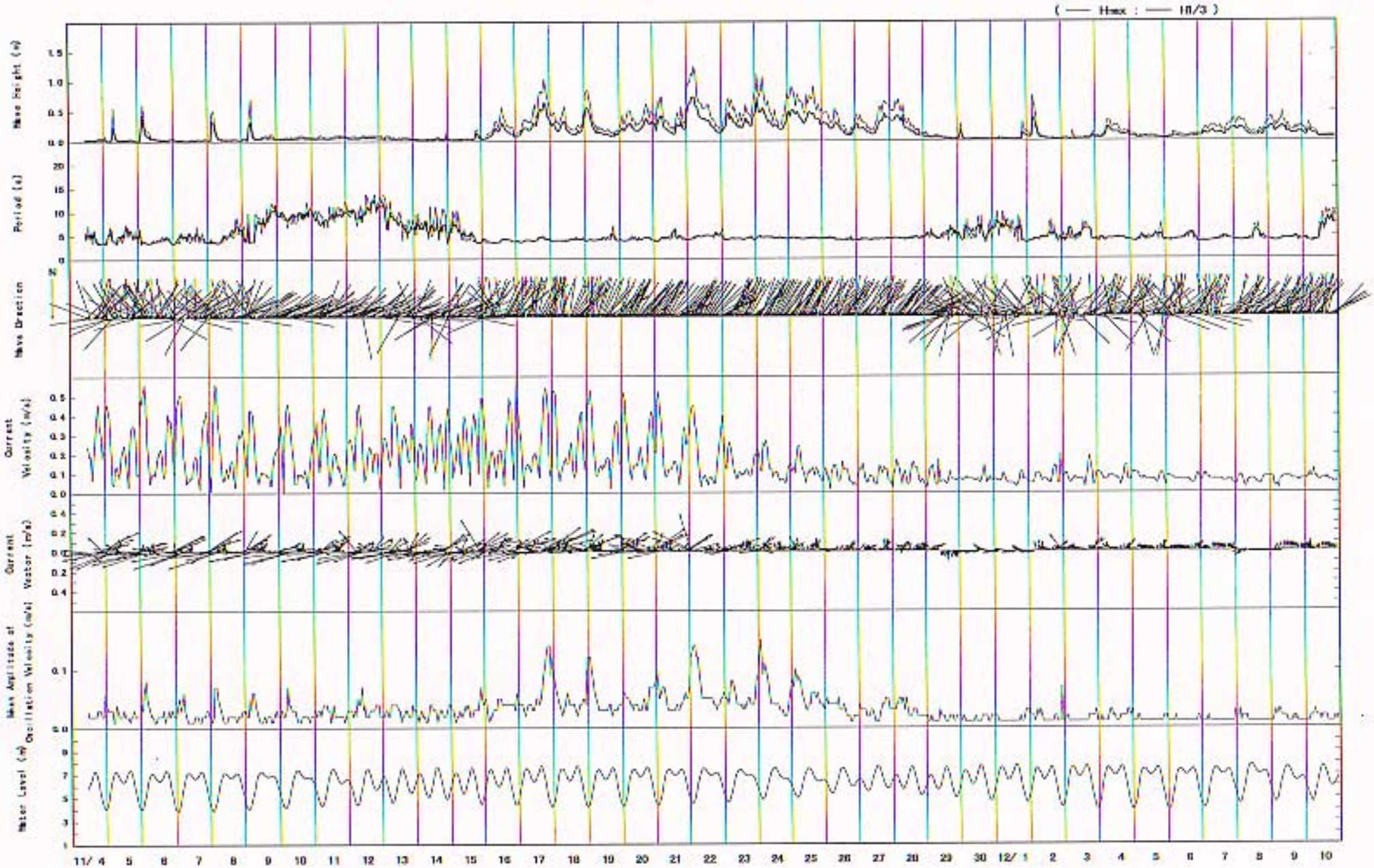


Figure 19.6.2 Time Series of Wave Height and Current (Muara Sabak, November-December 2001)

20. ENVIRONMENTAL CONDITIONS

20. 1 Environmental Characteristics of Development Site

20.1.1 Geomorphology of Low land Swamp

The Southeast region of Sumatra including the study area is formed with the swamp area and the tropical rain forests. The region is endowed with the vast area and precipitation, but the soils in the region is not suitable for paddy because the region is consisted of swamp area like floating on the peat swamp layer with high ground water level. And the region doesn't have the geological conditions that construct the cities and the connecting roads between the cities.

Since the coastal area is blessed with the navigable rivers that cover the vast area, passenger's movement and the distribution of the products have been dependent on the river transport system. Moreover the residential area and the land use features have been formed along the rivers, large and small, and the commercial urban areas were developed at the confluences.

The roads connecting the upstream and downstream areas of the river have been begun to construct lately in 1982. The construction of trans-Sumatra highway has just started.

20.1.2 Deforestation in River Basin

The region's economy is still dependent on the mineral resources and forest products. In the river basin of Batanghari River, the tremendous forest exploitation was carried out especially from 1970s. The deforestation has reached to a severe stage.

Currently the very large forestland area has been converted to the oil palm plantation and oil palm industry is becoming the main industry accounting for the 10 % of GRDP of the region's economy.

Oil palm plantation development has been carried out in the mid stream area of the river basin, the roads construction in the area has quickened the oil palm plantation development. And the urban area connected with the roads has been the base of products processing from the plantation.

The process of the deforestation in Batanghari River basin in 1932, and 1982 and 1996 is shown in Figure 20.1.1.

The current high volume of the soil erosion caused by the deforestation of the upstream area obviously increase, the discharge of soil into the river. the sedimentation in the last three decades at the Jambi old port is one of the evidences of the exploitation of mountain area in the river basin.

20.1.3 Estimation of Soil Erosion Volume Caused by Deforestation

(1) Estimation equation of soil erosion volume

An estimation of the soil erosion was set out to evaluate the effects of the deforestation in the Batanghari River Basin to the siltation in the river channel.

We adopt USLE (Universal Soil Loss Equation) for the estimation of soil erosion volume caused by deforestation in the Batanghari Basin. The method of estimation is USLE and the function of USLE is as follows:

$A = R * K * L_S * C$

Where

A: Annual soil erosion volume in unit area (t/yr.) this is the Emission Factor.

R: Coefficient of precipitation

K: Coefficient of Soil

L_S: Coefficient of topography

C: Coefficient of vegetation (Land use)

(2) Deforestation area and soil erosion volume

Deforestation area was calculated with the USLE function. And the eroded soil volumes were calculated with the USLE above described. They are summarized in Table 20.1.1.

Table 20.1.1 Eroded Soil caused by Deforestation

Batanghari	Basin Area: 4,455,400 ha Deforestation area (ha)		
1932-1982	479,717		
1982-1996	1,650,722		
Batanghari	Forest area (ha)	Farmland and others (ha)	Eroded soil (t/yr)
1932	4,052,406	402,993	604,939
1982	3,572,689	882,710	1,218,977
1996	1,921,967	2,533,432	3,331,901
Annual soil erosion (t/ha/yr)	0.02	1.3	

If this estimated volume of eroded soil 3,331,901 (t/yr) using by USLE is compared with the estimated suspended sediment 3,043,690 (t/yr) in Table 8.1.2 in Chapter 8 which is calculated by multiplying Observed Suspended Solid by Yearly Discharge, these two different estimations come out approximately the same values.

(3) Deforestation area and soil erosion volume in Batanghari Basin

The forest area remaining in 1932 was over 4 million ha, however it was decreased less than 2 million ha by about 2 million ha in 1997 after 64years period. Regarding the soil erosion volume during the period of 64 years from 1932 to 1997, 604,939 t/yr. in 1932, and 3,331,901 t/yr. in 1997. It can be said that over 5 times soil volume is flowed into

river year by year.

The deforestation area rate from 1982 to 1996 is 126,978 ha/yr.. Let's assume that 125,000 ha forest area deforested annually, forests in Jambi are extinct and 5.7 million ton of eroded soil will be estimated to flow into the Batanghari Basin in 2011 Let's try to simulate this estimation to the oil palm plantation expansion program of Jambi Province. Oil plantation area in 1999 is 0.3 million ha, the program mentioned that it should be expanded 1 million ha in the future.

Table 20.1.2 Soil Erosion Estimation in 1996 and 2011

	1996	2011
Forest Area (ha)	1,921,967	46,967
Farmland and Other area (ha)	2,533,432	4,408,432
Soil Erosion from Forest (t/ha)	38,439	3,293,462
Soil Erosion from Farmland and Other area (ha)	2,533,432	4,533,432
Total Soil Erosion Volume (t/yr)	3,331,901	5,891,900

The Source: JICA study team

Table 20.1.3 Soil erosion increment from Oil Palm Plantation

Oil palm plantation area (ha)	Soil erosion volume estimation (t/yr)
300,000	390,000
1,000,000	1,300,000

The Source: Oil palm plantation area: BPS of Jambi
Soil Erosion estimation: JICA Team

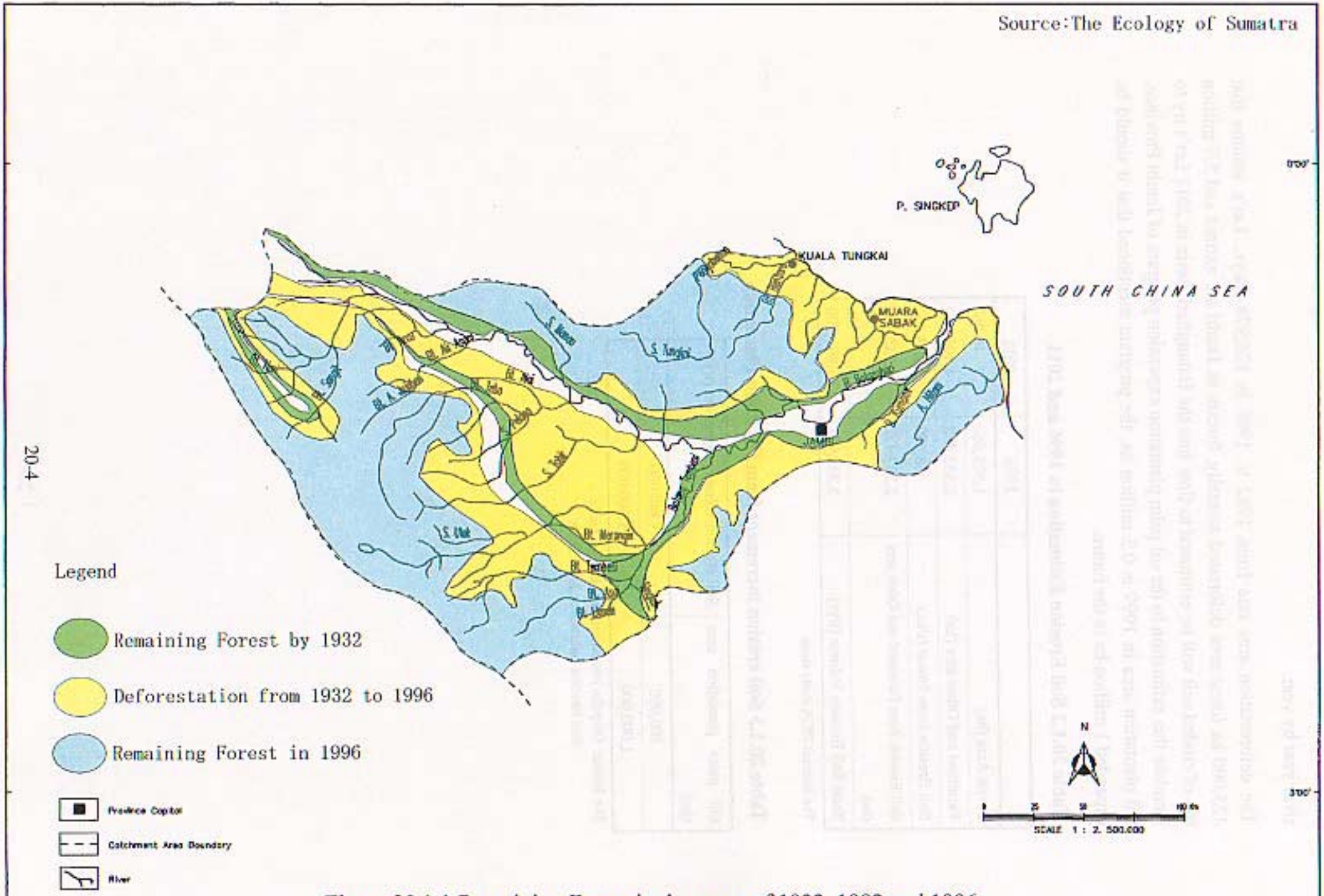


Figure 20.1.1 Remaining Forest in the years of 1932, 1982 and 1996

20.2 Environmental Conditions Survey

Full scale Environmental Survey has been conducted by JICA Study Team at the two priority ports. The objectives of the environmental survey are to understand the current condition of environment and to obtain primary data in order to prepare Environmental Impact Assessment (EIA: AMDAL Study). Choosing of survey items and survey accuracy should satisfy the AMDAL requirement.

In order to conduct the EIA study for the Short-term development of the two priority ports, following environmental items were studied.

(1) Social Environment (Socio-Economic Aspects, Land use, Traffic)
(2) Environmental Pollution (Water Quality, Riverbed Material, Air Quality, Noise, and Vibration)
(3) Biological Environment (Terrestrial and Aquatic Fauna and Flora)

20.2.1 Method of Environmental Survey

(1) Survey area (Water, Air, and Traffic survey)

Survey area of the environmental study was in accordance with the Master Plan of port development. Survey areas in Jambi Province were as follows and the detail locations are shown in Figure 20.2.1 and Figure 20.2.2 (see at the end of this section).

Province	Name of survey area
Jambi	Talang Duku
	Muara Sabak
	Estuary area of Batanghari River

(2) Survey Method

Survey items are summarized in Table 20.2.1.

20.2.2 Results of Environmental Condition Survey

(1) Social Environment

Present social environmental conditions are tabulated in Tables 20.2.2 (Talang Duku) and 20.2.3 (Muara Sabak).

(2) Environmental Pollution

Present environmental pollutions are tabulated in Tables 20.2.4 (Talang Duku) and 20.2.5 (Muara Sabak).

Table 20.2.1 Survey Method

Environmental Parameters		Studied Items	Method
Social Environment	Socio Economy	a. Population b. Economy c. Culture d. Public Health	Secondary data collection and interview survey
	Land Use	a. Port facilities b. Commercial area c. Residential area d. Cultivated area e. Forest area f. Fishery area	Secondary data collection and interview survey
	Traffic Volume	a. Sedan car b. Bus c. Truck (large) d. Truck (small) e. Motorcycle	The surveyor counted the vehicles passing the sampling points.
Environmental Pollution	Water Quality	a. Salinity b. Suspended Solid c. Dissolved oxygen d. BOD e. COD f. Coliforms g. Oil and grease content h. Phenol i. Ammonia nitrogen j. Total N k. Total P l. Cadmium m. Chromium n. Copper o. Nickel p. Iron q. Lead r. Zinc	Sampling was done twice a year, one in the dry season and another in the rainy season. Water samples were collected at two layers (lower and upper layer) of water column. And the water sampling was carried out twice a day, i.e., one in ebb tide and another in flood tide.
	Riverbed Material	a. Granular Analysis b. Ignition loss c. Density d. Water content e. Mercury f. Arsenic g. Lead h. Chromium i. Cadmium	Sampling was carried out twice, one in the dry season and another in the rainy season .
	Air	a. CO b. SO_2 c. NO_x d. SPM (Suspended Particulate Matter)	Sampling was continuously carried out for 7 days at the same point.
	Noise and Vibration	Noise level (Leq) and Vibration level	For each Noise and vibration measurements, Sampling was continuously carried out for 7 days at the same points.
Biology	Biological survey	Fauna and Flora	The fauna and flora were surveyed in and surrounding of the proposed project sites. The inventory of fauna and flora in the area was studied by field survey and interview survey, especially regarding Mangroves, Fish, and Animals.

(3) Biological Environment (Fauna and Flora)

1) Fauna

a. Terrestrial Fauna

There is not many kind of animals around the project area because most of the animal habitat are yard vegetation and mixed plantation. Also surrounding area of the project site has been already developed.

Some wild animals were found around the Talang Duku locations. They are big monkey, squirrel, bird, and wild pig. Besides wild animals, there are also domestic animals, pets or livestock. They are as follows; goat (*Capra sp.*), cow (*Bos taurus*), buffalo (*Bubalos bubalis*), dog (*Canis sp.*), chicken (*Galus galus*), duck, goose, and cat.

b. Aquatic Fauna

Observation results on fishery in Batanghari River (Talang Duku) close to river ports are as follows. Based on the report of identification and inventory of "plasma nutfah" germ of life of fishery in Jambi Province water on 1993, found about 14 genus, 24 family, and 131 species of fish. Some of fish have wide area of distribution starting from high land (Kerinci District) to lower land (Jambi Council Office). They are Barau fish (*Hampala macrolepidota*), "tilam" (*Mastocumbelus maculatus*), "keperas" (*Puntius tawarensis*).

- Biodiversity

  Several fishes are important and have economic value for human consumption. These fishes were found during survey, such as: belida (*Notopterus sp*), "patin", "kelemak", and "ringo". In addition to these, there are also fishes known as ornamental fishes i.e.: "tilam", "botia", "langli", "keleso", etc.

- Endangered Fish

  Kind of endangered fish are as follows: "botia" (*Botia macracantha*), "belido" (*Notopterus sp*), "Patin" (*Pangasius pangasius*), "Caka ― caka" (*Chaca chaca*), "beledo" or "arwana" (*Schleropages formosis*) and "bajubang" (*Balansiocheilus melanopterus*), which have economic value as consumption fish as well as ornamental fish.

- Potential Kind of Fish

  In order to maintain biodiversity of fish and as an economic resource, "Dinas Perikanan Daerah" (Local Fishery Department) of Jambi Province proposed several primary/potential kind of fish in some Kabupaten such as Kabupaten Tanjung Jabung, and Kota Jambi.

  Primary/potential fish in Kabupaten Tanjung Jabung are "patin" (Pangusius pangusius), "belido" (Napopterus sp), and "Keleso" (Scheropages formasis) which has economic value as consumption and ornamental fish. Primary fish in Kotamadya Jambi are

"Botia" (Botia macracanthus), "Ringo"(Thymethys thynoides), "Lampan"(Puntius schwanefeldi), "Kelemak" (Leptobarbus koevini), and "Putting beliung" or " Caka—caka" (Chaka chaka).

c. Other Aquatic Organisms

Other plant and animals in water such as plankton and benthos can be used as biological indicator. Plankton consist of microscopic plant (*Phyitoplankton)* and microscopic animal *(Zooplankton).* Existence of plankton is affected by quality and quantity of water as a biotic component of aquatic ecosystem.

2) Flora

Flora in study area consist of forest ecosystem, swamp ecosystem, and agriculture ecosystem that consist of plantation, yard, and bushes.

- Forest Ecosystem

  Forest in surrounding area of the study area is wet tropical forest.

- Swamp Ecosystem

  Some Swamp ecosystem is caused by tidal—wave from Batanghari river. A number of identified swamp plants are Nipah *(Nipa fruticans),* Api—api *(Avicenia sp),* Ketapang *(Terminalia catappa),* Nyamplung *(Calophylum soulatri),* Pandan—pandanan *(Pandanus tectarias*), Paku—pakuan *(Stenachlaena palustris),* dan Butun *(Baringtonia racemosa).*

- Plantation Ecosystem

  Plantation Ecosystem consists of monoculture plantation and mixed plantation. Monoculture ecosystem, such as perenial plants, has short life cycle. Some of them are Paddy (*Oryza sativa*), Corn (*Zea mays*), Soybean (*Glycine max*). Besides these annual monoculture are identified, such as Coffee (*Coffea s*p), Coconut (*Cocos nucifera*) and rubber plantation *(Hevea sp.)* which has economically potential for local population.

- Bushes Ecosystem

  Bushes ecosystem is plants that grow without human interference. Bushes commonly found in unused plantation, landslide, and riverbank.

  Identified bushes vegetation is Coarse grass *(Imperata cylindrica)*. Some of brushwood are big sensitive plant (*Mimosa vigra*), "sedudu jarak" (*Zatropa curcas*), "gelegah" (*Sacharum sp*., "kirinyuh" (*Cromolaena odorata*), "wedusan" (*Ageratum conyzoides*), "temblekan" (*Lantana camara*), "beluntas" (*Pluchea indica*), "rumput air" (*Axonopus conipressus*), grass (*Paspalum sp.*), Weed (*Cyperus sp.*), etc.

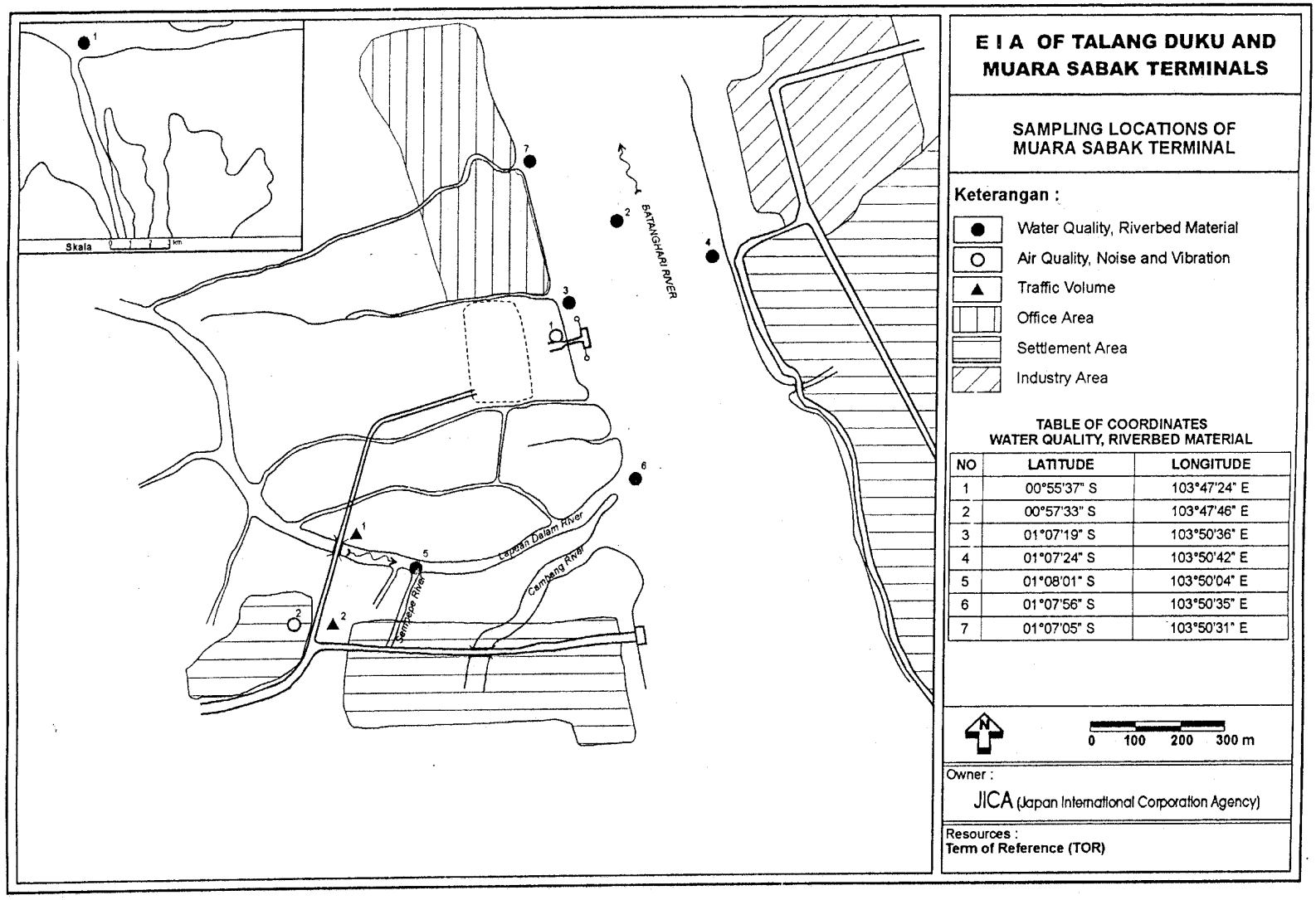


Figure 20.2.2 Location of Water, Air, Noise, and Traffic Survey at Muara Sabak Site

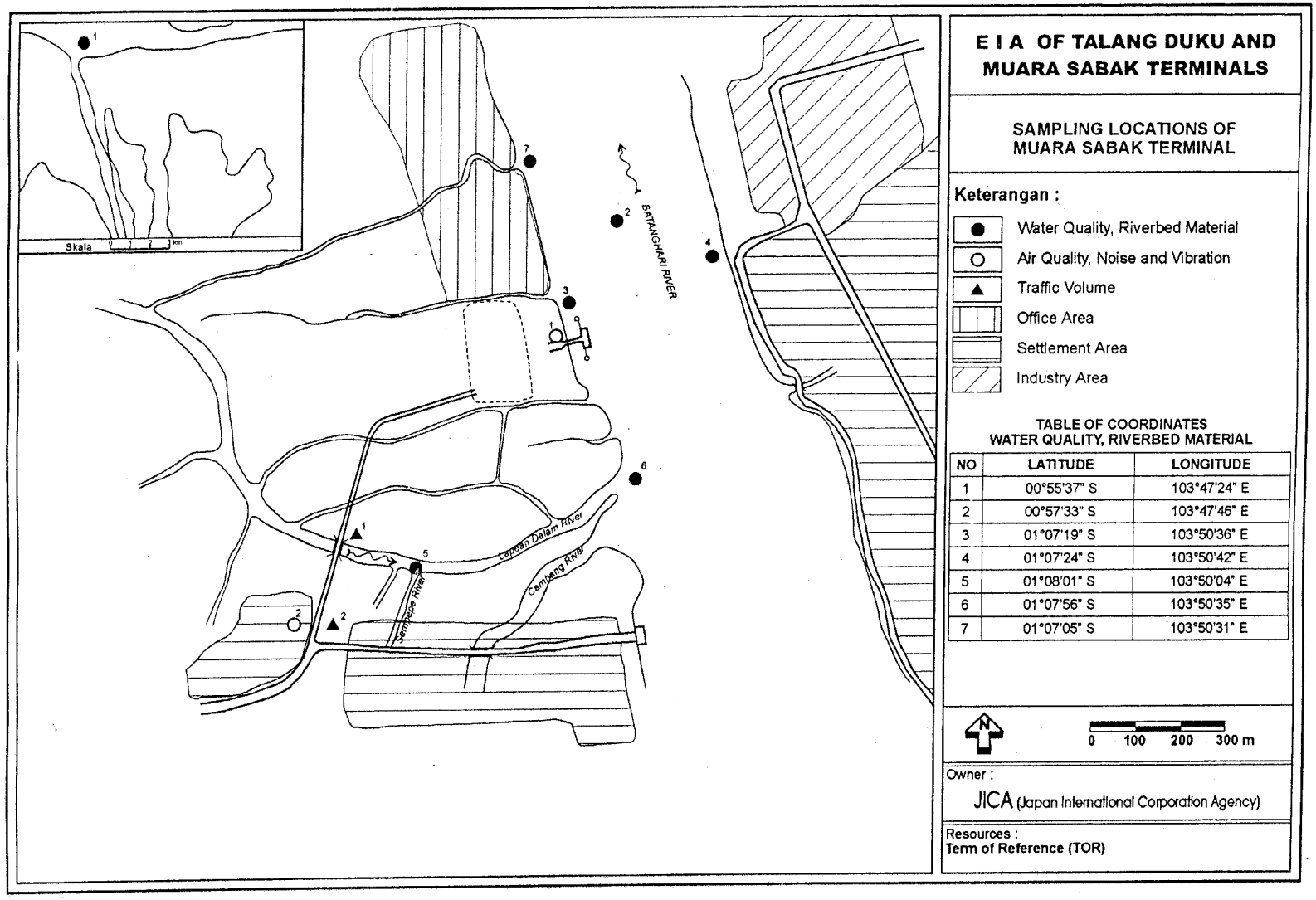


Figure 20.2.2 Location of Water, Air, Noise, and Traffic Survey at Muara Sabak Site

Table 20.2.2 Existing Social Environmental Conditions (Talang Duku Terminal)

Parameters	Items	Conditions
1) Social Economic Aspects and Culture	1. Population and Population Density	Number of people in Talang Duku village is 1,590 which comprises of 318 households. The area is 33 km^2 and population density is 48 inhabitant / Km^2.
	2. People Structure According to Age and Sex	People in Talang Duku are dominated by working age of 15—59 years that is 899 inhabitant (56.54 %) which constitute the most number of people in Talang Duku village and Maro Sabo Sub—District. According to sex ratio, people in Talang Duku village comprises of 800 (50.3 %) male, and 790 (49.7 %) female so that sex ratio is 1.01. In Maro Sabo Sub—District comprises of 10,047 male (49.3 %) and 10,352 female (50.7 %), while sex ratio is 0.97.
	3. Population Growth	The rate of people growth in Talang Duku village and Maro Sebo Sub—District are 0.04% and 0.10%, respectively, so that it is categorized as low growth rate. It is probably caused by low fertilities and low urbanization rate.
	4. Occupations and People Income	Most people in Maro Sebo Sub—District majorities is farmer (87.24%). The rest is fisherman (8.47%), labor (0.58%), trader (2.9%), Civil Servant/Soldier/ Pensioner (0.24%), craftsman (0.98%) and services (0.10%). The main farming activity of people is food plant and horticulture. The labors are farming labor, construction labor, industrial labor etc. Based on result of interview survey in surrounding area of the project location (Talang Duku), Majorities of people is farmer (25%), fisherman (25%), trader (15%), labor (10%), Civil Servant/Soldier/Pensioner (10%), craftsman (10%) and services (5%). Based on interview result with 40 respondents, from different occupation, most of them (55%) earn between Rp. 100,000 – Rp. 300,000 per month, while the average income surroundings the project area is Rp. 140,000 per month.
	5. Business Facilities	Business facilities in Maro Sebo Sub—District and Talang Duku village is low in number because there are not many business activities in surrounding of the port.
	6. Fishermen and Fishery	In Talang Duku, there are 70 fishermen who catch the river fish along Batanghari river from Angsoduo (fish harbour, upstream of Talang Duku) to down stream of Talang Duku Terminal. They use 50 boats to catch the fish with the yield about 6 kg/person/day in the dry season and 4 kg/person/day in the rainy season. The fishing ground is usually along the river bank so that no disturbance of river traffic

		happened on the fishermen activities.
	7. Education	Education facilities in Talang Duku Village consists only 2 Elementary School (SD) and one Junior High School (SLTP), while there are 35 Elementary School (SD) and 4 Junior High School (SLTP) in Maro Sebo sub－district.
	8. Religion	Majority of peoples in Maro Sebo Sub－District are Moslem (99%), and the rest is Protestant (1%), While in Talang Duku Village the people are 100% Moslem.
	9. Cultures and Habit	Culture and habit of people are difficult to quantify. But from daily activities it is clearly seen that cooperation among people is very dominant. In their daily activities they visit each other, come to see sick or die people, corporate to conduct a party, marriage, etc.
	10. Social Process	People around project location never has social problem with another groups because deliberation and tolerance are well implemented between them. Friction usually happens only between individuals. According to the interview result with several interviewer around the project 95 % of the people confess that they have no quarrel with anybody or any group of people. The rest of 5% confess that they had quarrel about land property boundary, something lost, and about their own family problems.
	11. Social Stratification	Social Stratification of society around project location absolutely can't be seen. The gap between rich and poor people is not seen. This is caused by productive activity of rich people, such as buying livestock, opening small shop, buying rice field and only 5 % of them will buy consumptive things if they have extra money.
	12. Social Interaction	Social interaction will be occurred if two of different social groups are meet or mix each other. Social Interaction often happens between local people with new comer because of the difference between their customs, habit, culture, and religion. There is no social friction or social conflict between local people and new comer, because there is no cultural exclusivity in their community.
	13. People Perception on Project Activity	All of people around project location are agree with the Talang Duku River Port Development Project. The reasons are that they can create new job (30%), increase amount of people in the area so that they can sell/trade the daily requirement (40%), facilitate transportation (10%), to accelerate business

		development (15%), increase economical price of land around project area (5%), etc.
	14. Public Health Services	Public health facility in Maro Sebo Sub－District consists of 1 unit Public Health Services “Puskesmas”, 9 unit sub－Public Health Services Auxiliary (Puskesmas Pembantu), and 6 unit Family Planning Post which are served by 2, 5 medical aide or nurse and 10 midwife.
	15. Diseases Pattern	The most important diseases suffering people around project location are “ISPA” (upper breathing system irritated) and eczema. Generally these diseased caused by bad quality of environment, especially water quality for bathing and washing.
	16. Environmental Health	The majorities (100%) of people around project location use well water for drinking and cooking. Use of river water is limited for having bath and washing. Almost all of houses (90%) around project location have family WC/Toilet. But a part of familes dispose the domestic waste (excrement) to the river using connection pipe from their house to the river. Almost none of family toilet/WC use septic tank for family waste. Only 10% of the people in project location still use river for relieving their self (defecate).
2) Land Use	Existing Land Use and Muara Sabak Sub District	The land use of Muara Sabak City is dominated by yard and unused land. Total area of Muara Sabak Sub District is 21,265 ha (100 %) composed of housing 320.50 ha (1.51 %), forest 5,145.30 ha (24.2 %), and agricultural field 10,272 ha (48.31 %), and River 1,143 ha (5.37 %). Based on the data of Muara Sabak Sub District, the area of Savannah is wider than that in other sub district. This condition shows that community in Muara Sabak Sub District is depending on the agriculture sector.
3) Traffic Volume		The record of traffic volume indicates the business activity of the study area. The bigger the traffic volume indicates the bigger business intensity, which show that there are the centers of business activities. There are three traffic directions in Talang Duku, i.e Kemingking, Kota Jambi, and Talang Duku Terminal (PELINDO). The biggest traffic volume is in the direction of Jambi with total volume 1,784 vehicles/day and Kemingking 985 vehicles/day. The traffic intensity of all directions is relatively high during the working day from 8:00 to 18:00, while the peaks at the intensity occur from 10:00 to 11:00 and from 15:00 to 16:00, and the lowest intensity occur in the night from 24:00 to 6:00. The traffic is dominated by motor cycles and most of the vehicles are in the direction to Jambi and Kemingking which are 760 and 438 vehicles/day,

		respectively. Small trucks in the direction to Jambi are 477 trucks/day, 241 trucks/day to Kemingking and 190 trucks/day to PELINDO. While big trucks are 293 trucks/day to Jambi, 159 trucks/day to Kemingking and 126 trucks/day to PELINDO. The intensity of sedan car traffic is relatively low, only 253, 147, and 145 cars/day on the direction of Jambi, Kemingking, and PELINDO. In addition to traffic activities the number of pedestrian is also recorded. The total pedestrian is 265 persons/day consisting of in the direction of Kemingking 100 persons/day, Jambi 98 persons/day and PELINDO terminal 63 persons/day.

Table 20.2.3 Existing Social Environmental Conditions (Muara Sabak Terminal)

Parameters	Items	Conditions
1) Social Economic Aspects and Culture	1. Population Growth	The residential population in Muara Sabak in 1994 was 9,503 inhabitants, and has increased to 9,694 in 1999. Average growth rate of population during 1994—1999 was 0.4% . The growth is relatively low if it is compared with the average population growth of Indonesia.
	2. Distributions and Population Density	Distribution of people in Muara Sabak is concentrated in the center of the city. Based on the data in 1999, the most people is living in Kelurahan Muara Sabak, there are 606 habitants in it. The density of the people in Kota Muara Sabak is 46 inhabitants/Km^2. The highest density is in Desa Muara Sabak which is 101 inhabitants/Km^2. It is caused by Desa Muara Sabak is the center of city activities and center of sub—district and there are regional government offices. The lowest of density is in Desa Nibung Putih, 11 inhabitants/Km^2. Refers to density classification to the UUPA above, Desa Muara Sabak and Kota Muara Sabak is classified as low–dense.
	3. Structure of People	According to sex, people in Muara Sabak Sub—District comprises of 4,885 male (50.4 %) and 4,808 female (49.60 %), sex ratio is 1.02 in year 1999.
	4. People Structure According to Occupation and Income	People in Muara Sabak is dominated by productive (working) age (15—59 years) that is 899 inhabitant (57.99 %). Working age constitute the most number of people in Muara Sabak village and Muara Sabak Sub—District. This structure is very profitable to provide manpower supply. But on the contrary, it demands enough number of field of work. Based on observation in the site, activities of people in Kota Muara Sabak according to profession structure are as follows: Trading construction services, general services, river and land transportation, small industry and farming. The most favorite activities are trading, transportation, and farming.
	5. People Structure According to Religion	Most of people in Muara Sabak are Moslem. Beside Moslem, the religions of people in Muara Sabak are Protestant—Christian and Buddhist. In 1997, Moslems are 9,645 (99%) inhabitants, Protestants are 60 (0.6 %) inhabitants and Buddhist are 5 (0.05%) inhabitants.

	6. Agriculture Production and Animal Husbandry	In the production of agriculture, rubber plantation is the biggest (296.1 ton), followed by coconut plantation (178.3 ton), and the total amount with other plantation is 506.45 ton. Almost all of the coconut is produced from Muara Sabak. However Muara Sabak has not many animal husbandry. The total number of animal is only 165.
	7. Occupation and People Income	Most people in Muara Sabak are farmers (81.2 %). The rest are farming labor (3.7 %), labor (4.9 %), trader (6.4 %), fisherman (0.9 %), entrepreneur (0.7 %), service transportation (0.9 %), and handicraft (1.3 %). Based on interview result with 40 respondent, most of them (62.5 %) earn between Rp 300,000 — Rp 500,000 per month while the average income of the people in surrounding of the project area is Rp 250,000 per month.
	8. Business Facilities	There are not many business activities in surrounding of the port.
	9. Fishery and Fishermen	There are 3,204 fishermen, consists of 2,511 marine fishermen, 370 river fishermen , and fishermen living on fresh water fish ponds and coastal fish ponds. The biggest number of fishermen is 866 persons who live in Muara Sabak. The total fish production in Tanjung Jabung Timur is 25,900 tons/year which consists mostly marine fishery 25,077 tons/year. Field survey on study area in Muara Sabak and Kampung Laut which will be effected by the development and operation of the river terminal and the dredging of Batanghari river channel indicated that there are 80 river fishermen using 20 motor boats and 40 traditional boats in Muara Sabak. The fishermen who live in Kampung Laut consists of 182 non trawl fishermen who catch the fish in the river mouths and near shore sea using 125 motor boats and 50 speed boats, and 200 to 400 trawl fishermen who catch the fish in off shore sea using trawl boats .
	10. Education	Education facilities in Muara Sabak Sub—District is not enough, there are 7 Elementary School (SD), 2 Junior High School (SLTP) and one Senior High School (SMA) in Muara Sabak Village. In Muara Sabak sub—district 10 Elementary School (SD), 2 Junior High School (SLTP) and 1 Senior High School (SMA) are found.
	11. Culture and Habit	Major ethnic in Muara Sabak are Melayu, Bugis, Chinese and Java. Culture and Habit of people are difficult to quantify. But from daily activities it is clearly seen that cooperation among them is very dominant. In their daily activities they visit

		each other, come to see sick or died people, corporate to conduct a party, marriage, etc.
	12. Social Process	People around project location never has social problem with another groups because deliberation and tolerance is well implemented between them. Friction usually happens (even rare) between individuals.
	13. Social Stratification	Social Stratification of society around project location absolutely can't be seen. The gap between rich and poor people is not seen. This is caused by productive activity of rich people, such as buying livestock, opening small shop, buying rice field and only 5 % of will buy consumptive things (car, embellishment etc) if they have extra money.
	14. Social Interaction	Social Interaction is occurred if two of different social groups are meet or mix each other. Social Interaction often happens between local people with incomer because of the difference between their customs, habit, culture, and religion. There is no social friction or social conflict between local people and incomer because there is no cultural exclusivity in their community.
	15. People Perception on Project Activity	Most of people surrounding project location are agree with the project Muara Sabak River Port on Pre－Construction, construction, and operation and maintenance. The reasons are that they can create new job (40%), increase population mobility so that they can sell/trade agriculture and fisheries production (35.0%), increase easy population mobility (5.0 %), accelerate business development (15.0 %), and Muara Sabak is coming cheerful to develop (5.0 %), etc.
	16. Public Health Services	Recently, public health facility in Muara Sabak Sub－District consists of 1 unit Public Health Services "Puskesmas", 1 unit sub－Public Health Services Auxiliary (Puskesmas Pembantu), and 16 unit Family Planning Post. Medical personnel existing in Muara Sabak Sub－District consists of 1 Doctor.
	17. Diseases Pattern	The most important diseases suffering people around project location are "ISPA" (upper breathing system irritated) and eczema. Generally these diseases are caused by bad quality of environmental conditions, especially water quality used for bathing and washing.

	18. Sanitation	The majorities (100%) of people around project location use well water and PAM water for drinking and cooking. Use of river water is limited for bathing and washing. Almost all of the people's house (90%) around project location have WC/Toilet family. But a part of families dispose the domestic waste (excrement) to the river using connection pipe from their house to the river. Almost none of family toilet/WC use septic tank for family waste. Only 10% of people in project location still use river for relieving their self (defecate).
2) Land Use	Existing Land Use and Muara Sabak Sub District	The land use of Muara Sabak City is dominated by yard and unused land. Total area of Muara Sabak Sub District is 21,265 ha (100 %) composed of housing 320.50 ha (1.51 %), forest 5,145.30 ha (24.2 %), and agricultural field 10,272 ha (48.31 %), and River 1,143 ha (5.37 %). Based on the data of Muara Sabak Sub District, the area of Savannah is wider than that in other sub district. This condition shows that community in Muara Sabak Sub District is depending on the agriculture sector.
3) Traffic Volume		The intensity of traffic volume in Muara Sabak is less than Talang Duku. Muara Sabak is the capital of Tanjung Jabung Timur District. But there is no bridge crossing Batanghari River which devides the city into the west part and east part. The island traffic on the road is terminated in the west part and it is continued to the east Terminal with boats crossing the river. There are two traffic directions in Muara Sabak, i.e Terminal and Kota Jambi. The biggest traffic volume is in the direction of Jambi with total volume of 184 vehicles/day and in the direction of Terminal with total volume of 126 vehicles/day. The busy traffic happened during the daytime to the night from 8:00 to 20:00 while the peak hours occur from 11:00 to 12:00 in the morning and from 15:00 to 16:00 in the afternoon. The traffic is dominated by motor cycles. Most of the vehicles is in the direction of Jambi 95 vehicles/day and of the Terminal 54 vehicles/day. There is only one truck/day to the river terminal and no small truck to Jambi. There also no big truck in the direction of Jambi and river terminal. Small Bus in the direction of Jambi is 27 small buses/day and on 41 small buses/day to river terminal. The intensity of sedan car traffic is relatively low, only 43 cars/day to Jambi and 47 cars/day to river terminal. In addition to traffic activities the number of pedestrian is also recorded. There is only 4 persons/day pedestrian to the terminal and no pedestrian to Jambi.

Table 20.2.4 Environmental Pollution (Talang Duku Terminal)

Parameters	Items	Conditions
1) Water quality	1. pH	Observation result of water pH around Talang Duku in the dry season is normal (7.0 to 7.6), this condition is almost the same in the rainy season (6.7 – 7.4).
	2. Dissolved Oxygen (DO), BOD, and COD	Water quality of Talang Duku River Port in the dry season indicates that dissolved oxygen content (5.9 – 7.2 mg/L) is relatively in good condition, even the BOD (2.0 – 13.0 mg/L) and COD (4.0 – 27.0 mg/L) concentrations sometimes exceed the standards. In the rainy season concentrations of BOD and COD are 9.2 – 14 mg/L for BOD and 23.6 – 34 mg/L for COD.
	3. Salinity	Batanghari River water at Talang Duku is fresh water as indicated by very low salinity.
	4. Suspended Solid	The concentration of suspended solid in the river water in the dry season is very small. In the rainy season the concentration of suspended solid is about 150 - 400 mg/L.
	5. Oil and Grease	Oil and Grease concentrations in the dry season are high (21 – 34 mg/L) and far above the standards, which is caused by waste oil or/and spilled oil from river transportation. A condition is almost the same in the rainy season as UD (undetected/undetectable) – 15 mg/L.
	6. Phenol	Phenol concentration is UD – 0.04 mg/l in the dry season and no phenol is detected in all samples in the rainy season.
	7. Ammonium (NH_4)	Ammonium concentrations in the both seasons are relatively normal. Those are 0.007 – 0.029 mg/L in the dry season and 0.07 – 0.22 mg/L in the rainy season, which are still below the standards.
	8. Total Nitrogen (Total-N) and Total Phosphorous (Total-P)	Total N and P concentrations in the dry season are 0.033 — 0.219 mg/L and 0.272 — 0.384 mg/L, respectively. In the rainy season concentrations are 0.08 – 0.28 mg/L (Total—N) and 0.91 – 1.32 mg/L (Total—P), respectively. These high N and P values indicate water pollution caused by effluents from human settlements and agricultural areas.

	9. Heavy Metal Parameter	Heavy metals concentration in the dry season are UD — 0.02 mg/L (Cu), 0.09 – 0.12 mg/L (Cr), UD – 0.01 mg/L (Ni), 0.01 mg/L (Zn), 0.11 – 0.92 mg/L (Fe) and UD (Pb), which are lower than the standards. Cd is UD – 0.02 mg/L which is some times higher than the standard. Concentration of Cu, Cr, Ni, Pb, and Cd in the rainy season were UD. Fe and Zn concentration are 0.18 – 0.71 mg L (Fe) and 0.01 – 0.18 mg L (Zn). (Note: UD – undetected)
	10. Bacteriological Parameters	In the dry season fecal coliform in the river water are 305 – 7,599 /100 mL. In the rainy season fecal coliform at the study site is 7,200 – 9,000 /100 mL. In both seasons fecal coliform is lower than the standard, which indicates water pollution caused by human and animal waste.
2) Riverbed Quality	1. Ignition Loss	Ignition loss in the bottom sediment in the both seasons are 1.71–9.15 % (dry season) and 24.02—28.74 % (rainy season), respectively.
	2. Bulk Density and Water Content	Physical characteristic of river bottom sediment of Talang Duku River Terminal indicates that the density of representative sediments are 1.28 – 1.50 gram/cm^3 and water content are 14.63 – 22.41 % for in the dry season. In the rainy season the density of representative sediments are 1.11 – 1.41 gram/cm^3 and water content are 29.10 – 37.94 %.
	3. Heavy Metals	Heavy metal concentrations in the dry season are 9.0 mg/kg(Pb), 0.9 – 4.0 mg/kg(Cr), 9.6 – 13 mg/kg(Cd), 0.02 – 0.03 mg/L(Hg) and 12 — 33 mg/L(As). Heavy metal concentrations in the rainy season are 1.15 – 1.78 mg/kg(Pb), 3.45 – 7.34 mg/kg(Cr), 0.73 – 1.67 mg/kg(Cd). Hg and As were undetected.
3) Air Quality and Noise		The concentration of air pollutants such as CO, NO_x, SO_x, and SPM are still below the air quality standard according to Ministry of Environmental No. 02/MENKLH/I/1998. The air pollution load of exhaust gas from the sources of emission like cars, ships and industries in the area surrounding Talang Duku is still low even though there are increasing of development and business activities. Also noise level is not high.

Table 20.2.5 Environmental Pollution (Muara Sabak Terminal)

Parameters	Items	Conditions
1) Water quality	1. pH	Analytical result of water pH around Muara Sabak and its estuary in the dry season is normal between 6.5 - 7.4. This pH condition is almost the same with in the rainy season which is between 6.2 and 8.0.
	2. Dissolved Oxygen (DO), BOD, and COD	Water quality at Muara Sabak Terminal in the dry season indicates that dissolved oxygen content (4.0 – 7.1 mg/L) is in extremely good condition, even though BOD (2.0 – 92.0 mg/L) and COD (3.0 – 162.0 mg/L) concentrations are sometimes exceeding the water quality standard. The concentrations of BOD and COD in the rainy season are 4.1 – 14 mg/L and 12.4 – 29.4 mg/L, respectively.
	3. Salinity	Batanghari River water at Muara Sabak and the estuary area of Batanghari River are fresh water at station 3 – 5 and saline water toward the river mouth at station 1 – 2.
	4. Suspended Solid	The concentration of suspended solid in the river water in the both seasons are low between 16 – 180 mg/L. This is caused by sedimentation process in the wide river.
	5. Oil and Grease	Oil and Grease concentration which is caused by oil wasted or spilled from river transportation in the dry season are very high (32 – 2,141 mg/L) and exceed the standard. The condition was better in the rainy season (Oil and Grease concentration from UD to 16 mg/L).
	6. Phenol	Phenol concentration is from 0 to 0.07 mg/l in the dry season and all samples in the rainy season contain no phenol at all.
	7. Ammonium (NH_4)	Ammonium concentrations in both seasons are relatively normal condition, those are 0 – 0.03 mg/L in the dry season and 0.05 – 5.06 mg/L in the rainy season. In dry season it is over the standard.
	8. Total Nitrogen (Total-N) and Total Phosphorous (Total-P)	Total N and Total P concentrations in the dry season are 0.02 — 0.22 mg/L and 0.22 – 0.40 mg/L, which indicate the water pollution caused by effluents from human settlements and agricultural areas. In the rainy season concentrations are 0.1 – 5.5 mg/L (Total—N) and 0.04 – 1.3 mg/L Total—P.

	9. Heavy Metal Parameter	Heavy metal concentrations in the dry season are UD — 0.02 mg/L (Cu), 0.01 – 0.19 mg/L (Cr), UD – 0.01 mg/L (Ni), 0.01 – 0.06 mg/L (Zn), 0.63 – 15.20 mg/L (Fe) and 0.01 – 0.09 mg/L (Pb) and 0.01 – 0.03 mg/L (Cd). Heavy metal concentrations in the rainy seasins are 0 – 0.05 mg/L (Cu), 0 – 0.09 mg/L (Cr), 0 – 0.23 mg/L (Ni), 0 – 0.16 mg/L (Pb), and 0 – 0.06 mg/L (Cd). Fe and Zn concentration are 0.09 – 1.12 mg/L (Fe) and 0.02 – 0.98 mg/L (Zn).
	10. Bacteriological Parameters	In the dry season fecal coliform contents in the river water are 0 – 286 /100 mL. In the rainy season fecal coliform at the study site are 5,000 – 9,900 /100 mL. In rainy season measured values are over the standard, which indicates influence by human and animal waste discharge.
2) Riverbed Quality	1. Ignition Loss	A percentage of ignition loss in the bottom sediment describe in the both seasons are as follow: ignition loss are 1.87 – 13.97 % (dry season) and 21.98 — 29.54 % (rainy season).
	2. Bulk Density and Water Content	Physical characteristic of the river bottom sediment of Muara Sabak Terminal indicates that bulk density of representative sediment is 0.99 – 1.47 gram/cm^3 and water content are 20.12 – 24.22 % in the dry season. In the rainy season bulk density is 1.02 – 1.41 gram/cm^3 and water contents are 26.67 – 40.26 %.
	3. Heavy Metals	Heavy metal concentrations in the dry season are as follows: Pb is lower than 10 mg/kg, Cr is 0.08 – 0.033 mg/kg, Cd is 9.6 – 13 mg/kg, Hg is 0.02 – 0.09 mg/L and As is 21 — 41 mg/L. Heavy metal concentrations in the rainy season are as follows: Pb is 0.99 – 2.78 mg/kg, Cr is 8.34 – 12.71 mg/kg, Cd is 0.70 – 1.1 mg/kg. Hg and As are undetected.
3) Air Quality and Noise		The concentration of all parameters are still below the standard and these are better than air quality of Talang Duku. Also noise level is not high.