3.6 Impact Prediction and Evaluation

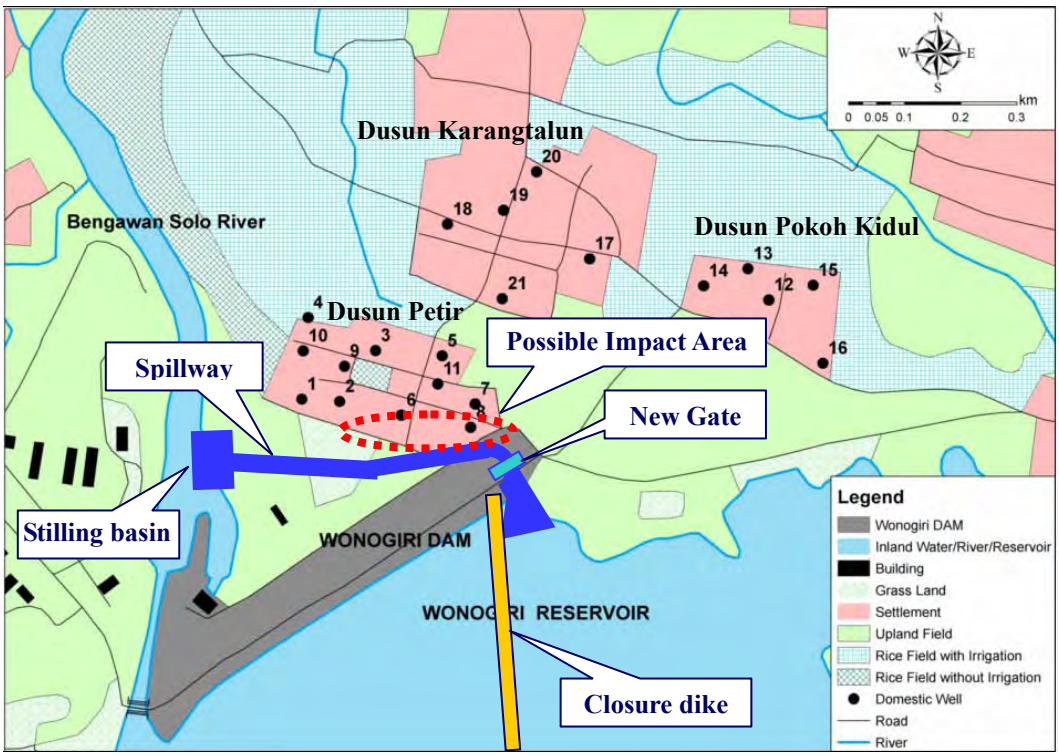
3.6.1 Physical Environment

(1) Groundwater

1) Impact Prediction

The possible impact is drawdown of groundwater level due to the excavation work for construction of spillway, and as a consequence, the inconvenience of well water use would happen.

The nearest settlement area where the groundwater well is equipped at individual house is Dusun Petir, Desa Pokoh Kidul. The distance between the existing settlement area and the spillway is about 50 m at the nearest point as shown on Figure 3.6.1.



Source: JICA Study Team

Figure 3.6.1 Possible Impact Area of Groundwater Drawdown

The design depth of the spill water is 17 m from ground surface at maximum at the location of proposed new gate and it gradually decreases toward the stilling basin and finally reaches to zero. The elevation of the bottom of the spill way is 125 m at the new gate and approx. 118m just before the stilling basin with a gradient of 1/100 (Refer to Supporting Report II Annex No.7 "Preliminary Design and Technical Evaluation on Structural Sediment Management Alternatives" for the details).

The elevation of groundwater level in Dusun Petir ranges from 120.61m to 130.94m in September, 2006 (refer to Table 3.5.2) , some of which are higher than the elevation of spill way. Accordingly, there is a possibility of groundwater drawdown due to the excavation work during construction period.

The possibility of groundwater drawdown will be limited to within Dusun Petir,

because the distance to the other two settlement areas, Dusun Karangtalun and Poloh Kidul are far enough (more than 200m) from excavation area. In addition, there is a groundwater ridge, or higher elevation of groundwater table in between the two villages and spillway (refer to Figure 3.5.2), and therefore the impact of excavation would not reach beyond the ridge.

4) Impact Evaluation

Analysis result of impact prediction indicated that the project components would cause groundwater drawdown in the vicinity of spillway due to excavation, which may result in inconvenience of water use of domestic well. The table below shows evaluation result of impacts on groundwater.

Table 3.6.1 Evaluation Result of Impact on Groundwater

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People of the nearest settlement area (Dusun Petir of Desa Pokoh Kidul) would receive the impact.
2.	Spatial extent of area subject to impact	In the vicinity of proposed location of spillway (a part of Dusun Petir of Desa Pokoh Kidul)
3.	Intensity and duration of impact	Groundwater level will drawdown until the bottom level of spillway at construction stage
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Not cumulative
6.	Reversibility or irreversibility of impact	Irreversible
Weight of impact		**Negative, Important but Not significant (-TP)**

Source: JICA Study Team

(2) Air quality

The possible impact on air quality is deterioration of ambient air quality due to the emission gas and dust generated during civil works.

1) Type of Civil Works

As shown in construction schedule (Section 3.4 Project Description), major types of civil works included in the Project are listed in table below:

Table 3.6.2 Major Types of Civil Works Included in the Project

Type of civil work	Targeted Structure	Required heavy machine
Excavation work	Spillway, Closure dike, Overflow dike	Bulldozer, Wheel loader,
Hauling	ditto	Dump truck, Bulldozer
Filling	Spillway, Closure dike	Bulldozer, Wheel loader
Concrete work	Spillway, Overflow dike	Concrete pump car
Piling	Closure dike	Vibro-hammer
Gate construction	Spillway	Track crane
Dredging	Spillway	Cutter-suction dredger

Source: JICA Study Team

Among these civil works listed in table above, excavation work including hauling is most dominant because they include a large scale of earth works such as cutting, embankment and transportation of soil.

In this Study, therefore, an analogous case Study was conducted for obtaining the basic information on possible impact on ambient air quality due to a large scale of excavation works.

2) Analogous Study

A soil mining activity was chosen as a target activity of the analogous study because it includes a large scale of excavation and hauling works. The details of the study are as follows:

Date of sampling: 1) September 18th, and 2) December 12th, 2006.

Location of analogous project: Site of the analogous study is located in Desa Banjarharjo, Kabupaten Karanganyar.

Types and numbers of heavy machine: Five (5) units of dump trucks and two (2) units of backhoes.

Result: The measurement result of analogous case study is listed in table below: most of parameters recorded higher concentration except for O_3 and Pb. However, the concentration was still far below environmental standard level, except for Dust (TSP) in September (dry season). The concentration of it was 755.724µgr/$Nm^{3,}$, which is more than three times larger than the standard level. Meanwhile, the figure in December (rainy season) was still below the standard level.

Table 3.6.3 Result of Analogous Study for Prediction of Air Quality

Unit: µgr/Nm^3

No.	Parameter	Analogous Study (September)	Analogous Study (December)	Ambient air quality (near project site)	Environmental Standard*)
1	NO_2	33.456	29.100	2.56 – 14.47	316
2	SO_2	12.092	9.000	0.37 – 9.00	632
3	CO	441.771	363.810	121.09 – 365.14	15,000
4	O_3	18.859	3.810	3.84 – 26.17	200
5	Dust TSP	755.724	37.324	23.60 – 160.32	230
6	Hydrocarbon	1,2	0.2	nd – 0.4	160
7	Pb	nd	nd	nd – 0.1	2

nd : not detected

Note : *) Central Java Governor's decree No. 8 Year 2001, on the Standard of Quality of Ambient Air in Central Java Province

Source: JICA Study Team

3) Impact prediction

Based on the result of analogous study, it is predicted that concentration of NOx, SOx, CO, Dust (TPS) and Hydrocarbon will increase in the vicinity of Construction site. As for Dust, it is highly predicted that its concentration will exceed environmental standard (230 µgr/Nm^3), especially in dry season. The impact of Dust is estimated to be limited to the vicinity of earth works within Dusun Petir.

4) Impact Evaluation

Analysis result of impact prediction indicated that the project components would increase the concentration of parameters of air quality as mentioned above. The table below shows evaluation result of impacts on air quality.

Table 3.6.4 Evaluation Result of Impact on Air Quality

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People of the nearest settlement area (Dusun Petir of Desa Pokoh Kidul) would receive the impact
2.	Spatial extent of area subject to impact	In the vicinity of Construction work sites (a part of Dusun

		Petir of Desa Pokoh Kidul)
3.	Intensity and duration of impact	High intensity (dust) but limited only during dry season in construction stage
4.	Other environmental components subject to impact	Public health (in the worst case)
5.	Cumulative characteristics of impact	Not cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Significant and Important (-P)**

Source: JICA Study Team

(3) Noise

The possible impact is the occurrence of noise pollution due to the heavy machines during civil works. Major types of civil works are listed in the previous section (Refer to Table 3.6.2). Excavation work including hauling, which is the most dominant civil works during construction stage, is the major impact producing activity of noise pollution.

In this Study, therefore, an analogous case study was conducted for obtaining the basic information on possible impact on noise due to a large scale of excavation works.

1) Analogous Study

A soil mining activity was chosen as a target activity of the analogous study, because it includes a large scale of excavation and hauling works. The details of the study are as follows:

Date of measurement: October 6th and 7th, 2006.

Location of analogous project: Site of the analogous study is the same location of air quality, located in Desa Banjarharjo, Kabupaten Karanganyar

Types and numbers of heavy machine: Ten (10) units of dump trucks and two (2) units of backhoes.

Analyzed parameter: Analyzed parameters is noise level at different distance from noise source. Based on the noise level measurement data, Lsm, or equivalent noise level was calculated.

Result: The measurement result of analogous study is listed below. During the day time (L1, L2 and L3), noise level exceeded 70 dB (A) at Location I due to earth works while during night time (L4, L5 and L6) noise level decreases until the level less than 55 dB(A). The noise level decreases along with a distance from noise source, and recorded approximately 60±3 dB(A) during the day time at Location III.

Table 3.6.5 Result of Analogous Study for Prediction of Noise Level

Unit: dB(A)

Measurement No. and Time	Location I (site at 15m from noise source)	Location II (site at 110m from noise source)	Location III (site at 210 m from noise source)
L1 (07:00)	71.5	67.3	63.7
L2 (10:00)	72.3	61.9	57.6
L3 (15:00)	74.3	68.6	57.3
L4 (20:00)	56.7	57.9	59.0
L5 (23:00)	54.3	42.9	52.8
L6 (01:00	53.7	45.4	54.9
L7 (04:00)	46.5	57.5	53.8

Lsm	69.5	63.6	59.6
Noise Level Standard*	55		

Source: Primary data of JICA Study Team

Note) *: Decree of State Minister of Environment No. 48/MENLH/11/1996 regarding Noise Level Standard.

2) Impact prediction

a. Calculation model of noise level

Noise level from a single noise source was predicted using mathematical model, theoretical propagation equation from point noise source:

$Ln = PWL - 20 \log_{10} X - 8 - \alpha_d$

where Ln : Noise level at the distance of X meter (dB)

PWL: Power level of the noise source (dB),

X : Distance between noise source and receiver (m), and

α_d : Noise level decrease due to diffraction (dB)

In this regard, α_d was not considered because of safety side prediction.

During civil works a number of construction equipments will be operating. The compound of noise level from each construction equipment was calculated using the following equation:

$L = 10 \log_{10} (10^{L1/10} + 10^{L2/10} + 10^{L3/10} + ... + 10^{Ln/10})$

Where L : Compound noise level (dB),

n : The number of noise sources,

Ln: Noise level from each noise source(dB).

b. Basic conditions on construction machine

According to the construction work schedule, the number of operating construction machines varies depending on the type and progress of works. It will become a maximum during the construction work of spillway at the 3rd month from the commencement of the work. The table below shows the type and number of construction machines as well as noise power level:

Table 3.6.6 Type, Number and Noise Power Level of Construction Machines

Construction machine	Power / Volume	Noise power level (dB)*	Nos. of operating machines
Bulldozer	21 t	113	6
Bulldozer	11 t	112	4
Wheel loader	2.3 m^3	112	4
Dump truck	10 t	109	7
Concrete pump car	55 m^3/h	110	3
Vibratory roller	3-5 t	107	4

Source: JICA Study Team

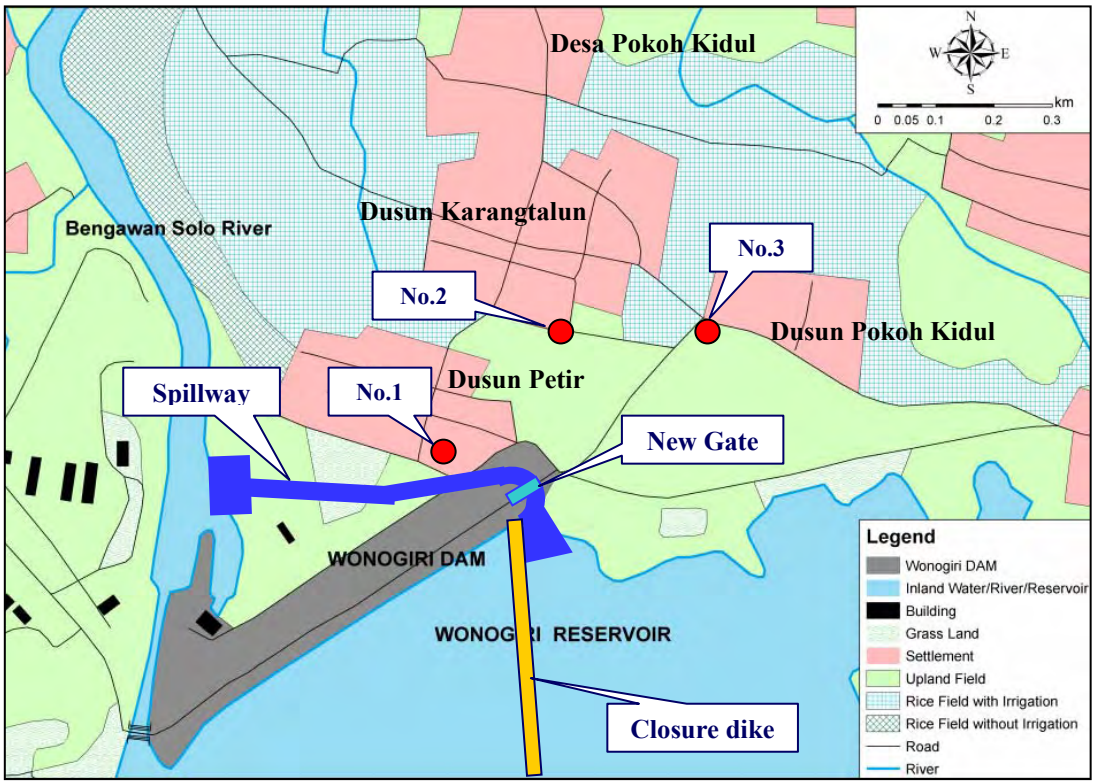
Note) *: Data source: "Regional Noise Environment Planning," Japan Engineering Society of Noise Control, 1997

Location of each construction machines was set along the alignment of spillway considering the actual construction method.

c. Location of noise level prediction

Noise level prediction was made at the nearest three (3) settlement areas in Desa Pokoh Kidul as follows (refer to Figure 3.6.2):

1) Nearest house in Dusun Petir,
2) Nearest house in Dusun Karangtulun, and
3) Nearest house in Dusun Pokoh Kidul.



Source: JICA Study Team

Figure 3.6.2 Location of Noise and Vibration Level Prediction

d. Result of noise level prediction

Table below shows the result of noise level prediction:

Location	Noise Level (dB)	Civil works / period
Nearest house in Dusun Petir	74.6	Spillway construction work / 3rd month from the commencement of the work
Nearest house in Dusun Karangtulun	67.1	
Nearest house in Dusun Pokoh Kidul	64.5	

Source: JICA Study Team

Regarding the methodology of noise level prediction, it should be noticed that the predicted noise level is the maximum level under the conditions that all the construction machines are simultaneously being operated, and that there is no countermeasure for mitigation, such as setting-up of noise prevention wall.

3) Impact Evaluation

Analysis result of impact prediction indicated that the project components would increase noise level exceeding noise level standards at maximum intensity of civil work. The table below shows evaluation result of the impacts.

Table 3.6.7 Evaluation Result of Impact of Noise Pollution

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People of the nearest settlement area (Dusun Petir of Desa Pokoh Kidul) would receive the impact.
2.	Spatial extent of area subject to impact	In the vicinity of construction work sites (a part of Dusun Petir of Desa Pokohkidul)
3.	Intensity and duration of impact	High intensity but limited only during construction of spillway
4.	Other environmental components subject to impact	Public health (in the worst case)
5.	Cumulative characteristics of impact	Not cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Significant and Important (-P)**

Source: JICA Study Team

(4) Vibration

1) Analogous Study

An analogous study was conducted for impacts of civil works because of the same reason as that of noise. The details of the study are as follows:

Date of measurement: February 2nd, 2007.

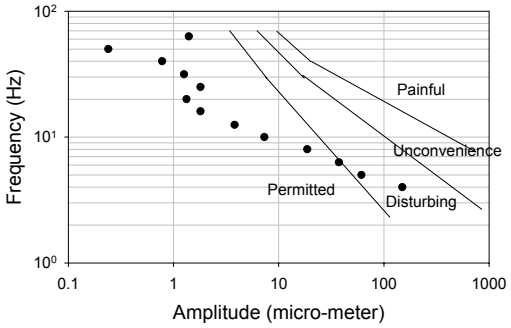
Location of analogous project: Site of the analogous study is the same location as those of noise.

Types and numbers of heavy machine: Seven (7) units of dump trucks and one (1) unit of backhoes.

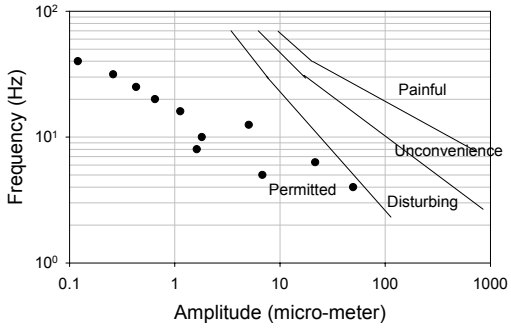
Analyzed parameter: The vibration measurement was conducted based on the Decree of State Minister of Environment No. 49/MENLH/11/1996 regarding Vibration Level Standard. Analyzed parameters is amplitude and peak velocity at different distance (10 m, 30 m and 60 m) from vibration source, with the frequency range from 4 Hz to 63Hz.

Result: The result of vibration level at analogous case was shown on Figure 3.6.3. Measurement results indicated that only the measurement result at 10 m distant from vibration source, namely earth work, exceeded the vibration standard level (case (a).). Meanwhile, the measurement result of vibration for building safety indicated the vibration level was below the standard one (case (d).).

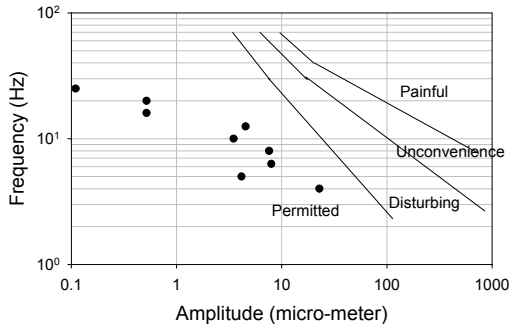
(a) Location at 10 m from vibration source



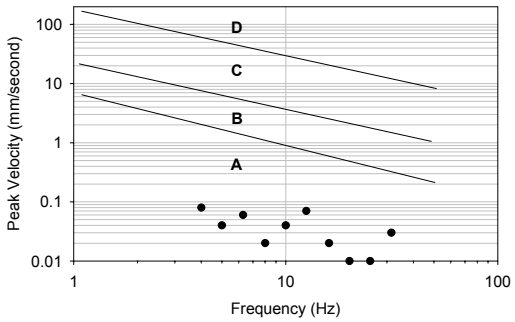
(b) Location at 30 m from vibration source



(c) Location at 60 m from vibration source



(d) Measurement result for building safety



Source: JICA Study Team

Figure 3.6.3 Measurement Result of Vibration for Analogous Study

2) Impact prediction

a. Calculation model of vibration level

Vibration level from a single noise source was predicted using mathematical model, theoretical propagation equation from point vibration source:

$L_x = L_o - 8.7\,\lambda\,(r - r_o) - 20 \log_{10} (r/r_o)^n$

where L_x : Vibration level at the distance of r meter (dB)

L_o : Vibration level at the distance of r_o meter (dB),

λ : Internal vibration constant of the ground (m), and

n : A constant depending on vibration wave

(In case of wave, n= 0.5)

During civil works a number of construction equipments will be operating. The compound of vibration level from each construction equipment was calculated using the following equation:

$L = 10 \log_{10} (10^{L1/10} + 10^{L2/10} + 10^{L3/10} + \ldots.. + 10^{Ln/10})$

Where L : Compound vibration level (dB),

n : The number of vibration source,

Ln: Vibration level from each noise source (dB).

b. Basic conditions on construction machine

According to the construction work schedule, the number of operating construction machines varies depending on the type and progress of works. It will become a maximum during the construction work of spillway at the 3rd month from the commencement of the work. The table below shows the type and number of construction machines as well as vibration power level:

Table 3.6.8 Type, Number and Vibration Level of Construction Machines

Construction machine	Power / Volume	Vibration level (dB)*	Nos. of operating machines
Bulldozer	21 t	75 (at 5 m)	6
Bulldozer	11 t	66 (at 5 m)	4
Wheel loader	2.3 m^3	67 (at 5 m)	4
Dump truck	10 t	56 (at 7 m)	7
Concrete pump car	55 m^3/h	56 (at 7 m)	3
Vibratory roller	3-5 t	71 (at 7 m)	4

Source: JICA Study Team

Note) *: Data source: "A Countermeasure Manual for Vibration from Construction Works," Japan Association of Construction Works Mechanization, 1994, etc.

Location of each construction machine was set along the alignment of spillway considering the actual construction method.

c. Location of vibration level prediction

Vibration level prediction was the same as those of noise level prediction as follows (refer to Figure 3.6.3):

1) Nearest house in Dusun Petir,
2) Nearest house in Dusun Karangtulun, and
3) Nearest house in Dusun Pokoh Kidul.

d. Result of vibration level prediction

Table below shows the result of vibration level prediction:

Location	Noise Level (dB)	Civil works / period
Nearest house in Dusun Petir	60.9	Spillway construction work / 3rd month from the commencement of the work
Nearest house in Dusun Karangtulun	44.8	
Nearest house in Dusun Pokoh Kidul	31.8	

Source: JICA Study Team

Regarding the methodology of vibration level prediction, it should be noticed that the predicted vibration level is the maximum level under the conditions that all the construction machines are simultaneously being operated, and that there is no countermeasure for mitigation, such as setting-up of vibration prevention trench.

4) Impact Evaluation

Analysis result of impact prediction indicated that the project components would increase vibration levels but only at maximum intensity for a limited period. The table below shows evaluation result of the impacts.

Table 3.6.9 Evaluation Result of Impact of Vibration

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People of the nearest settlement area (Dusun Petir of Desa Pokoh Kidul) would receive the impact
2.	Spatial extent of area subject to impact	In the vicinity of Construction work sites (a part of Dusun Petir of Desa Pokoh Kidul)
3.	Intensity and duration of impact	High intensity but limited only during construction of spillway
4.	Other environmental components subject to	Public health (in the worst case)

	impact	
5.	Cumulative characteristics of impact	Not cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Significant and Important (-P)**

Source: JICA Study Team

(5) Water Quality

1) Impact Prediction

The possible impact is deterioration of water quality, especially SS, of Bengawan Solo river due to sluicing from sediment storage reservoir through the new gate. In this section, therefore, the change of SS concentration was predicted. In addition discharge of Bengawan Solo river during sluicing was predicted as well. Impacts on aquatic organisms, especially on fish in the Bengawan Solo river due to the deterioration of water quality is described in Sub-section (2) Aquatic Biota, Section 3.6.2 Natural Environment.

Turbidity analysis for the downstream stretch of Wonogiri dam was conducted in this Study (Refer to Supporting Report I Annex No.6 "Turbidity Analysis for Downstream Reaches, Solo River Estuary."). In Annex No. 6, SS concentration was calculated using a simulation model － a combined model of one-dimensional unsteady flow model and advection-diffusion model.

In order to predict SS concentration, which was assumed to fluctuate depending on the amount of rainfall, the following three (3) cases were chosen:

a. Rainfall condition during 2004/05 as a dry year,
b. Rainfall condition during 1995/96 as a normal year,
c. Rainfall condition during 1998/99 as a wet year.

After confirming enough reproducibility of the analysis model by calibrating it based on field observation data, SS concentration of Bengawan Solo river was predicted for both "with / project (W/ Project: the condition under which sediment reservoir storage with new gate is given)" and "without / project (W/O Project: existing condition)." The target locations for prediction of SS concentration are the following:

Target location of SS prediction	Distance from Wonogiri dam
(1) Downstream (D/S) of Wonogiri dam	0 km
(2) Colo weir	14 km
(3) Jurug Bridge	51 km
(4) Tangen Bridge	99 km

Figure 3.6.4 illustrates the results of SS concentration analysis. Tables 3.6.10 and 3.6.11 summarize the findings from SS concentration analysis:

a) Change of SS concentration at the beginning of rainy season

At the beginning of rainy season, sluicing is not yet carried out. Reservoir water is drained through existing intake. SS concentration under W/Project is lower at D/S of Wonogiri dam and Colo weir because highly turbid water from Keduang river will be confined in the sediment storage reservoir. which results in decreasing SS concentration at the existing intake point. SS concentration of highly turbid water to be released from sediment storage reservoir through the new gate is predicted to be more or less 5,000 mg/l (W/ Project) at maximum while it in case of W/O Project is higher than 15,000 mg/l (Table 3.6.10).

At the downstream locations such as Jurug Bridge and Tangen Bridge, SS concentration will be decreased owing to dilution effect by the water from tributaries flowing into the Bengawan Solo river. This effect is recognized regardless of rainfall condition, i.e., dry year, normal year or wet year.

Table 3.6.10 Fluctuation of SS Concentration at the Beginning of Rainy Season

Unit: mg/l

Case	Date of rainfall event	Location	W/O Project	W/ Project
(1) Dry year	Dec. 1st - 2nd, 2004	D/S of dam	16,877	5,506
		Colo weir	15,381	5,376
		Jurug Bridge	1,642	1,024
		Tangen Bridge	1,600	1,580
(2) Normal Year	Nov. 22nd – 26th , 1995	D/S of dam	13,857	3,045
		Colo weir	12,765	2,999
		Jurug Bridge	1,381	1,103
		Tangen Bridge	1,208	1,208
(3) Wet Year	Nov. 6th – 8th, 1998	D/S of dam	13, 372	2,915
		Colo weir	12,429	2,911
		Jurug Bridge	2,295	1,594
		Tangen Bridge	2,593	2,246

Note) Each figure shows the highest SS concentration during the date of rainfall event.
Source: JICA Study Team

b) Change of SS concentration after opening of the new gate for sluicing

SS concentration under W/Project is higher than that under W/O Project at all the locations because highly turbid water of sediment storage reservoir will be released through the new gate (i.e., sluicing). This impact (increase of SS) will last for several days, and this impact occurs several times during rainy season. SS concentration of highly turbid water to be released from sediment storage reservoir through the new gate is predicted to be about 12,000 mg/l (W/ Project) at maximum while it in case of W/O Project is less than 4,000 mg/l (Table 3.6.11).

This highly turbid water reaches until Tangen Bridge because the discharge volume from the new gate is relatively large comparing with those from tributaries, and accordingly the dilution effect of tributaries is relatively small.

Table 3.6.11 Fluctuation of SS Concentration During Sluicing

Unit: mg/l

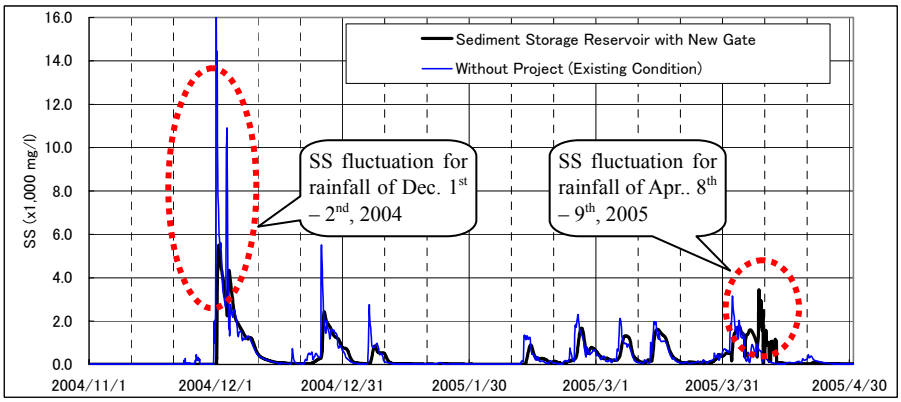
Case	Date of rainfall event	Location	W/O Project	W/ Project
(1) Dry year	Apr. 8th – 9th, 2005	D/S of dam	956	3,450
		Colo weir	981	4,418
		Jurug Bridge	908	2,916
		Tangen Bridge	700	1,267
(2) Normal Year	Feb. 9th – 13th , 1996	D/S of dam	2,137	5,178
		Colo weir	2,152	6,905
		Jurug Bridge	1,509	3,162
		Tangen Bridge	1,311	2,228
(3) Wet Year	Jan. 3rd – 4th, 1999	D/S of dam	3,313	10,367
		Colo weir	3,953	12,712
		Jurug Bridge	3,274	8,747
		Tangen Bridge	2,868	7,596

Note) Each figure shows the highest SS concentration during the date of rainfall event.
Source: JICA Study Team

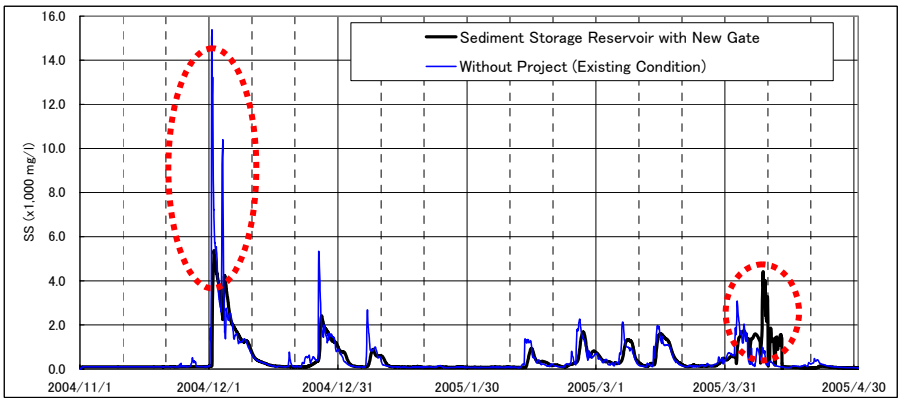
c) Change of discharge of Bengawan Solo river

Regarding water discharge in Bengawan Solo river, it was revealed that the discharge will not significantly change. Specifically, it will fluctuate with the same level (discharge) as that in case of W/O Project. Figure 3.6.5 shows one case of simulation results to illustrate the change of river water discharge between W/ and W/O Project at Tangen Bridge (Refer to Supporting Report I Annex No. 6 for the details.).

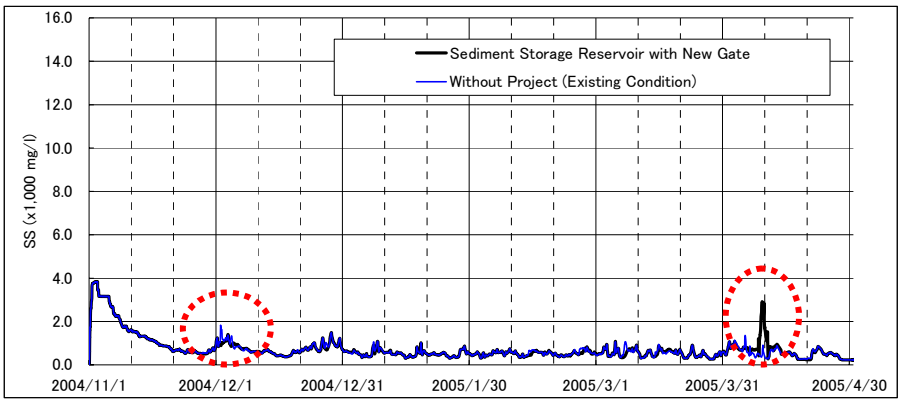
Downstream (D/S) of Dam



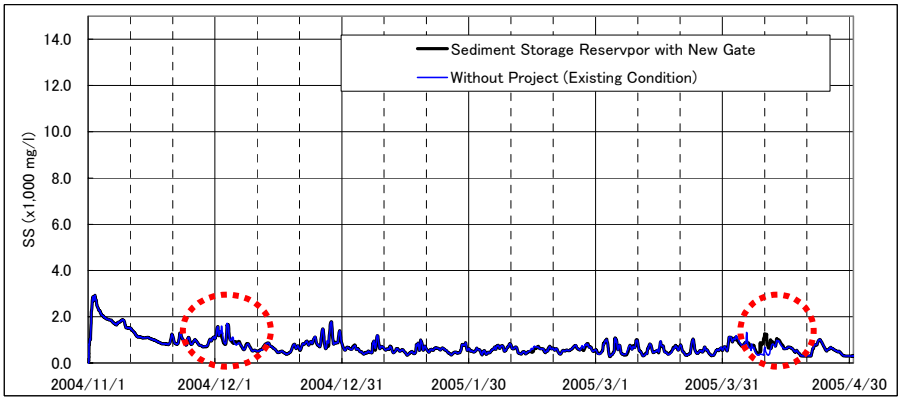
Colo Weir



Jurug Bridge



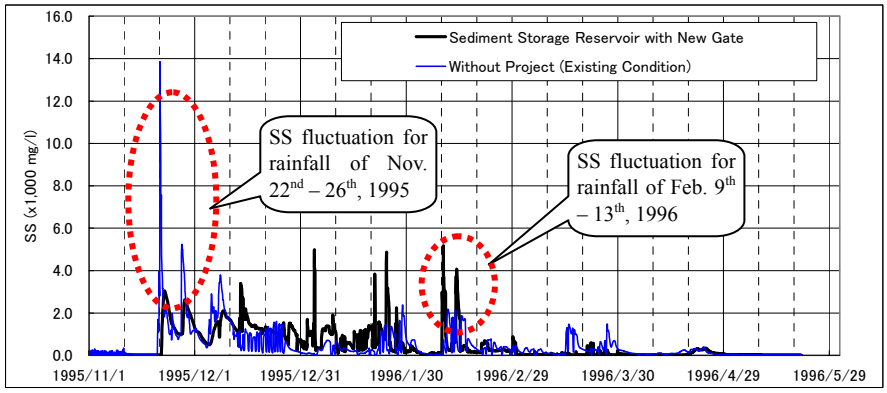
Tangen Bridge



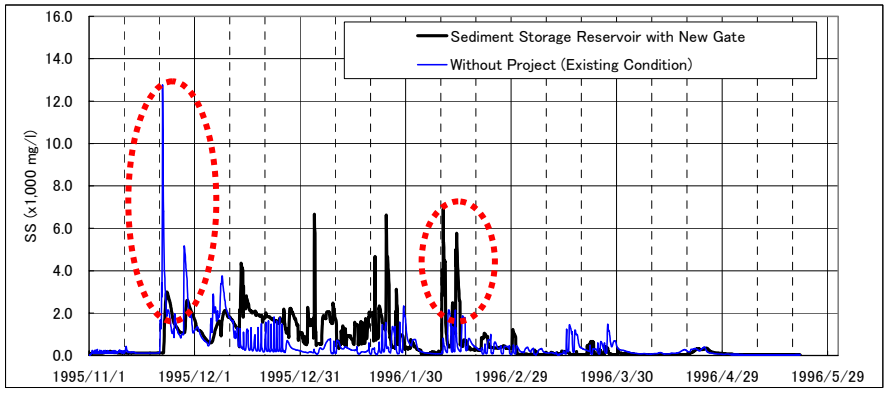
Source: JICA Study Team

Figure 3.6.4(1) Comparison of SS Concentration in Bengawan Solo River between W/ and W/O Project in Case of Dry Year

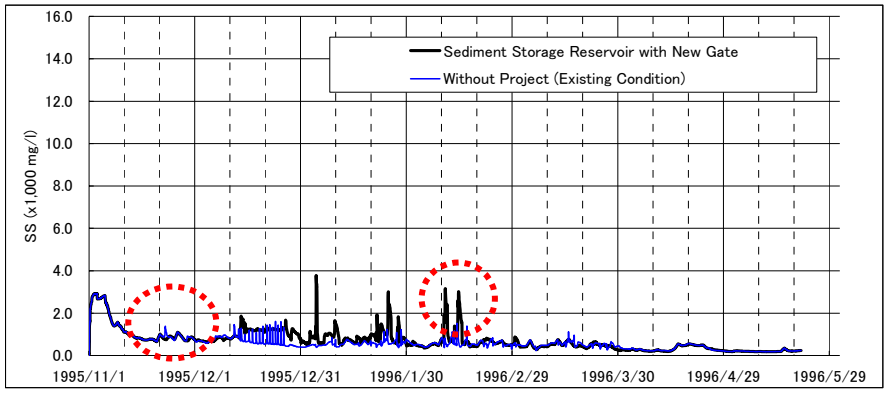
Downstream (D/S) of Dam



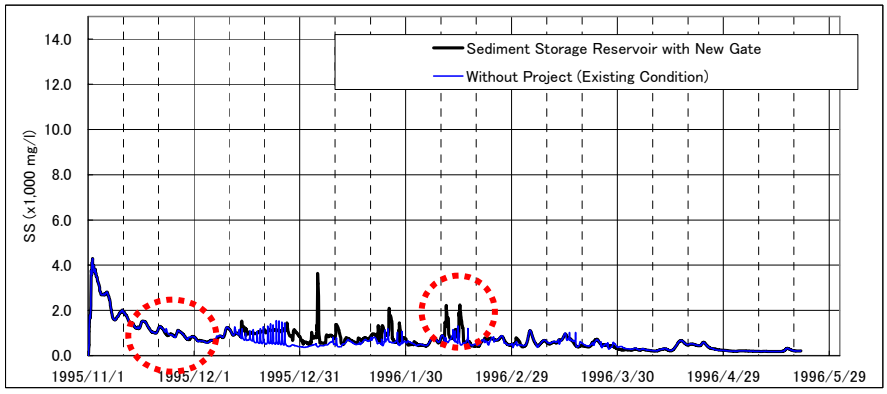
Colo Weir



Jurug Bridge



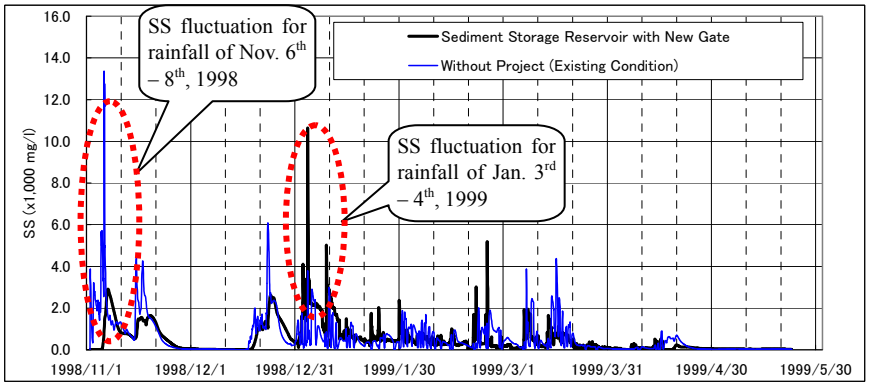
Tangen Bridge



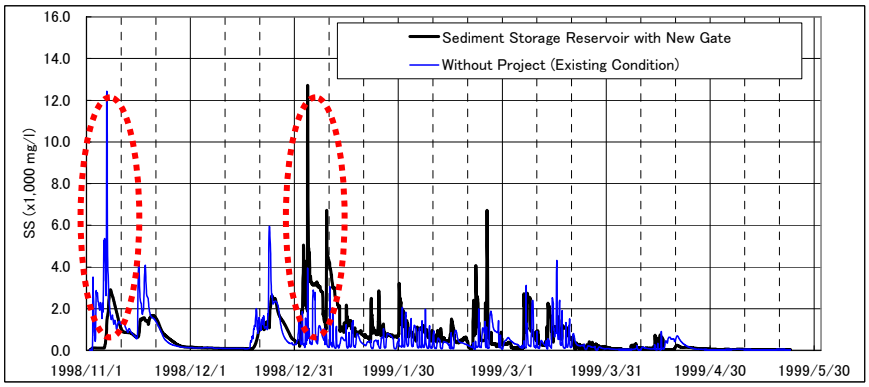
Source: JICA Study Team

Figure 3.6.4(2) Comparison of SS Concentration in Bengawan Solo River between W/ and W/O Project in Case of Normal Year

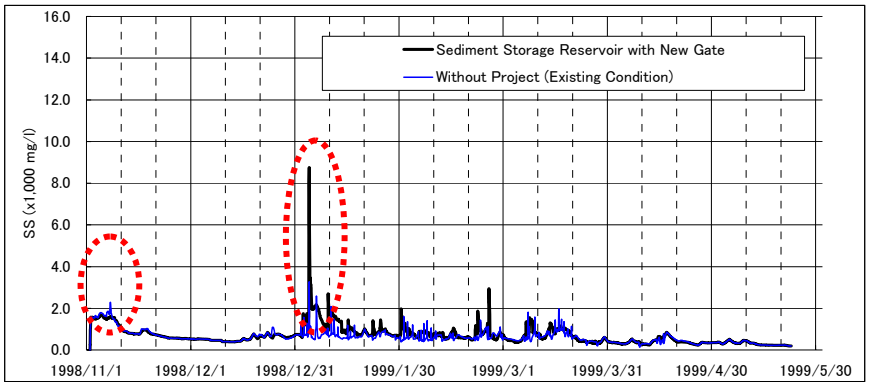
Downstream D/S of Dam



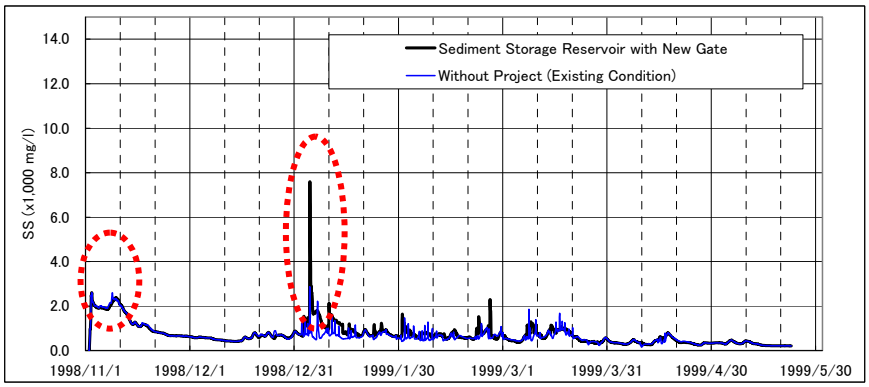
Colo Weir



Jurug Bridge

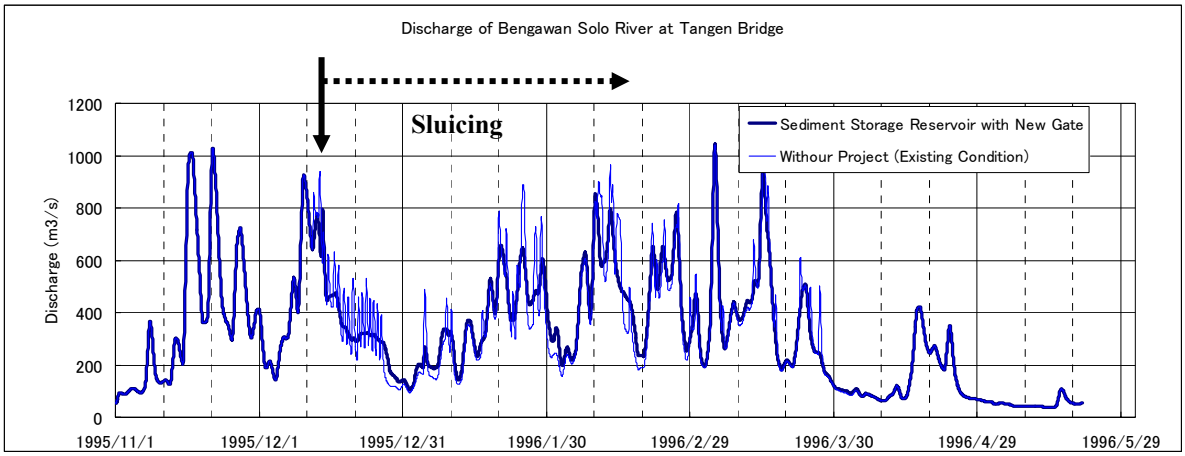


Tangen Bridge



Source: JICA Study Team

Figure 3.6.4(3) Comparison of SS Concentration in Bengawan Solo River between W/ and W/O Project in Case of Wet Year



Source: JICA Study Team

Figure 3.6.5 Simulation Result of Discharge of Bengawan Solo River Comparing W/ and W/O Project at Tangen Bridge

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would increase SS concentration in early rainy season but vise versa in mid or late period of rainy season. On the other hand, impact of sluicing on discharge of Bengawan Solo river is minor. The table below shows evaluation result of the impacts.

Table 3.6.12 Evaluation Result of Impact on Water Quality of Bengawan Solo River

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People along the downstream reach of Bungawan Solo river.
2.	Spatial extent of area subject to impact	Downstream river reach of Bengawan Solo river at least until Tangen Bridge in Kabupaten Sragen, Central Java Province.
3.	Intensity and duration of impact	High SS concentration beyond 10,000 mg/l in late rainy season while less concentration in early rainy season depending on the rainfall condition.
4.	Other environmental components subject to impact	Aquatic organisms in Bengawan Solo river
5.	Cumulative characteristics of impact	Not cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

3.6.2 Natural Environment

(1) Terrestrial Flora and Fauna

1) Impact Prediction

The possible impacts on terrestrial flora and fauna are:

- Decrease of individuals of terrestrial flora and fauna due to clearance of vegetation for preparation of the Project site, and
- Impacts on terrestrial ecosystem near the Project site.

a) Impact on Terrestrial Flora

Decrease of individuals of terrestrial flora will be caused by site clearance for preparation of the Project site. The main location of necessary site clearance is:

- Site for spillway at right bank side of Wonogiri dam, including the area for stilling basin. The area for these structures is approximately 2.2 ha.
- Site for closure dike and overflow dike connecting Wonogiri dam and a peninsula in the reservoir, including access road to these structures. The area for these structures is approximately 1.2 ha.

The inventory survey indicated that there growing 67 species of wild plants in the proposed site of spillway. Likewise, 51 species of wild plants were identified to grow in the site near the closure dike.

The growing plants will be cut and removed from the area for planned facility site, and accordingly the individuals will be decreased. However, the area of site clearance for project facilities is already modified by human activities, and there is no natural vegetation. In addition, the species identified by the inventory survey are not the rare species but commonly observed in Indonesia. Furthermore, the total area for the Project, 3.4 ha in total, is limited comparing with the total area of Keduang river basin, approx. 42,100 ha. Considering these reasons, therefore, the impact of terrestrial flora is predicted to be minor.

According to the inventory result, no protected species designated by Indonesian Regulation was identified. Therefore, there will be no impact on protected fauna species.

b) Impact on Terrestrial Fauna

Responding to site clearance for project site, habitat for terrestrial fauna will be disturbed. According to inventory survey, 10 species and 12 species of wild birds were identified in planned site of spillway and closure dike, respectively. Accordingly, the habitat of some wild birds will be disturbed.

Even though the habitat of wild birds will be disturbed, they can move to other area to habit or feed in the Wonogiri reservoir because the impact area, or the area in and around the Project site is limited comparing with the whole reservoir area (mentioned above). Accordingly, the impact of the priority project on terrestrial fauna is minor.

According to the inventory result, no protected species designated by Indonesian Regulation was identified. However, there are five (5) mammals and four (4) birds of protected species recorded to inhabit in the secondary data. The impacts on the protected species are discussed in Section (3) Protected Species.

c) Impacts of watershed management of Keduang river basin

Project activities included in watershed management of Keduang river basin will not contain site clearance, i.e., clearance of vegetation. On the contrary, it will facilitate planting at riser of terrace and agro-forestry. The impacts on terrestrial flora and fauna, therefore, is positive one in terms of greening and improvement of vegetation.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would cause decrease of individuals of terrestrial flora species and habitat disturbance of terrestrial fauna, especially bird species but the impacts is predicted to be minor. The table below shows evaluation result of the impacts.

Table 3.6.13 Evaluation Result of Impact on Terrestrial Flora and Fauna

No	Determinant Factor	Evaluation Result
1.	People subject to impact	None
2.	Spatial extent of area subject to impact	The area for site clearance is approximately 3.4 ha.
3.	Intensity and duration of impact	Vegetation or cultivated area will be changed to man-made structures, such as spillway, dike and weir, and road.
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Irreversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

(2) Aquatic Biota

1) Impact Prediction

Methodology of Impact Prediction: Impacts on Aquatic organisms are carried out analogically referring to the analogous case studies on sediment flushing, concept of stress index and characteristics of fish focusing on tolerance to high turbidity.

Possible impacts due to sediment flushing: Possible impact on aquatic biota, especially on fish, is injury and/or death of fish in the Bengawan Solo river due to water quality deterioration caused by sediment releasing through the new gate.

Experience of Sediment Flushing in the Brantas River: Wlingi and Lodoyo dam reservoirs on the Brantas river are suffering from massive sedimentation alike. Coordinated flushing was conducted in 2004 at these reservoirs under the Water Resources Existing Facilities Rehabilitation and Capacity Improvement Project.

As the result of monitoring of water quality and impacts on fish, the environmental impacts of the coordinated flushing were summarized as follows:

- Impact on water quality of river and reservoirs is considered to be “significant,” because it will cause extremely high concentration of SS, Turbidity, Sediment Concentration, BOD, and COD.
- Impact on aquatic organisms is considered to be “significant,” because a lot of fish were killed or injured due to respiration problem caused by high SS and low DO.

Environmental Management during Sediment Flushing: High concentration of SS and low DO caused by flushing resulting in death fish are pointed out by the studies conducted by France, Switzerland, Canada and Japan. The outcome of the studies has been utilized as Water Quality Management Standard for sediment flushing in France and Switzerland. The Management Standard for sediment flushing in Switzerland is introduced below.

Table 3.6.14 Water Quality Management Standard for Sediment Flushing in Switzerland

Dam	Flushing Standard	Actual result (Maximum)
Palagnedra	• Maximum: 10,000 mg/l • 24 hrs: 5,000 mg/l • 48 hrs: 2,500 mg/l • >48 hrs: 1,250 mg/l	10,000 – 40,000 mg/l
Verbois	• Maximum: 25,000 mg/l • 15,000 mg/l should not last for long time.	10,000 – 35,000 mg/l
Gebidem	• Maximum: 20,000 mg/l but shorter than 2 hours. • Constantly less than 10,000 mg/l	10,000 – 60,000 mg/l

Source: Gester and Rey, 1994, Gartmann, 1990, Conca, 1990.

Concept of Stress Index: In Canada, Newcombe at al (1991) studied the impacts on fish due to volcanic ash flowing into rivers and proposed the following equation:

$SI = \log_e (SS * T)$,

where, SI: Stress Index, SS: Suspended Solids (mg/l), and T: Duration in hours.

Dr. Sumi (2000) pointed out that SI for Water Quality Management Standard for sediment flushing in Switzerland was between 9 and 11. He also indicated that the SI for the case of coordinated sediment flushing of the Dashidaira and Unazuki dams in Japan was around 10, and that SI of 10 is a standard for water quality management for sediment flushing.

Prediction of Change of Water Quality (SS) and Stress Index: As discussed in previous section, the change of SS concentration due to sediment releasing is summarized as follows:

Item	At the beginning of wet season	Mid and late period of wet season
Sediment releasing	Not yet commenced	Commenced
SS concentration	W/ Project < W/ O Project (> 15,000 mg/l)	W/ O Project < W/ Project (≒12,000 mg/l)

Source: JICA Study Team

At the beginning of wet season, SS concentration is higher (more than 15,000 mg/l) in case of W/O Project. After commencement of sediment releasing in mid and late wet season, highly turbid water (more or less 12,000 mg/l at maximum) is released, which increases SS in Bengawan Solo River. Comparing SS concentration in the two cases, it was recognized that SS concentration under W/O Project is higher.

Table 3.6.15 shows calculation results of Stress Index based on the simulation data of SS concentration at W/ Project and W/O Project for three cases: Dry Year, Normal Year and Wet Year (refer to Figure 3.6.4 (1) – (3)). With this regard, Stress Index for W/ Project was calculated for the same rain events shown in Tables 3.6.10 and 3.6.11.

According to the simulation results, following findings were obtained.

- The maximum Stress Index reaches to more or less 12 under W/ Project (existing condition),
- Under W/O Project (during releasing), Stress Index reaches to more or less 11 in case of Dry Year and Normal Year. In case of Wet Year, Stress Index reaches more than 12.

Consequently, it was implied that Stress Index under W/ Project condition (during sediment releasing) will be less than that under W/ O Project (existing condition) in case of Dry or Normal Year. In case of Wet Year, however, Stress Index under W/ Project condition will be the same level as or higher than that under W/O Project.

Table 3.6.15 Comparison of Stress Index (SI) between W/ and W/O Project

a) Case of Dry Year (Rainfall condition: 2004 – 2005)

Case	Date	Location	SS (mg/l)	2,000	3,000	5,000	7,000	10,000
W/O Project (Existing Condition)	Dec. 1st - 2nd, 2004	D/S of dam	Duration (hrs)	76	49	33	16	10
			SI	**11.9**	**11.9**	**12.0**	**11.6**	**11.5**
		Colo	Duration (hrs)	72	45	31	14	8
			SI	**11.9**	**11.8**	**12.0**	**11.5**	**11.3**
		Jurug	Duration (hrs)	0	0	0	0	0
			SI	**-**	**-**	**-**	**-**	**-**
		Tangen	Duration (hrs)	0	0	0	0	0
			SI	**-**	**-**	**-**	**-**	**-**
W/ Project (During Sediment Releasing)	Apr. 8th – 9th, 2005	D/S of dam	Duration (hrs)	15	1	0	0	0
			SI	**10.3**	**8.0**	**-**	**-**	**-**
		Colo	Duration (hrs)	33	16	0	0	0
			SI	**11.1**	**10.8**	**-**	**-**	**-**
		Jurug	Duration (hrs)	19	0	0	0	0
			SI	**10.5**	**-**	**-**	**-**	**-**
		Tangen	Duration (hrs)	0	0	0	0	0
			SI	**-**	**-**	**-**	**-**	**-**

b) Case of Noraml Year (Rainfall condition: 1995 – 1996)

Case	Date	Location	SS (mg/l)	2,000	3,000	5,000	7,000	10,000
W/O Project (Existing Condition)	Nov. 22nd – 26th, 1995	D/S of dam	Duration (hrs)	33	21	11	7	5
			SI	**11.1**	**11.1**	**11.0**	**10.8**	**10.8**
		Colo	Duration (hrs)	34	23	12	8	4
			SI	**11.1**	**11.1**	**11.0**	**10.9**	**10.6**
		Jurug	Duration (hrs)	0	0	0	0	0
			SI	**-**	**-**	**-**	**-**	**-**
		Tangen	Duration (hrs)	0	0	0	0	0
			SI	**-**	**-**	**-**	**-**	**-**
W/ Project (During Sediment Releasing)	Feb. 9th – 13th, 1996	D/S of dam	Duration (hrs)	15	6	1	0	0
			SI	**10.3**	**9.8**	**8.5**	**-**	**-**
		Colo	Duration (hrs)	25	15	4	0	0
			SI	**10.8**	**10.7**	**9.9**	**-**	**-**
		Jurug	Duration (hrs)	16	2	0	0	0
			SI	**10.4**	**8.7**	**-**	**-**	**-**
		Tangen	Duration (hrs)	2	0	0	0	0
			SI	**8.3**	**-**	**-**	**-**	**-**

c) Case of Wet Year (Rainfall condition: 1998 – 1999)

Case	Date	Location	SS (mg/l)	2,000	3,000	5,000	7,000	10,000
W/O Project (Existing Condition)	Nov. 6th – 8th, 1998	D/S of dam	Duration (hrs)	44	15	6	5	5
			SI	**11.4**	**10.7**	**10.3**	**10.5**	**10.8**
		Colo	Duration (hrs)	102	16	11	6	5
			SI	**12.2**	**10.8**	**10.6**	**10.6**	**10.8**
		Jurug	Duration (hrs)	6	0	0	0	0
			SI	**9.4**	**-**	**-**	**-**	**-**
		Tangen	Duration (hrs)	90	0	0	0	0
			SI	**12.1**	**-**	**-**	**-**	**-**
W/ Project (During Sediment Releasing)	Jan. 3rd – 4th, 1999	D/S of dam	Duration (hrs)	86	7	6	2	1
			SI	**12.1**	**10.0**	**10.1**	**9.5**	**9.2**
		Colo	Duration (hrs)	107	89	7	5	3
			SI	**12.3**	**12.5**	**10.5**	**10.5**	**10.3**
		Jurug	Duration (hrs)	20	14	5	3	0
			SI	**10.6**	**10.6**	**10.1**	**10.0**	**-**
		Tangen	Duration (hrs)	20	8	4	1	0
			SI	**10.6**	**10.1**	**9.9**	**9.8**	**-**

Source: JICA Study Team

Discussion based on characteristics of fish: Turbidity may affect fish on their

swimming in water or reducing their growth rate, resistance to disease or even killing them.. Alabaster and Lloyd (1982) noted that most individuals of all species including goldfish (*Carassius auratus*) and common carp (*Cyprinus carpio*) endured maximum turbidity of 100,000 mg/l occurring during experiments lasting a week or more, and some individuals of these two species survived occasional exposure to 225,000 mg/l for one to three weeks. However, barb (*Rasbora heteromorphia*) was killed in a day with about 40,000 mg/l bentonite clay, but survived for one week in 6,000 mg/l.

These experiment results implies that the sediment releasing in Wonogiri reservoir seems not affect directly on carp, but may affect the barb, *Rasbora* sp. How high the effect on barb depends on how high the turbidity is, and how long the high turbidity exposes to fish. The fish from Bagridae and Pangasidae families will not be affected by the turbidity, since those species are more resistant in general comparing with carp.

An excessive concentration of SS may also affect on reproduction because it may prevent spawning and successful development of fish eggs and larvae. The high SS may block spawning grounds, adhere to surface of eggs and kill them due to preventing sufficient exchange of oxygen and carbon dioxide between respiring egg and the water (Alabaster and Lloyd).

Most of identified species in the downstream of Bengawan Solo River is Cyprinidae which spawns in the early rainy season. Others species spawn in the dry season or they can spawn all the year round. Accordingly, the major species of fish in Bengawan Solo river would not undergo direct impact on eggs, if the sediment releasing is carried out in late rainy season.

According to the study results so far, it is anticipated that sediment releasing will not cause significant impact in terms of SS concentration and Stress Index as well as tolerance to high concentration of SS. However, impact on fish is not only caused by increase of SS concentration but also other parameters of water quality, e.g., DO. Therefore, there is still unclear part to conclude the impact on fish.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would not cause significant impact on fish in the downstream of the Bengawan Solo river although some unclear part is still remained. The table below shows evaluation result of the impacts.

Table 3.6.16 Evaluation Result of Impact on Fish in the Bengawan Solo River

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Fishermen who catch fish in Bengawan Solo river
2.	Spatial extent of area subject to impact	Downstream of the Bengawan Solo River
3.	Intensity and duration of impact	Impact intensity is not high. Impact would occur during sediment releasing in operation and maintenance stage
4.	Other environmental components subject to impact	Fishery
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Irreversible
Weight of impact		**Negative, Important but Not significant (-TP)**

Source: JICA Study Team

(3) Protected Species

Possible impacts on protected species are the disturbance of habitat, population or reproduction of each protected species. During field inventory of terrestrial fauna, no protected species was identified near the proposed locations of structural measures.

However, there was information from local people that Porcupine (*Hystrix branchyuran*) inhabits in Desa Jendi, Kecamatan Girimarto, Kabupaten Wonogiri, where is located in a part of target area of Watershed Management. There was another information that Leopard (*Panthera pardus*) inhabits in Desa Tanjungrari, Kecamatan Jatisrono, Kabupaten Wonogiri.

Watershed Conservation targeted for the Kuduang watershed does not include vegetation clearance but promote planting and improve vegetation in upland fields and settlement area. Accordingly, there will be no impact of project implementation on protected species.

3.6.3 Socio-Economic Environment

(1) Land Acquisition and Resettlement

In this project, land acquisition is not required for procuring the land for the proposed project facilities, because all of the proposed facilities and spoil bank area is located within the premise of Wonogiri reservoir area, all of which is owned by Indonesian Government. Nor is required resettlement of existing houses.

Accordingly, it is concluded that there will be no impact of land acquisition or resettlement in this Project.

However, the land for temporary usage for construction work, such as temporary parking lot, yard for heavy machines and material stock, etc. might be needed near the construction site, especially around the project site of spillway or planed spoil bank area. For these temporary land use, it is necessary to monitor if an appropriate land compensation is made.

(2) People's Unrest and Conflict / Opposition

1) Impact Prediction

People's unrest would generate when a socialization of project components to local people is implemented. Local people who would have unrest are:

- People around the reservoir who often uses tidal low land area (the area between normal high water level and low water level) and green belt for farming, and
- People who often uses some areas around Wonogiri dam for recreational and educational activities such as playing football, valley ball, boyscout training, the event of motor cross, etc.

These people know the land used for these activities is owned by Government. But they would not be willing to return the land to the Government and might require compensation money because they have been using the land for long period after completion of Wonogiri dam in 1982.

If the negotiation for returning the land is not appropriately accomplished between local people and Project owner, there would happen some conflict or opposition against the Project. At present, however, the possibility of opposition movement is not high because there is no interest group in and around the Project site who is in opposition against the Project implementation.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would spawn people's unrest and conflict in case of inappropriate consultation between Project owner and local people. The table below shows evaluation result of the impacts.

Table 3.6.17 Evaluation Result of Impact on People's Perception

No	Determinant Factor	Evaluation Result
1.	People subject to impact	The people of Pokoh Kidul and Pondoksari.
2.	Spatial extent of area subject to impact	The area for nearby settlement area, including Desa Poko Kidul and Pondoksari.
3.	Intensity and duration of impact	Possibility of people's unrest when socialization of the project (Pre-construction stage) is high but possibility of conflict or opposition is low.
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

(3) Job Opportunity

1) Impact Prediction

Table 3.6.18 shows the estimate of labor resources required for implementation of the Project. It is necessary to procure about 230 workers per day for construction of sediment reservoir storage. Of which 120 people are common worker, who should be hired from people villagers. The recruitment of local people may brought about increase of income, which may result in improving livelihood.

Table 3.6.18 Estimate of Labor Required for Construction Works

Facility / Activity	Category	Total man･day	Daily
Sediment Storage Reservoir, including spillway and closure dike	Common worker	approx. 48,000.	110
	Skilled / Foreman	approx. 49,000.	120
Maintenance dredging	Common worker	approx. 180	-
	Skilled worker	approx. 90	-

JICA Study Team

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would spawn job opportunity of local people. The table below shows evaluation result of the impacts.

Table 3.6.19 Evaluation Result of Impact on Job Opportunity

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Daily number of common workers to be hired from local people is 120 persons.
2.	Spatial extent of area subject to impact	The area for nearby settlement area, including Desa Pokokidul and Pondoksari.
3.	Intensity and duration of impact	Total workable day is estimated to approx. 420 days.
4.	Other environmental components subject to impact	Livelihood change
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility of irreversibility of impact	Reversible
Weight of impact		**Positive, Important and Significant (+P)**

Source: JICA Study Team

(4) Livelihood Change

1) Impact Prediction

The possible impacts of the implementation of the Project on livelihood change includes the following:

- Livelihood change of people who will be hired as construction workers by the Project,
- Livelihood change of people whose cultivating land is to be acquired for the Project site,
- Livelihood change of people whose fishing ground is adversely affected by the Project.

Regarding to the first impact, it was discussed in previous section that the project would bring about positive and significant impact. Regarding the third one, the impact will be brought about on fishing in the Bengawan Solo river to be caused by sluicing, and the details of this impact will be discussed in the following section.

Regarding the second one, the impact is predicted to be negative because the cultivating land will be used for the land of structural measures, which would cause decrease of agricultural production and income. However, most of this cultivating land is located in green belt and/or tidal low land area, and is not owned by local people but by the government. According to field survey, it is estimated that about 200 of farmers cultivate the land in the government-owned lands over green belt and tidal low land area.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would cause decrease of agricultural production and income. The table below shows evaluation result of the impacts.

Table 3.6.20 Evaluation Result of Impact on Livelihood of Farmers

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Approximately 200 of farmers who cultivate the land owned by government around Wonogiri reservoir.
2.	Spatial extent of area subject to impact	The area of green belt and tidal low land area (the land between normal high water level and low water level) around Wonogiri reservoir in Desa Pokoh Kidul and Pondoksari.
3.	Intensity and duration of impact	Intensity of impact is low because most of farmers possesses farmland other than that located in green belt / tidal low land.
4.	Other environmental components subject to impact	Conflict between Project owner and local people (in the worst case)
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

(5) Economic Activities of Downstream Reaches

Impacts on activities of downstream reaches including a) sand mining, b) inland navigation, c) river water use for water supply, d) river water use for irrigation e) fishing

activity. Impact factor, i.e., impact producing activity is sluicing of sediment deposits through the new gate.

1) Sand Mining:

a. Impact Prediction

There are three (3) types of sand mining in its method of collecting sand, stone or gravel: they sand are mining by 1) motor pump, 2) boat or raft and 3) manual tools. Of which sand mining by boat or raft and manual tools is done in only dry season due to the physical difficulties. Only the sand mining by motor pump is done even during rainy season (refer to Table 3.5.6).

Taking into account the timing of sluicing which is proposed to conduct in rainy season, no impact will occur on sand mining by boat or raft and manual tools because these are not done in rainy season. Regarding the sand mining by motor pump, however, it will coincide with the timing of sluicing. Accordingly, it might be needed to temporarily stop the mining activity for safety season because of large volume of discharge (400 m^3/s at maximum) will be drained through the new gate during sluicing. However, the change of discharge in the downstream reaches due to sluicing is minor as discussed in previous Sub-section (5) Water Quality, Section 3.6.1 Physical Environment, the impact on sand mining by motor pump is predicted is minor.

b. Impact Evaluation

Analysis result of impact prediction indicated that the Project would cause minor impact on sand mining. The table below shows evaluation result of the impact.

Table 3.6.21 Evaluation Result of Impact on Sand Mining

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Sand miners in downstream reaches of Bengawan Solo river, especially those who conduct sand mining by motor pump.
2.	Spatial extent of area subject to impact	Downstream reaches of Bengawan Solo river
3.	Intensity and duration of impact	Intensity of impact is low, because change of river discharge due to sluicing is minor.
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

2) Inland Navigation

a. Impact Prediction

There are 10 locations of inland navigation under operation for crossing the Bengawan Solo river. Inland navigation is usually operated all through the year except for flooding period for safety reason.

The sluicing from sediment storage reservoir is proposed to be implemented during rainy season. But it is not limited only during flooding period. Accordingly, if the sluicing is conducted during the period when inland navigation is in operation, it might bring about large volume of discharge in the Bengawan Solo river and the inland navigation has to be stopped temporarily because of the safety reason. However, the change of discharge in the downstream reaches due to sluicing is

minor as discussed in previous Sub-section (5) Water Quality, Section 3.6.1 Physical Environment, the impact on inland navigation is predicted is minor.

b. Impact Evaluation

Analysis result of impact prediction indicated that the project would cause minor impact on inland navigation. The table below shows evaluation result of the impact.

Table 3.6.22 Evaluation Result of Impact on Inland Navigation

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Boat operator of inland navigation and passengers to cross Bengawan Solo river
2.	Spatial extent of area subject to impact	Downstream reaches of Bengawan Solo river
3.	Intensity and duration of impact	Intensity of impact is low, because change of river discharge due to sluicing is minor.
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

3) River water use for PDAM (municipality water supply system)

a. Impact Prediction

There are two (2) intakes of PDAM on the Bengawan Solo river between the river reach from Wonogiri dam and the confluence point with the Madiun river. They are PDAM of Wonogiri and Jurug, which take water from the Bengawan Solo river (Refer to Figure 3.5.6).

During the sluicing, SS concentration of Bengawan Solo river at downstream reaches will increase. But the main problem at intake points of the two PDAM is not high concentration of SS but industrial waste water drained into the river from nearby factories. In addition, predicted SS concentration, which is approximately 12,000 mg/l, is such that often occurs during the ordinary flooding period. Accordingly, the impact of sluicing on water intake at PDAM is predicted to be minimal.

However, a lot of garbage will be contained in the drained water from Wonogiri Reservoir during sluicing. Considering this situation, it is necessary to monitor the condition of intake water during sluicing because of sanitary reason.

b. Impact Evaluation

Analysis result of impact prediction indicated that the project would cause minimal impact on river water use for PDAM. The table below shows evaluation result of the impact.

Table 3.6.23 Evaluation Result of Impact on Water Use of PDAM

No	Determinant Factor	Evaluation Result
1.	People subject to impact	People who use water provided by PDAM Wonogiri and Jurug
2.	Spatial extent of area subject to impact	The area covered by PDAM Wonogiri and Jurug
3.	Intensity and duration of impact	Intensity of impact is low, because SS concentration is not conditioning factor of water treatment at PDAM
4.	Other environmental components subject to impact	None

5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

4) River water use for irrigation

a. Impact Prediction

There is Colo weir at 14 km downstream of Wonogiri dam, from which two (2) irrigation canals, East and West Canals, are in operation to irrigate to 27,740 ha of paddy field. The likely concern due to sluicing during operation and maintenance stage is the following two:

- Whether water distribution system of Wonogiri reservoir after the Project implementation would cause a water deficit for irrigation, and
- Whether the sluicing causes sedimentation at Colo weir and irrigation canals.

According to proposed operation rule (tentative) of water distribution (refer to Section 3.4 Project Description.), the total water release from Wonogiri reservoir will basically not change even after the new gate is constructed. Accordingly, no impact would occur on water use for irrigation at Colo weir.

Regarding the second concern, the impact is predicted to be minor because of the following reason: More than 90 % of sediment deposits to be released by sluicing is wash load (Refer to Supporting Report I Annex No. 6 "Turbidity Analysis for Downstream Reaches, Solo River Estuary."), meaning almost all of released sediment deposits will be drained through Colo weir to downstream. The impact of sedimentation in Colo weir and irrigation canals is, therefore, minor.

b. Impact Evaluation

Analysis result of impact prediction indicated that the project would cause minor impact on water use for irrigation. The table below shows evaluation result of the impact.

Table 3.6.24 Evaluation Result of Impact on Water Use for Irrigation

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Farmers using East and West irrigation canals running from Colo weir
2.	Spatial extent of area subject to impact	Irrigation area from Colo weir and downstream reaches of Bengawan Solo river
3.	Intensity and duration of impact	Intensity of impact is low
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

5) Fishing activity.

Fishing is carried out in the Bengawan Solo river using fish net, gill net, fish hook as well as poison and electricity devices. As for the local fisherman in the river, fishing is not a main job but usually they have primary job. Income from fishing is about Rp. 20,000 – 100,000 per day depending on the fish catch of the day, according to the interview survey with local fisherman.

The main impact factor, or impact producing activity of the Project is sluicing from

sediment storage reservoir in Wonogiri reservoir during rainy season. Possible impact is the death of fish or injury due to the respiratory problem of fish caused by high concentration of SS, which might cause decrease of fishing activity and fish catch.

As described is Sub-section (2) Aquatic Biota, Section 3.6.2 Natural Environment, however, the impact of sluicing on fish in the Bengawan Solo river is predicted to be minor on the basis of simulation result of SS concentration of the Bengawan Solo river during sluicing. Accordingly, the impact on fishing activity in the Bengawan Solo river is predicted to minor.

b. Impact Evaluation

Analysis result of impact prediction indicated that the project would cause minor impact on fishery in Bengawan Solo river. The table below shows evaluation result of the impact.

Table 3.6.25 Evaluation Result of Impact on Fishery

No	Determinant Factor	Evaluation Result
1.	People subject to impact	Fishermen in the Bengawan Solo river
2.	Spatial extent of area subject to impact	Downstream reaches of Bengawan Solo river
3.	Intensity and duration of impact	Intensity of impact is low
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Irreversible
Weight of impact		**Negative, Important and Not significant (-TP)**

Source: JICA Study Team

(6) Traffic and Transportation

1) Impact Prediction

During construction stage, vehicles for transportation of excavated material from excavation site of spillway to spoil bank and temporary dumping site would cause impact on local traffic and transportation. The transportation route of excavated material was shown on Figure 3.4.3. The volume of material which will be required to transport is listed in table below:

Table 3.6.26 Volume of Excavated Materials to be Translated

Category	volume	Destination of transportation with volume
(1) Excavation for spillway	370,000m^3	Once stocked in the premise of Wonogiri reservoir area and transported to be used for embankment of closure dike (168,000m^3)
		Dumping to spoil bank area (156,000m^3)
		Backfilling along spillway after completion of structure (46,000m^3)
(2) Excavation for forebay	183,000m^3	Once stocked around Wonogiri reservoir and transported to be used for embankment of closure dike (183,000 m^3)

Source: JICA Study Team

Among items listed in the table above, the excavation for forebay, excavated materials at forebay site (183,000m^3) will not be transported through existing road but temporary road along the reservoir.

Regarding the excavation for spillway, however, existing village road will be used

for transportation of excavated materials. Assuming the load capacity of one truck is six (6) m^3, the total number of trucks required for transportation is approximately 61,700. And as the total work days for construction of spillway is 418 (Refer to Supporting Report Ⅲ Annex No. 12 "Cost Estimate."), the average daily number of trucks for transportation of excavated material is estimated to be about 150/day.

Owing to this project-related transportation activity, local people would undergo negative impacts such as inconvenience of local traffic and transportation due to traffic jam and possibly traffic accidents at the existing roads in Desa Pokohkidul.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would cause adverse impact on traffic and transportation on existing roads. The table below shows evaluation result of the impacts.

Table 3.6.27 Evaluation Result of Impact on Traffic and Transportation

No	Determinant Factor	Evaluation Result
1.	People subject to impact	The people living in Desa Pokoh Kidul and Pondoksari and nearby villages.
2.	Spatial extent of area subject to impact	Existing village road in Desa Pokoh Kidul and Pondoksari.
3.	Intensity and duration of impact	Total volume to be transportation is 370,000 m^3, Averaged daily number of trucks required for transportation is about 150.
4.	Other environmental components subject to impact	Dust, Noise and Vibration, and Public Health (in the worst case)
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Significant (-P)**

Source: JICA Study Team

(7) Historical and cultural heritage

1) Impact Prediction

Possible impact is to damage the existing historical and cultural heritages due to the sluicing from Wonogiri reservoir. According to the survey result on existing cultural heritage along the Bengawan Solo river, several heritages were identified along the Bengawan Solo river (refer to Table 3.5.29). Among them, *Kungkum* is the possible objective to be affected by sluicing because it is an activity to sit in the Bengawan Solo river for a certain hours. If no announcement is made about schedule of sluicing in advance, it might cause a dangerous situation due to a sudden increase of discharge in the Bengawan Solo river.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would cause adverse impact on the traditional custom of *Kungkum* in the Bengawan Solo river. The table below shows evaluation result of the impacts.

Table 3.6.28 Evaluation Result of Impact on *Kungkum* (a Traditional Custom)

No	Determinant Factor	Evaluation Result
1.	People subject to impact	The people who participate in the *Kungkum* ceremony.

2.	Spatial extent of area subject to impact	Central Java and nearby areas
3.	Intensity and duration of impact	The ceremony of *Kungkum* has to be stopped during sluicing
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not Significant (-TP)**

Source: JICA Study Team

(8) Public Health

1) Impact Prediction

Possible impacts of the implementation of the project on public health is the following:

- Impacts of waste form base camp for construction works on sanitary condition,
- Impacts of degradation of air quality, noise and vibration generated from construction works and mobilization of heavy equipments, and
- Impacts of sediment flushing on the sanitary condition of Bengawan Solo river.

Impact of base camp establishment on sanitary condition includes wastewater (effluent from lavatory) and garbage from it. The emergency clinic would be equipped for work accident, from which medical waster would generate. These wastes are possible source to deteriorate sanitary condition around the base camp unless proper treatment is made.

Impacts of construction works on air quality, noise and vibration would spawn health problem and psychology issues of the people living near the construction site in the worst case. Traffic accident and workplace accident are also included as possible impacts.

Dust due to earth works might cause eyes irrigation such as conjunctivitis, dust allergic and respiratory disease. Noise pollution might cause (1) psychology problem such as insomnia and decrease of concentration, (2) changes on character such as easy to angry and sensitive feeling, and (3) physical problems such as hormonal, physiological and immunological system in the worst case (in case of noise level more than 85 dB). Vibration pollution might cause resonance with human body and impacts on blood pressure.

Impacts of sediment flushing on the Bengawan Solo rive includes deterioration of river water with turbidity and garbage. The impact of sluicing on SS concentration is not significant as indicated in the previous section. The impact of garbage to be released through the new gate, on the other hand, is estimated not to be minor because large volume of garbage from the Keduang river basin will be released into the Bengawan Solo river.

2) Impact Evaluation

Analysis result of impact prediction indicated that the project would cause adverse impact on the sanitary condition. Table 3.6.29 shows evaluation result of the impacts of base camp establishment and construction works on sanitary condition of the people living around the project site. Table 3.6.30 shows evaluation result of the impacts of sluicing on sanitary condition of downstream stretch of the Bengawan Solo river.

Table 3.6.29 Evaluation Result of Impact on Health of Local People Around Project Site

No	Determinant Factor	Evaluation Result
1.	People subject to impact	The people living near the construction site
2.	Spatial extent of area subject to impact	Desa Pokoh Kidul and nearby settlement area
3.	Intensity and duration of impact	Not intensive condition and limited duration only during construction stage
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Non cumulative
6.	Reversibility or irreversibility of impact	Reversible
Weight of impact		**Negative, Important and Not Significant (-TP)**

Source: JICA Study Team

Table 3.6.30 Evaluation Result of Impact on Sanitary Condition in Bengawan Solo River

No	Determinant Factor	Evaluation Result
1.	People subject to impact	The people who utilize river channel/river water of Bengawan Solo river
2.	Spatial extent of area subject to impact	Downstream stretch of Bengawan Solo river
3.	Intensity and duration of impact	The intensity of impact is not minor
4.	Other environmental components subject to impact	None
5.	Cumulative characteristics of impact	Cumulative
6.	Reversibility or irreversibility of impact	Irreversible
Weight of impact		**Negative, Important and Significant (-P)**

Source: JICA Study Team

3.7 Environmental Management and Monitoring Plans

3.7.1 Environmental Management Plan

Environmental Management Plan (RKL *(Rencana Pengelolaan Lingkungan Hidup)* in Indonesia) was formulated aiming at preparing action program for minimizing negative impacts of the Project so that the Project owner can make sure to take necessary actions fro sustainability of the Project.

Environmental Management Plan was studied for the priority project components at the following three (3) stages: (1) Pre-construction, (2) Construction, (3) Operation and Maintenance stages. The examination of environmental management was carried out in the following approaches:

- Technical Approach,
- Socio-economic Approach, and
- Institutional Approach.

Technical approach is the one to apply / mobilize present technology for impact alleviation and/or mitigation, such as civil works to prevent erosion, countermeasures for minimizing noise and vibration, installation of alternative water supply system, etc. Socio-economic approach is to adopt measures to contribute to improve livelihood / welfare of local community, such as prioritization of local people for recruitment as construction workers, distribution of electricity to local community, etc. Institutional approach is the activity of stakeholders for organization development to make sure environmental management, necessary coordination and monitoring, and reinforcement of regulation, etc.

Environmental Management Plan was described in Table 3.7.1, indicating action program

for mitigating environmental and social impacts in the following viewpoints that are the same as those of RKL in Indonesia:

- Types of impacts,
- Source of impacts,
- Impact parameters,
- Purpose of environmental management,
- Environmental actions / efforts
- Locations of environmental management,
- Institution (Initiator, Supervisor, Report Recipients), and
- Cost component.

3.7.2 Environmental Monitoring Plan

Environmental Monitoring Plan (RPL *(Rencana Pemantauan Lingkungan Hidup)* in Indonesia) was also formulated aiming at clarifying necessary monitoring activities during all the stages of project implementation so that environmental and social negative impacts can be detected as soon as possible and prevented / avoided for ensuring sustainability of the Project. It was studied for priority project components at three stages as itemized in RKL above.

The advantage of Environmental Monitoring Plan is as follows:

(1) Advantage for Project owner

- To secure the implementation of project activities by executing Environmental Management Plan,
- To optimize construction and management cost and capacity of resources, and
- To coordinate and systematize the activities of management, monitoring and measures for environmental impacts.

(2) Advantage for concerned agency

- To avoid over usage of natural resources,
- To prevent social unrest, and
- To secure efficient usage of benefit of project development and infrastructure for social welfare.

(3) Advantage for local community

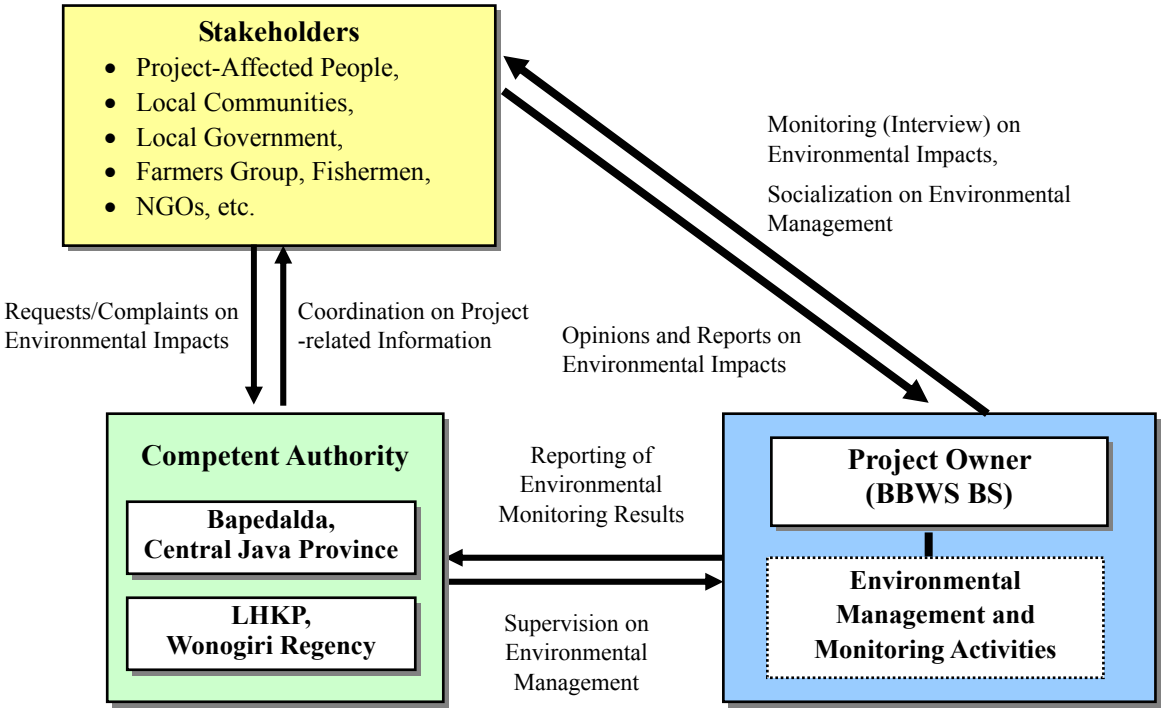
- To get information about the project and environmental change as early as possible,
- To avoid the misunderstanding which can raise negative perception and social unrest, and
- To secure for local community to participate in the project in early stage.

Environmental Monitoring Plan was shown in Table 3.7.2, indicating monitoring activities for the anticipated environmental and social impacts in the following viewpoints that are the same as those of RKL in Indonesia:

- Types of impacts,
- Source of impacts,
- Impact parameters,
- Purpose of environmental monitoring,
- Methodology (data collection, analysis, location, timeframe and frequency),
- Locations of environmental management,
- Institution (Initiator, Supervisor, Report Recipients), and
- Cost component.

3.7.3 Institution for Environmental Management and Monitoring

Figure 3.7.1 shows the institution concerning with environmental management and monitoring for the Project. Project owner (Implementer), BBWS BS, is to conduct necessary environmental management as well as monitoring activities. Competent Agency, or Bapedalda, Central Java Province, is to supervise environmental management for the Project jointly with Environmental Agency (LHKP), Wonogiri Regency. In addition, it is supposed to facilitate necessary socialization about the Project activity, environmental management and coordination between the Project implementer and stakeholders.



Source: JICA Study Team

Figure 3.7.1 Institutional Relationship concerning with Environmental Management of the Project

3.8 Conclusion

Results of Environmental Impact Assessment (EIA) targeted for the priority project proposed as countermeasures in the Master Plan has been discussed in the previous sections. The possible impacts to be caused by the implementation of the Project were examined for physical, biological and socio-economic components at the three stages: pre-construction, construction and operation and maintenance stages.

Impact Matrix (Table 3.8.1) as the result of EIA indicated that there will be several environmental impacts evaluated as "**negative and significant**," including,

- Impacts on air quality, noise and vibration exceeding environmental standard level due to construction works, especially excavation for spillway, and
- Impacts on local traffic and transportation due to transportation of excavated materials.

These impacts are anticipated to occur only during construction stage and therefore the period of impact is limited. The area of impact is confined in nearby villages as well. Accordingly, these impacts are judged not to cause serious problem but to be mitigated by proper socialization and appropriate countermeasures.

Table 3.8.1 Evaluation Result of Environmental Impact (Impact Matrix) of the Project

Environmental Components \ Project Activity		Project Stage									
		Pre-Construction		Construction						Operation & Maintenance	
		Socialization of the Project	Procurement of land required for project facilities	Mobilization and Establishment of base camp	Site clearance for project facilities	Construction work, especially excavation for work	Transportation of excavated materials	Recruitment as construction worker	Watershed management in Keduang river basin	Sluicing of sediment deposits from the reservoir	Periodic maintenance dredging
Physical Components	Groundwater					-TP					
	Air Quality					-P	-P				-TP
	Noise and Vibration					-P	-P				
	Water Quality and River Discharge									-TP	
Biological Components	Terrestrial Flora and Fauna				-TP				+TP		
	Aquatic Organisms									-TP	
	Protected Species										
Socio-economic Components	Land Acquisition and Resettlement										
	People's Unrest	-TP			-TP					-TP	
	Income and Livelihood Change				-TP			+P		-TP	
	Economic Activities of Downstream Areas*									-TP	
	Local Traffic and Transportation			-TP			-P				
	Public Health			-TP		-TP	-TP			-TP	

Note) -P: Negative and significant, -TP: Negative but not significant, +P: Positive and significant, +TP: Positive but not significant.

*: Economic activities include: 1) sand mining, 2) inland navigation, 3) water use by PDAM and irrigation, and 5) fishery,

Source: JICA Study Team

However, the following impacts are not thoroughly clarified but there is still unclear part:

- Impacts on fish species of downstream of Bengawan Solo River due to the change of water quality during sediment releasing through the new gate, and
- Impacts on downstream river environment due to garbage release through the new gate during sediment releasing.

Regarding these impacts, it is necessary to carry out monitoring of river environment during sediment releasing focusing on water quality and sanitary condition of Bengawan Solo river so that the optimal operation of sediment storage reservoir can be established in view of minimizing environmental impacts.

In conclusion, the Project can be evaluated to be valid in environmental point of view under the appropriate management and monitoring activities.

3.9 Information Disclosure

Study results of Environmental Assessment Impact (EIA) was disclosed to stakeholders at Public Consultation Meeting (PCM) held in Kabupaten Wonogiri. The details of the PCM is summarized below focusing on presentation topics, comments/opinions from stakeholders and answers from Project Owner (BBWS BS) and JICA Study Team, including Environmental Survey Team of UNS (University of Seblas Maret) hired by JICA Study Team.

3.9.1 Outline of Public Consultation Meeting (PCM)

- Date: March 1st, 2007
- Venue: BAPPEDA Office of Kabupaten Wonogiri
- Attendants invited:
  - Government Official of Bappedalda (Environmental Agency), Central Java Province,
  - Government Officials of Kabupaten Wonogiri (LHKP (Environmental Agency), Agricultural Agency, Fishery Agency, Regional Development and Planning Agency and Local Government Secretary),
  - Government Officials of relevant Kabupaten and Kota (Sukoharjo, Karanganyar, Klaten, Sragen and Surakarta),
  - Government Officials of relevant Kecamatan (Wonogiri, Jatipurno, Ngadirojo, Jatiroto, Nguntoronadi, Jatisrono, Sidoharjo, Slogohimo, Girimarto),
  - Government Officials of relevant 15 Desa (villages),
  - Representatives of relevant organizations (K2TA: Farmers conservation group for soil and water, GP3A: Farmers association),
  - Representative of local people and NGOs
  - Nos. of Participants: 86 (incl. PPWS Bengawan Solo and JICA Study Team)
- Objectives of PCM:
  - To present the result of Environmental Impact Assessment (EIA) for the priority project for Countermeasures for Sedimentation in the Wonogiri Multipurpose Dam Reservoir,
  - To exchange opinions and receive comments form stakeholders concerned for the priority project components and environmental and social impacts to be caused by the Project.
  - To incorporate (feedback) the discussion results of PCM in the Feasibility Study of the priority project.
- Presentation Topics:

No.	Agenda	Presenter
1	Opening Address of PCM	Mr. Tri Rohadi, Manager of Evaluation and Program, BBWS Bengawan Solo
2	Key note speech from Bupati, Kabupaten Wonogiri	Read by Mr. Suprapto, Head of Bappeda, Kabupaten Wonogiri
3	**Presentation I:** Outline of Priority Project	Ms. Lilik Retno, BBWS Bengawan Solo
4	**Presentation II:** Environmental Impacts of the Project on Physical Elements	Mr. Ari Handono and Mr Mukhlisin (JICA Study Team / Sebelas Maret University).
5	**Presentation III:** Environmental Impacts of the Project on Biological Elements	Mr. Sajidan and Mr. Murwantoko (JICA Study Team / Sebelas Maret University).
6	**Presentation IV:** Environmental Impacts of the Project on Socio-economic Elements	Mr. Maulana (JICA Study Team)
7	Panel discussion	Chaired by Mr. Al. Sentot Sudarwanto, Vice Director of Post Graduate Program on Environmental Department, Sebelas Maret University

3.9.2 Discussions in PCM

(1) Major comments on environmental impact

- Impacts on well water use due to groundwater drawdown should be

compensated by installing drinking water supply.

- It is concerned that sluicing or flushing from sediment storage reservoir through the new gate will generate environmental impacts on downstream area, including impact on Colo weir and irrigation canals.
- Environmental Management and Mitigation Plan have to be presented in very detail, including institutional issues, such as who will responsible for being a project owner, funding, implementing agency etc.
- How is the impact of dredging and dumping of dredged materials to spoil bank generated?
- Main problem of sedimentation in reservoir is erosion from upstream area (watershed area).
- Today's presentation of EIA Study is not accordance with AMDAL system in Indonesia. It is necessary for Project owner to follow AMDAL system. Project owner should coordinate with AMDAL Commission.
- How will the impact of air quality be alleviated, especially dust from uncovered truck?

(2) Answers from BBWS Bengawan Solo and JICA Study Team

- Compensation, including installation of water supply system (PDAM) is supposed to be one form of solutions for inconvenience of well water use of local people.
- Result of grain size survey in the course of the JICA Study concluded that sediment materials to be sluiced / flushed through the new gate is wash load, namely very fine soil particles, accordingly they can drain until estuary beyond Colo weir and the impact is estimated to be minor.
- The dredged materials will be dumped over the land currently used for the area of motor cross of motor cycles. But this area is the land owned by government (BBWS Bengawan Solo). So it is not necessary to acquire land for spoil bank.
- EIA based on JICA Study for the proposed Project is different from AMDAL in Indonesia. Accordingly, EIA is to be done based on JICA Guideline for Environmental and Social Considerations. That is why EIA does not follow procedures required by AMDAL. If AMDAL is required for the Project the Project owner has to follow necessary procedures of AMDAL in the future.
- Regarding environmental impact, including the problems of dust to be caused by uncovered transportation vehicles, it is necessary to establish a monitoring team that has responsibility for giving information and rules and procedures to avoid negative impacts.

Figure 3.9.1 shows the photos of the Public Consultation Meeting Study Result of Environmental Impact Assessment held.

	
Registration of attendants	Opening ceremony
	
First presentation by Ms. Lilik	Views of attendances
	
Second presentation by Mr. Ari Handono	Views of attendance

Figure 3.9.1 Photos of Public Consultation Meeting on Study Result of Environmental Impact Assessment held on March 1st, 2007

Tables

Table 1.5.1 Procedures of Environmental and Social Considerations for Master Plan Study at Full-Scale Study Stage

Category A Study	Category B Study
1. JICA involves a member(s) for environmental and social considerations in study teams;	1. JICA involves a member(s) for environmental and social considerations in study teams;
2. JICA collects relevant information and conducts field surveys covering a wider area than that of the preparatory study stage, holds consultations with the recipient governments, and prepares draft of scoping;	2. JICA collects relevant information and conducts field surveys covering a wider area than that of the preparatory study stage, holds consultations with the recipient governments, and prepares draft of scoping;
3. JICA consults with local stakeholders in collaboration with the recipient governments after disclosure of drafts of scoping, and incorporates results of consultation into TOR of environmental and social considerations studies. The consultation widely covers the needs of projects and the analysis of alternatives.	3. JICA consults with local stakeholders in collaboration with the recipient governments after the disclosure of drafts of scoping when necessary;
4. The TOR includes an understanding of needs, the impacts to be assessed, study methods, an analysis of alternatives, a schedule and other matters. JICA endeavors to incorporate the concept of Strategic Environmental Assessment into such studies. JICA then obtains an agreement on the TOR with the recipient governments through consultations;	4. The TOR includes an understanding of needs, the impacts to be assessed, study methods, an analysis of alternatives, a schedule and other matters. JICA endeavors to incorporate the concept of Strategic Environmental Assessment into such studies. JICA then obtains an agreement on the TOR with the recipient governments through consultations;
5. In accordance with the TOR and in collaboration with the recipient governments, JICA conducts IEE-level environmental and social considerations studies, and analyzes alternatives including a "without project" situation. During studies, JICA incorporates its results into related reports prepared in a process accordingly;	5. In accordance with the TOR and in collaboration with the recipient governments, JICA conducts IEE-level environmental and social considerations studies, and analyzes alternatives including a "without project" situation. During studies, JICA incorporates its results into related reports prepared in a process accordingly;
6. When preparing a rough outline of environmental and social considerations, JICA holds a series of stakeholder consultations in collaboration with the recipient governments after information disclosure and incorporates the result of consultation into there studies.	6. JICA consults with local stakeholders after information disclosure in collaboration with the recipient governments, when necessary;
7. Based on the above-mentioned procedure, JICA prepares drafts of the final reports incorporating results of environmental and social considerations studies, and explains them to the recipient governments to obtain their comments. JICA discloses the drafts to and consults with local stakeholders in collaboration with the recipient governments, and incorporates the results of that consultation into the final reports.	7. Based on the above-mentioned procedure, JICA prepares drafts of the final reports incorporating results of environmental and social considerations studies, and explains them to the recipient governments to obtain their comments. JICA consults with local stakeholders in collaboration with the recipient governments after disclosure of drafts of the final reports when necessary;
8. JICA prepares final reports incorporating results of study, and submits them to the recipient governments after confirming that the report meet the requirements of the guidelines; and	8. JICA prepares final reports incorporating results of study, and submits them to the recipient governments after confirming that the report meet the requirements of the guidelines; and
9. JICA discloses final reports promptly after completion, on its website and at the JICA library and a relevant overseas office.	9. JICA discloses final reports promptly after completion, on its website and at the JICA library and a relevant overseas office.

Table 1.5.2 Procedures of Environmental and Social Considerations for Feasibility Study at Full-Scale Study Stage

Category A Study	Category B Study
1. JICA involves a member(s) for environmental and social considerations in study teams; 2. JICA collects relevant information, conducts field surveys in a wider area than that of preparatory studies, holds consultations with the recipient governments and prepares drafts of scoping; 3. After disclosing the drafts of scoping, JICA consults with local stakeholders in collaboration with the recipient governments and incorporates results of consultation into the TOR of environmental and social considerations studies. The consultations widely cover needs of projects and analysis of alternatives; 4. The TOR includes understanding of development needs, impacts to be assessed, study methods, analysis of alternatives, a schedule, etc. JICA obtains an agreement on TOR with the recipient governments through consultations; 5. In line with TOR and in collaboration with the recipient governments, JICA conducts EIA-level environmental and social considerations studies including a monitoring plan, and institutional arrangement, and mitigation measures to avoid, minimize or compensate for adverse impacts. JICA analyzes alternatives including a "without project" situation. JICA incorporates the results of studies into relevant reports prepared accordingly; 6. When considering the rough outline of environmental and social considerations, JICA consults with local stakeholders, after information disclosure, and incorporates results into the studies; 7. JICA prepares drafts of the final reports, incorporating the results of environmental and social considerations studies, and explains them to the recipient governments to obtain comments. After disclosure of drafts of the final reports, JICA consults with local stakeholders in collaboration with the recipient governments and incorporates results of consultation into the final reports; 8. JICA prepares final reports and submits them to the recipient governments after confirming that they meet the requirements of the guidelines; and 9. JICA discloses final reports promptly after their completion, on its website and at the JICA library and a concerned overseas office.	1. JICA involves a member(s) for environmental and social considerations in study teams; 2. JICA collects relevant information and conducts field surveys in a wider area than that of preparatory studies, conducts scoping together with the recipient governments, and prepares TOR of environmental and social consideration studies; 3. The TOR includes understanding of development needs, impacts to be assessed, study methods, analysis of alternatives, a schedule, etc. JICA obtains an agreement on TOR with the recipient governments through consultations; 4. In accordance with the TOR, JICA conducts IEE-level environmental and social considerations studies in which are analyzed alternatives including a "without project" situation. The results are incorporated into various reports prepared in study process, accordingly; 5. JICA reviews screening based on the results of IEE-level studies. For studies newly categorized into Category A, JICA takes procedures as noted in those of the Category A. For studies again classified into Category B, the results of environmental and social considerations studies are incorporated into drafts of the final reports. For studies newly categorized into Category C, the process of environmental and social considerations is finished. 6. JICA prepares drafts of the final reports, into which are incorporated the results of environmental and social considerations studies, and explains them to the recipient governments to obtain comments. The comments are incorporated into final reports; 7. JICA prepares final reports, and submits them to the recipient governments after confirming that they meet the requirements of the guidelines; 8. JICA holds consultations with local stakeholders after information disclosure, in collaboration with the recipient governments, if necessary; and 9. JICA discloses final reports promptly after their completion, on its website and at the JICA library and a concerned overseas office.

Table 2.5.2 (1/3) Brief Description of Candidate Project Components

a. Countermeasures for Sediment Deposits and Garbage at Intake

Candidate components	Description of project components	Dimension
a) Modification of the intake	• Installation of new intake tower on the existing intake. • This is aimed that the intake point will not be affected by the sedimentation deposits. • The new intake tower is supposed to construct on the existing intake structure.	• Concrete tower: H=26.0m • Roller gate: B=12.6m, H=5.0m, 2 nos.
b) Relocation of the intake	• Construction of a new intake structure with a tower and a tunnel at upper left bank around 300m far from the existing intake point. • This is aimed to avoid the impact of sediment on power generation by replacing intake structure with the same effect as the previous one. • A headrace tunnel is to be constructed to connect it to existing headrace tunnel along the left bank side of the reservoir.	• Concrete tower: H=32.0m • Roller gate: B=10.0m, H=5.0m, 2 nos. • Tunnel: D=5.5m, L=570m
c) Garbage trapping structure at intake	• Installation of additional screen structure around the existing intake and access bridge road for garbage cleaning. • This is aimed to block garbage such as crop stem, root of plants to enter the intake. • An access road connects dam crest and this structure is to ease maintenance work. • Garbage on trash rack shall be removed by heavy equipments such as back hoe or crane.	• Screen: B=8.0m, L=111.2m, A=889.6m2. • Access road: B=7.0m, L=105.7m, A=739.9m2. • Pier: Φ=1,000 mm, H=9.0m, N=34 nos.
d) Garbage trapping structure at Keduang River	• Installation of a weir structure with steel racks at the river mouth of the Keduang river. • This measure is aimed to trap and remove debris including trees, plant stem and other garbage coming from the Keduang river before flowing down to the reservoir. • The basic form of this structure is one of concrete slit sabo dam with reinforced bars.	• Weir: B=56.3m, H=9.3m, 1 no. • Steel rack: B=25.0m, H=4.0m
e) Hydro-suction sediment removal system	• Installation of sediment removal system by utilizing water head between reservoir water level and downstream river water level. • Sediment deposits are to be removed through suction mouth and drained to the Bengawan Solo river. • Discharge pipe is to be installed underneath the spill way of the Wonogiri Dam. • Hydro-suction Sediment Removal System is classified into two types: Fixed Type and Mobile Type. The latter is considered to be effective for Wonogiri case.	• Discharge pipe: D = 600mm, L=500m. • Design sand discharge: less than 100,000m3/y
f) Hydraulic dredging	• This is aimed at removing sediment deposits around existing intake point by dredging using conventional dredger. • This method is reliable but requires huge volume of spoil bank area for disposal of dredged material.	• Design sand discharge: less than 100,000m3/y.

Table 2.5.2 (2/3) Brief Description of Candidate Project Components

b. Countermeasure for decreased effective storage in the reservoir

Candidate components	Description of project components	Dimension
a) Keduang River sediment bypass	• Construction of new sediment bypass channel on the Kuduang river. • This is aimed at flushing highly turbid water from Keduang river during floods into the B. Solo river at downstream of Wonogiri dam. • Sediment bypass channel is composed of the three components: 1) a diversion weir, 2) bypass tunnel and 3) open channel by widening the existing river. • The location of diversion weir is at Desa Gedong, and then the channel goes through Desa Pndok, Pokoh Kidul by a tunnel and Purworejo by an open channel. • Excavation volume for tunneling is estimated at approx. 200,000m3.	• Diversion Weir (concrete body): W=137.9m, H=9.3m, • Bypass Tunnel: horseshoe channel, 2R=5.0m, L=6,435m, Gradient=1/1,000, • Design discharge (Qmax) = 50m3/s • Open channel (by widening of existing river): Design discharge (Qmax) = 65 m3/s, L=2,395m, Gradient = 1/160, • Cross section: B=10.0m, H=3.0m
b) Sediment sluicing by new gates	• Construction of new sediment sluicing gate at the right bank of bank side of Wonogiri dam, • This is aimed at sluicing the highly turbid water from Keduang river during floods into the B. Solo river at downstream of Wonogiri dam. • The sediment sluicing gate is composed of four radial gates connecting to spillway with the maximum design discharge of the gate is 400m3/s, which is the same as the maximum discharge rate of downstream river reach. • Planned excavation volume for apron in front of the sluicing gate is 140,000m3.	• Radial gate: B=5.0m, H=12.6m, 4 nos. • Spillway: B=20m, L=723m • Apron: EL=127.0m
c) Compartmented reservoir with new flushing gates	• A combination of the sediment sluicing gates above mentioned and an embankment from the gates site to a peninsula in the reservoir. • This is aimed at conducting sediment flushing regularly taking advantage of increased turn-over rate at the outlet water area of the Keduang river created by the embankment.	• Embankment (steel sheet pile): : L=650m, H=15.0m, B=10.0m, • Spillway of embankment: L=100m, B=10.0m

c. Countermeasures for Sediment Inflow from Other Tributaries (1/2)

Candidate components	Description of project components	Dimension
a) Sediment storage dam for sediment removal	• Construction of a new sediment storage dam at the downstream of the Keduang river. • This is aimed to prevent the sediment flowing into deep portion of the Wonogiri reservoir. • Regular excavation of stored sediment in the dam and its dumping to spoil bank is needed.	• Sediment storage dam (concrete dam): W=115.9m, H=9.3m • Overflow section: B=70m
b) Hydraulic dredging in reservoir	• This is aimed at removing sediment deposits around existing intake point by dredging using conventional dredger. • This method is reliable but requires huge volume of spoil bank area for disposal of dredged material.	• Cutter-suction dredger: 600 SP x 6 units, • Working period: 6 months / year.
c) Dry excavation in reservoir	• Excavation works under dry condition near the outlet of the Tirtomoyo, Temon, Upper Solo, Alang and Wuryantoro rivers. • This is aimed to conduct as a supplementary countermeasure with the other ones. • The excavation work is to be done using bulldozers, crawler loaders and transport it by dump truck for disposing on green belt and/or spoil bank.	• Bulldozer: 4t, swamp x 2,960 units., • Crawler loader: 2.3m3 x 110 units., • Dump truck: 10t x 640 units, • Working period: 2 months / year.

Table 2.5.2 (3/3) Brief Description of Candidate Project Components

c. Countermeasures for Sediment Inflow from Other Tributaries (2/2)

Candidate components	Description of project components	Dimension
d) Managing of sediments within reservoir by water releasing from intake	• This is aimed at managing sediments within the reservoir by moving it from the depth of effective storage (EL. 127.0 – 136.0m) to the depth of sediment storage (EL. < 127.0m). • This is also aimed to drain the sediment deposits by water releasing from the existing intake in the early rainy season of the year.	• Design water release volume: 693 million m3/y, • Design sediment drainage volume: 542,000 m3/y.
e) Re-allocation of reservoir storage capacity	• This is aimed at increasing the decreased effective storage by sedimentation deposits in the reservoir. • The decreased effective storage, or 160 million cubic meters, is predicted to be restored by heightening the dam up to 2m.	• Heightening of dam: 2 m.

d. Watershed conservation

Candidate components	Description of project components	Dimension
a) Watershed conservation by terracing and planting	• This countermeasure is targeted at 1) upland field, 2) upland field in settlement area and 3) settlement area, which are the main soil erosion sources in Wonogiri reservoir. • The conservation measure consists of 1) Soil and water conservation measures and 2) agricultural measures, aiming to prevent from raindrop impact and soil erosion by water. • Soil and water conservation further consists of 1) terrace improvement and terrace formation / upgrading with vegetative measure, 2) agro-forestry promotion and 3) land use modification. • Agricultural measure further consists of 1) cropping system improvement, 2) soil improvement, promotion of agro-forestry with tree crops, 3) improvement of vegetative cover in housing yard, and 4) livestock promotion. • Support program for promoting watershed conservation measures, consisting of 1) empowerment of beneficiary farmers and farmer group including technical guidance, and 2) support program for operation/implementation of conservation measures.	• Extent of targeted area: (1) Upland field: 39,800 ha, (2) Upland field in settlement area: 19,500 ha, (3) Settlement area: 7,300 ha. • Earth work volume: 700 – 1,700 m3/ha for new terrace formation, • Planting: 1,700 – 5,300m/ha for lip, 600 – 6,000m2/ha for riser.

e. No Action

No action to be done for existing problems	• No action for ongoing watershed devastation, including soil erosion over upland area. • No action for ongoing sedimentation problem in Wonogiri reservoir. • No action for ongoing debris trapping problem at existing intake.	

Table 2.6.3 (1/2) Result of Water Quality Analysis (at the beginning of rainy season)

No.	Parameters	Unit	Standard Class II	Location												
				No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13
1	Temperature	ºC	±3	28	28	30	31	31	29	30	31	30	29	29	30	30
2	Turbidity	NTU	---	312	136	50	138	26	198	101	123	120	342	209	262	288
3	Electric conductivity	µmhos/cm	---	166	127	364	356	232	152	370	306	160	155	128	129	139
4	Total Solids (TS)	mg/L	1,050	466	229	300	355	185	296	342	330	266	451	288	347	370
5	Total Suspended Solids (TSS)	mg/L	50	357	145	60	123	32	196	98	128	160	349	203	261	278
6	pH	-	6-9	7.1	7.0	7.2	7.2	7.0	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.1
7	Hardness	mg/L	---	56	64	191	171	102	66	117	115	76	74	4	62	60
8	Iron (Fe)	mg/L	(0.3)	1.05	0.51	0.50	0.13	0.57	0.68	0.44	0.72	0.83	0.45	1.03	0.46	1.03
9	Manganese (Mn)	mg/L	(0.1)	1.08	0.46	0.64	0.12	0.63	1.20	0.64	0.93	0.66	0.41	1.10	0.61	0.49
10	Copper (Cu)	mg/L	0.02	0.08	0.01	0.01	nd	0.01	0.01	nd	nd	0.02	0.01	nd	nd	nd
11	Zinc (Zn)	mg/L	0.05	0.136	0.049	0.029	0.008	0.033	0.012	0.187	0.062	0.028	0.160	0.043	0.012	0.038
12	Chromium (VI) (Cr6+)	mg/L	0.05	0.339	0.270	0.309	0.246	0.536	0.458	0.294	0.397	0.398	0.784	0.658	0.464	0.664
13	Cadmium (Cd)	mg/L	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
14	Total Mercury (T-Hg)	mg/L	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	Lead (Pb)	mg/L	0.03	nd	nd	0.008	nd	0.008	0.006	nd	0.016	nd	0.003	0.016	0.015	0.014
16	Arsenic (As)	mg/L	1	0.017	0.001	nd	0.001	0.004	0.004	nd	0.006	0.011	0.006	0.007	0.003	0.009
17	Cyanide (CN)	mg/L	(0.02)	0.071	0.009	0.002	0.001	0.007	0.027	0.002	0.007	0.019	0.030	0.034	0.033	0.022
18	Ammonia (NH_3)	mg/L	(0.5)	2.63	0.45	0.22	0.20	0.21	1.55	0.65	1.42	1.10	1.15	1.26	1.22	0.84
19	Nitrate (NO_3)	mg/L	10	1.438	0.674	0.631	0.787	0.235	nd	nd	nd	nd	nd	nd	nd	nd
20	Nitrite (NO_2)	mg/L	0.06	0.115	0.109	0.114	0.098	0.110	0.123	0.174	0.452	0.117	0.116	0.144	0.225	0.220
21	Total Phosphorus (T-P)	mg/L	0.2	0.150	0.010	0.067	0.041	0.090	0.116	0.290	0.313	0.068	0.259	0.198	0.223	0.174
22	Dissolved Oxygen (DO)	mg/L	4	6.4	6.8	6.4	6.4	6.8	6.4	5.1	4.4	6.4	6.4	6.8	6.6	6.2
23	Biochemical Oxygen Demand (BOD)	mg/L	3	13.5	1.4	4.5	3.7	1.4	3.6	14.8	14.3	8.2	4.5	4.0	4.5	7.9
24	Chemical Oxygen Demand (COD)	mg/L	25	58	17	48	50	19	52	24	43	53	43	58	19	29
25	Detergent	mg/L	200	0.130	0.095	0.024	0.056	0.228	0.011	0.092	nd	0.111	0.121	nd	nd	nd
26	Phenol	mg/L	---	0.014	0.011	0.010	0.014	0.013	0.012	0.013	0.011	0.011	0.011	0.011	0.011	0.014
27	Oil and fat	mg/L	1,000	22	18	13	8	7	5	2	8	9	2	13	zero	1
28	Coliform group	JPT/100ml	5,000	2.4×10^5	2.4×10^5	4.6×10^5	1.1×10^6	2.3×10^4	2×10^4	9.3×10^4	zero	4×10^3	2.4×10^5	7.5×10^4	9×10^3	2.4×10^5
29	Coliform feces	JPT/100ml	1,000	9×10^4	2.4×10^5	1.5×10^5	4.6×10^5	2.3×10^4	zero	1.5×10^4	zero	zero	7×10^3	7.5×10^4	4×10^3	2.4×10^5
30	Aldrin	ppb	(17)	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Dieldrin	ppb	(17)	0.034	0	0	0	0	0	0.057	0	0	0	0.015	0.022	0.015
32	DDT	ppb	2	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Lindane	ppb	(56)	0.015	0	0.001	0	0	0	0	0	0	0	0	0	0.001
34	Endrin	ppb	4	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: JICA Study Team

Note) Sampling date: 7th - 9th, December, 2004.

"nd" means not detected.

Standard value: Class II of Government Regulation No.82/2001 (Class I in case a vakue of class II is not provided)

Table 2.6.3 (2/2) Result of Water Quality Analysis (at the end of rainy season)

No.	Parameters	Unit	Standard Class II	Location												
				No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13
1	Temperature	ºC	±3	31.0	31.5	29.5	34.5	32.0	31.0	29.0	30.5	31.0	30.5	31.0	31.0	31.0
2	Turbidity	NTU	---	6	6	12	7	8	1	9	7	4	1	8	8	22
3	Electric conductivity	µmhos/cm	---	248	238	404	402	260	180	492	475	179	178	181	178	180
4	Total Solids	mg/L	1,050	175	169	279	273	182	124	342	326	126	122	134	129	132
5	Total Suspended Solids	mg/L	50	9	12	12	8	10	5	18	11	8	5	15	12	13
6	pH	-	6-9	7.3	7.1	7.3	7.2	7.3	7.1	7.1	7.1	7.1	7.2	7.1	7.2	7.1
7	Hardness	mg/L	---	94	93	179	153	100	75	137	145	70	72	72	75	75
8	Iron (Fe)	mg/L	(0.3)	1.50	0.96	1.89	0.75	0.82	0.64	1.28	1.14	0.28	0.42	1.82	3.66	2.07
9	Manganese (Mn)	mg/L	(0.1)	0.01	0.07	0.15	0.02	0.22	0.02	0.37	0.32	nd	0.20	0.11	nd	0.30
10	Copper (Cu)	mg/L	0.02	0.01	nd	nd	0.09	0.02	0.02	0.01	0.03	0.03	0.04	0.04	0.01	0.02
11	Zinc (Zn)	mg/L	0.05	0.164	0.002	0.405	0.098	0.033	0.069	0.088	0.201	0.091	0.078	0.024	0.072	0.094
12	Chromium (VI) (Cr6+)	mg/L	0.05	0.068	0.069	0.071	0.072	0.074	0.069	0.077	0.075	0.069	0.069	0.070	0.069	0.072
13	Cadmium (Cd)	mg/L	0.01	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
14	Total Mercury (T-Hg)	mg/L	0.002	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
15	Lead (Pb)	mg/L	0.03	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
16	Arsenic (As)	mg/L	1	0.051	0.049	0.086	0.053	0.066	0.063	0.071	0.065	0.053	0.050	0.048	0.045	0.053
17	Cyanide (CN)	mg/L	(0.02)	0.008	0.001	0.000	0.000	0.001	0.005	0.000	0.001	0.002	0.004	0.006	0.001	0.002
18	Ammonia (NH_3)	mg/L	(0.5)	0.51	0.19	0.20	0.28	0.22	0.44	0.31	0.37	0.40	0.33	0.18	0.15	0.18
19	Nitrate (NO_3)	mg/L	10	0.781	nd	0.077	nd	nd	nd	0.109	nd	nd	nd	nd	nd	nd
20	Nitrite (NO_2)	mg/L	0.06	nd	nd	nd	nd	nd	nd	0.073	nd	nd	nd	nd	nd	nd
21	Total Phosphorus (T-P)	mg/L	0.2	nd	0.016	0.040	nd	nd	nd	0.334	0.448	nd	nd	0.017	nd	nd
22	Dissolved Oxygen (DO)	mg/L	4	7.6	6.3	5.8	5.9	7.8	7.8	5.1	3.7	6.6	6.8	6.8	7.4	7.8
23	Biochemical Oxygen Demand (BOD)	mg/L	3	2.5	4.2	5.9	2.9	3.8	1.5	10.9	11.3	2.2	2.1	7.7	2.5	1.0
24	Chemical Oxygen Demand (COD)	mg/L	25	21	31	31	21	21	13	62	103	31	16	26	16	21
25	Detergent	mg/L	200	0.063	0.055	0.070	0.071	0.108	0.008	0.245	0.113	0.015	nd	0.02	0.068	0.068
26	Phenol	mg/L	---	nd	nd	nd	0.019	nd	nd	nd	nd	0.018	nd	nd	nd	nd
27	Oil and fat	mg/L	1,000	27	21	13	11	27	18	3	18	2	2	nihil	2	2
28	Coliform group	JPT/100ml	5,000	4.3×10^3	4.6×10^4	4.6×10^4	1.1×10^5	2.3×10^3	9.0×10^2	2.4×10^4	1.5×10^4	9.0×10^2	9.0×10^2	9.3×10^3	2.0×10^3	1.1×10^5
29	Coliform feces	JPT/100ml	1,000	4.3×10^3	2.1×10^3	4.3×10^3	1.5×10^4	2.3×10^3	nihil	9.3×10^3	2.3×10^3	4.0×10^2	nihil	2.1×10^4	1.5×10^4	4.6×10^4
30	Aldrin	ppb	(17)	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Dieldrin	ppb	(17)	0	0	0	0	0	0	0	0	0	0	0	0	0
32	DDT	ppb	2	0	0	0	0	0	0	0	0	0	0	0	0	0.002
33	Lindane	ppb	(56)	0.027	0	0	0.017	0.046	0	0	0	0	0.008	0.046	0	0
34	Endrin	ppb	4	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: JICA Study Team

Note) Sampling date: 7th - 9th, December, 2004.

"nd" means not detected.

Standard value: Class II of Government Regulation No.82/2001 (Class I in case a vakue of class II is not provided)

Table 2.6.5 (1/2) Result of Bed Material Quality Analysis (Decenber, 2004)

No.	Parameters	Unit	Location												Min.	Max.	Ave.	Environmental Standard of Japan
			No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13				
1	Temperature	ºC	30.0	30.0	30.0	30.0	30.0	29.0	30.0	29.0	30.0	29.0	29.0	30.0	30.0	29.0	30.0	29.7	-
2	Smell (Odor)	---	Organic smell	Organic smell	Odorless	Odorless	Odorless	Organic smell	Organic smell	Organic smell	Organic smell	Organic smell	Drainage ditch smell	Drainage ditch smell	Organic smell	-	-	-	-
3	Ignition loss	%	4.525	5.990	6.755	5.155	4.370	10.645	8.085	11.395	22.230	12.380	14.685	9.910	9.875	4.370	22.230	9.692	-
4	pH	---	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7.0	7.0	6.0	6.0	6.0	6.0	6.0	7.0	6.2	-
5	Iron (Fe)	%	8.16	2.56	3.15	2.44	3.69	5.52	4.23	3.31	3.48	5.09	3.14	3.25	4.29	2.44	8.16	4.02	-
6	Manganese (Mn)	mg/kg	1538.80	1137.92	983.68	2595.42	1035.29	1910.45	975.95	1249.70	739.92	1720.75	1304.52	1896.75	1837.67	739.92	2595.42	1455.91	-
7	Copper (Cu)	mg/kg	31.40	43.06	31.54	27.52	31.40	40.71	34.50	43.43	43.48	36.08	33.60	36.98	35.01	27.52	43.48	36.05	125 mg/kg*
8	Zinc (Zn)	mg/kg	6.01	5.66	4.14	3.21	3.80	3.69	11.01	5.52	4.58	5.43	4.01	3.82	4.44	3.21	11.01	5.02	-
9	Chromium (VI) (Cr6+)	mg/kg	20.77	14.93	21.63	16.79	23.84	16.42	15.81	16.57	15.02	15.47	10.61	12.24	18.68	10.61	23.84	16.83	0.05 mg/l
10	Cadmium (Cd)	mg/kg	1.17	0.83	0.68	1.03	14.12	0.82	0.58	0.79	0.79	0.83	0.71	0.69	0.80	0.58	14.12	1.83	0.01mg/l and 1mg/kg**
11	Total Mercury (T-Hg)	mg/kg	0.106	0.044	0.132	0.056	0.106	0.102	0.068	0.028	0.033	0.052	0.068	0.025	0.050	0.025	0.132	0.067	0.0005 mg/l
12	Lead (Pb)	mg/kg	32.42	32.40	23.15	33.21	21.57	26.87	26.46	30.37	23.72	25.28	31.43	22.56	24.50	21.57	33.21	27.23	0.01 mg/l
13	Arsenic (As)	mg/kg	0.038	0.005	0.043	0.038	0.025	0.038	0.005	0.018	0.025	0.043	0.043	0.018	0.038	0.005	0.043	0.029	0.01 mg/kg and 15 mg/kg***
14	Cyanide (CN)	mg/kg	0.0670	0.0350	0.0265	0.0185	0.0165	0.0279	0.0222	0.0143	0.0268	0.0108	0.0195	0.0127	0.0900	0.0108	0.0900	0.0298	Not detected.
15	Phosphate(PO4)	mg/kg	579.217	342.161	391.727	229.313	283.961	449.384	398.557	327.988	331.941	410.358	292.417	314.054	435.008	229.313	579.217	368.160	-
16	Organic matter	mg/kg	179.43	155.39	139.36	203.51	123.31	107.29	75.22	75.22	219.54	179.43	115.31	99.27	83.23	75.22	219.54	135.04	-
17	COD	mg/kg	37.0	17.5	15.5	10.0	47.0	22.5	40.5	32.0	5.5	36.0	65.5	22.5	40.0	5.5	65.5	30.1	-

Source: JICA Study Team

Note) *: aplicable only for farmland.
**: ablicable only for rice.
***: aplicable only for farmland.

Table 2.6.5 (2/2) Result of Bed Material Quality Analysis (May, 2005)

No.	Parameters	Unit	Location												Min.	Max.	Ave.	Environmental Standard of Japan
			No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13				
1	Temperature	℃	28.0	27.0	27.0	28.0	28.0	28.0	28.0	28.0	27.5	27.0	28.0	28.0	28.0	27.0	28.0	27.7	-
2	Smell (Odor)	---	Soil smell	Soil smell	Soil smell	Organic smell	Soil smell	Soil smell	ainage ditch sm	ainage ditch sm	Soil smell	Soil smell	Soil smell	Soil smell	Soil smell	-	-	-	-
3	Ignition loss	%	10.9	7.4	11.7	12.5	9.9	12.1	11.1	15.5	14.3	13.6	13.1	14.1	13.1	7.410	15.520	12.251	-
4	pH	---	7.0	6.5	7.0	6.0	6.0	6.0	7.0	6.0	7.0	6.0	6.0	7.0	6.0	6.0	7.0	6.4	-
5	Iron (Fe)	%	2.76	3.55	2.71	2.05	1.96	2.66	4.02	2.15	2.44	2.25	2.49	2.82	2.55	1.96	4.02	2.65	-
6	Manganese (Mn)	mg/kg	2,041.83	2,041.83	1,603.59	3,140.00	838.32	2,700.00	1,666.67	2,198.02	940.59	2,043.65	1,982.07	3,106.51	2,888.45	838.32	3,140.00	2,091.66	-
7	Copper (Cu)	mg/kg	25.7	29.5	28.1	24.4	18.4	29.8	32.7	35.3	29.5	28.4	24.7	25.6	25.0	18.36	35.25	27.46	125 mg/kg*
8	Zinc (Zn)	mg/kg	91.6	169.8	90.6	55.0	67.4	85.5	995.9	268.3	69.3	73.4	71.7	75.0	75.7	55.00	995.86	168.40	-
9	Chromium (VI) (Cr6+)	mg/kg	16.9	32.9	34.9	28.0	14.0	16.0	31.6	22.8	9.9	13.9	12.0	13.8	23.9	9.90	34.86	20.80	0.05 mg/l
10	Cadmium (Cd)	mg/kg	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	0.01mg/l and 1mg/kg**
11	Total Mercury (T-Hg)	mg/kg	0.076	0.068	0.050	0.076	0.082	0.048	0.159	0.155	0.126	0.067	0.048	0.112	0.063	0.048	0.159	0.087	0.0005 mg/l
12	Lead (Pb)	mg/kg	42.83	38.84	28.88	48.00	32.93	31.00	37.48	53.47	48.51	25.79	22.91	24.65	32.87	22.91	53.47	36.01	0.01 mg/l
13	Arsenic (As)	mg/kg	1.550	1.550	1.950	1.450	1.550	1.150	0.950	1.300	1.650	1.400	1.200	1.450	1.250	0.950	1.950	1.415	0.01 mg/kg and 15 mg/kg***
14	Cyanide (CN)	mg/kg	2	1	0.1	1.2	3.2	1.6	12.5	9	5	1.7	1.7	1.5	1.2	0.0750	12.5250	3.1478	Not detected.
15	Phosphate(PO4)	mg/kg	521.3	465.0	448.0	323.8	254.9	397.5	571.8	561.3	215.5	296.8	277.5	311.3	405.0	215.500	571.750	388.413	-
16	Organic matter	mg/kg	111.4	60.2	53.8	53.8	66.6	60.2	60.2	47.2	60.2	47.2	40.8	53.8	41.0	40.80	111.40	58.18	-
17	COD	mg/kg	65.3	14.3	160.0	14.3	85.7	92.5	180.7	230.0	158.0	132.2	15.7	207.0	143.1	14.3	230.0	115.3	-

Source: JICA Study Team

Note) *: aplicable only for farmland.

**: ablicable only for rice.

***: aplicable only for farmland.

Table 2.6.6 Comparison of Analysis Result of Bed Material with Standard Values of Dredged Sediment in Several Countries

Parameter		Analysis Result of JICA Study (Average of all sampling location)		Analysis Result of JICA Study (Average of reservoir sampling location)		Hong Kong*1	Belgium		Germany*2		Norway					Spain*3	
						Existing standard (review)	Under proposal to SEBA*4		Under proposal to SEBA		Under proposal to SEBA					Existing standard	
		Dec. 2004	May 2005	Dec. 2004	May 2005	Management value	Action level 1 (target value)	Action level 2 (limit value)	Action level 1 (reference value)	Action level 2 (limit value)	Class 1 (Good)	Class 2 (Fair)	Class 3 (Poor)	Class 4 (Bad)	Class 5 (Very bad)	Action level 1	Action level 2
Test method		Content test		Content test		Content test	Content test		Content test		Content test					Content test	
Unit		mg/kg (dried sediment)		mg/kg (dried sediment)		mg/kg (dried sediment)	mg/kg (dried sediment)		mg/kg (dried sediment)		mg/kg (dried sediment)					mg/kg (dried sediment)	
Cadmium	(Cd)	**1.83**	**<0.02**	**0.81**	**<0.02**	>1.5	2.5	12.5	2.5	12.5	<0.25	0.25-1	1-5	5-10	>10	1	5
Chromium (IV)	(Cr^{6+})	**16.8**	**20.8**	**15.2**	**11.9**	>80	60	300	150	750	<70	70-300	300-1,500	1,500-5,000	>5,000	200	1,000
Copper	(Cu)	**36.1**	**27.5**	**39.78**	**28.95**	>65	20	100	40	200	<35	35-150	150-700	700-1,500	>1,500	100	400
Total Mercury	(Hg)	**0.07**	**0.09**	**0.043**	**0.097**	>1	0.3	1.5	1	5	<0.15	0.15-0.6	0-3	3-5	>5	0.6	3
Lead	(Pb)	**27.2**	**36**	**24.5**	**37.15**	>75	70	350	100	500	<30	30-120	120-600	600-1,500	>1,500	120	600
Zinc	(Zn)	**5.0**	**168.4**	**5.0**	**71.4**	>200	160	800	350	1,750	<150	150-650	650-3,000	3,000-10,000	>10,000	500	3,000
Arsenic	(As)	**0.029**	**1.415**	**0.034**	**1.525**		20	100	30	150	<20	20-80	80-400	400-1,000	>1,000	80	200

Note) *1: The standard values for Hong Kong are "management values" in order to judge "the object should be managed".
*2: The standard values for Germany are applied to sediment which grain size is less than 20μm.
*3: The standard values for Spain shall be compared with results which are converted with formula provided by each countries.
*4: SEBA: Working group on Sea-Based Activities

Source) "Environmental Aspects of Dredging 2a Conventions, Codes and Conditions: Marine Disposal" (International Association of Dredging Companies (IADC) / Central Dredging Association (CEDA),The Hague,1997.)

Table 2.7.1 (1/3) Description of Impact Factor and Conceivable Impacts due to Countermeasures for Sediment Deposits and Garbage at Intake

Stage	Impact factor / Conceivable impact	Countermeasures for Sediment Deposits and Garbage at Intake					
		Modification of the intake	Relocation of the intake	Garbage trapping structure at existing intake	Garbage trapping structure at Keduang river	Hydro-suction sediment removal system	Hydraulic dredging
(1) Impact factor (Impact producing activity)							
Pre-construction	Socialization of project component to local people	○	○	○	○	○	○
	Employment of local people for construction works	○	○	○	○	○	
	Set-up of access road for mobilization and construction works		○		○		
	Procurement of spoil bank area		○				○
Construction	Construction works (mobilization of equipments and construction machinery, transportation of construction material, excavation work, construction work of new facility, etc.)	○	○	○	○	○	
	Transportation and dumping of excavated material		○				
Operation and Maintenance	Operation of new facility	○	○	○	○		
	Maintenance work of removal of debris			○	○		
	Operation of dredging work.					○	○
(2) Conceivable impacts							
Pre-construction	People's unrest for new facility		○		○		
	Land acquisition for spoil bank and dumping of excavated material						○
Construction	Increase of income by working as construction laborer	○	○	○	○	○	
	Impacts during construction works (noise, dust, emission gas, turbid water flow, etc.),	○	○	○	○	○	
	Impacts during transportation and dumping of excavated material (noise, dust, emission gas, traffic accidents, etc.)		○				
	Stoppage of intake and power generation during construction work	○	○	○			
Operation and Maintenance	Maintenance waste disposal of removed debris at careen / weir			○	○		
	Impacts of turbid water discharge on aquatic organisms in the downstream reaches of the Bengawan Solo river					○	
	Impacts of dumping of dredged material to spoil bank						○
	Decrease of sediment and debris around existing intake facility					○	○
	Better functioning of intake facility for power generation and water supply	○	○	○	○	○	○

Note) "○" means that there would be a relationship between project component and factor or impact.

Table 2.7.1 (2/3) Description of Impact Factor and Conceivable Impacts due to Countermeasures for Sediment Inflow

Stage	Impact factor / Conceivable impact	Countermeasures for Keduang River			Countermeasures for other Tributaries				
		Keduang river sediment bypass	Sediment sluicing new gates	Compart-mented reservoir with new gates	Sediment storage dam for sediment removal	Hydraulic Dredging in reservoir	Dry excavation in reservoir	Managing of sediments by water releasing form intake	Re-allocation of reservoir storage capacity
(1) Impact factor (Impact producing activity)									
Pre-constructi on	Socialization of project component to local people	○	○	○	○	○	○		○
	Employment of local people for construction works,	○	○	○	○		○		○
	Set-up of access road for mobilization and construction works	○		○	○		○		
	Procurement of spoil bank area and/or disposal of excavated material	○	○	○		○	○		
Construction	Construction works (mobilization of equipments and construction machinery, transportation of construction material, widening of river, construction work of new structure, etc.)	○	○	○	○		○		○
	Large scale of civil works (Tunneling, excavation or closure dike)	○	○	○			○		○
	Transportation and dumping of excavated material	○	○	○			○		
Operation and Maintenance	Operation of new structure	○	○	○	○				○
	Maintenance work of removal of the sediment deposits				○				
	Operation of dredging work					○			
(2) Conceivable impacts									
Pre-constructi on	People's unrest for proposed structure and opposition	○	○	○	○		○		○
	Land acquisition for spoil bank and dumping of excavated material	○	○	○			○		○
	Impacts on farming activity and livelihood	○	○	○	○		○		○
Construction	Increase of income by working as construction laborer	○	○	○	○		○		○
	Impacts during construction works and transportation (noise, dust, emission gas, turbid water flow, traffic accident, etc.)	○	○	○	○		○		○
	Inconvenience of local traffic and impacts on economic activity	○	○	○			○		○
	Impacts on groundwater and well water use	○							○
Operation and Maintenance	Maintenance waste disposal of removed deposits at storage dam				○				
	Impacts of bypassing / sluicing of flood water on downstream reaches of B. Solo river (fishery, inland navigation and water use, etc.)	○	○	○					
	Impacts of dumping of dredged material to spoil bank					○			
	Mitigation of sediment deposits around the river mouth of Keduang river	○	○	○	○	○			
	Lengthening of lifetime of the Wonogiri dam reservoir	○	○	○	○	○	○		○

Note) "○" means that there would be a relationship between project component and factor or impact.

Table 2.7.1 (3/3) Description of Impact Factor and Conceivable Impacts due to Watershed Conservation and No Action

Stage	Impact factor / Conceivable impact	Watershed conservation	No Action
		Community-based soil conservation	Do nothing for sedimentation problem in Wonogiri reservoir
(1) Impact factor (Impact producing activity)			
Pre-construction	Socialization of project component to local people	○	
	Employment of local people for construction works, terracing and planting	○	
	Set-up of access road for mobilization and construction works		
	Procurement of area for structural measures		
Construction	Terrace improvement and terrace formation, and planting at terrace lip and/or riser	○	
	Promotion of agro-forestry and cropping system improvement	○	
	Construction works (mobilization of equipments and construction machinery, transportation of construction material , construction work of new structures, etc.)		
Operation and Maintenance	Implementation of support programs (formation and empowerment of farmer groups, technical training, and guidance, etc.)	○	
	Operation of improved / newly formed terrace	○	
	Operation of new sabo facility		
(2) Conceivable impacts			
Pre-construction	People's unrest for new activity (terracing and planting) / new facility		
	Land acquisition for structural measures (sabo facility)		
Construction	Increase of income by working as terracing and/or construction laborer	○	
	Impacts during terracing and planting / construction works (noise, dust, emission gas, turbid water flow, etc.)		
Operation and Maintenance	Functioning of terracing and planting for soil conservation and mitigation of sedimentation in Wonogiri reservoir	○	
	Functioning of structural measure (sabo facility) for mitigation of sedimentation in Wonogiri reservoir		
Problems in case of "No Action"	Devastation of upland areas, including agricultural and forest lands in Wonogiri reservoir catchment.		○
	Soil erosion, gully, land slide and other earth-related phenomenon will continue to occur.		○
	Sedimentation in reservoir will continue to occur with a rate of approx. 3.2 million m^3.		○
	Frequent stoppage of intake and power generation (on average, 20 times a year)		○
	Loss of effective storage will increase from 13.4% in 2005 to around 73% at 100 years later		○
	Decrease of dam safety during floods		○

Note) "○" means that there would be a relationship between project component and factor or impact.

Table 2.7.2 Comparison of Size and Duration of Civil Works involved in Candidate Project Components

Civil Works / Candidate Project Components		Pre-construction stage			Stages of construction, maintenance dredging				
		Necessity of Land Acquisition	Necessity of Temporary Access Road	Mobilization of Construction Labor*	Duration (month)	Dredged / Excavated Volume (m3)	Volume of Transportation (Trucks)	Stoppage of Intake	Other Special Matter to be considered
a. Countermeasures for Sediment Deposits and Garbage at Intake	Modification of the intake			+	15			Needed	
	Relocation of the intake		Needed	++	26	20,000	>2,000	Needed	Tunneling
	Garbage trapping structure at intake			+	13.5			Needed	
	Garbage trapping structure at Keduang River		Needed	+	12	<5,000	<500		
	Hydro-suction Sediment Removal System			+	16				Discharge of turbid water to B. Solo river
	Hydraulic dredging	Needed for spoil bank			Every year	<100,000 (/year)			
b. Countermeasures for Sediment Inflow from Keduang river	Keduang River sediment bypass	Needed for spoil bank	Needed	+++	56	200,000	>20,000		Tunneling, Discharge of turbid water to B. Solo river
	Sediment sluicing by new gates	Needed for spoil bank		++	18	140,000	>14,000		Discharge of turbid water to B. Solo river
	Compartmented reservoir with new flushing gates	Needed for spoil bank	Needed	++	18	140,000	>14,000		Separation dike by steel sheet pile, Sediment flushing
c. Countermeasures for Sediment Inflow from Other Tributaries	Sediment storage dam for sediment removal		Needed	+	12	<5,000	<500		
	Hydraulic dredging in reservoir	Needed for spoil bank		+	Every year	<100,000 (/year)			
	Dry excavation in reservoir	Needed for spoil bank	Needed	+++	Every year	2,000,000 (in total)	>200,000 (in total)		
	Managing of sediments within reservoir by water releasing from the intake								Management of sediment deposits without construction works
	Re-allocation of reservoir storage capacity	Needed for watershed area		Not clear	Not clear		Not clear	Needed	Enlargement of reservoir area
d. Watershed conservation				+++	Every year				

Note) Information in this table is based on preliminary study on construction works.
*) "+": Minor employment, "++": Medium employment, "+++": Major employment.

Table 2.7.3 Impact Matrix for Candidate Project Components in the Master Plan

Candidate Project Components	Environmental Elements	Physical Environment: Topography and Geology	Soil erosion	Waste (Dredged/excavated material)	Groundwater (well water use)	Water quality (Bengawan Solo river)	Water quality (Wonogiri reservoir)	Air quality (emission gas, dust.)	Noise and vibration	Natural Environment: Terrestrial flora and fauna	Aquatic flora and fauna	Protected species and areas	Socio-economic Environment: Land acquisition and Resettlement	People's unrest and conflict/opposition	Change of income / livelihood	Impacts on agriculture, fishery, forestry	Impacts on downstream area	Traffic and transportation
a. Countermeasures for Sediment Deposits and Garbage at Intake	Modification of the intake					-		-	-		-				+	-		-
	Relocation of the intake	-		-1		-		-1	-2		-			-	+1	-		-1
	Garbage trapping structure at intake			-		-		-	-		-				+	-		-
	Garbage trapping structure at Keduang river			-1			+	-	-		-			-	+	-		-
	Hydro-suction sediment removal system					-1	+	-	-		-1				+			-
	Hydraulic dredging			-1			+						-	-	+			
b. Countermeasures for Sediment Inflow from Keduang river	Keduang river sediment bypass	-1		-2	-2	-2	+1	-1	-2		-2		-1	-2	+2	-1	-	-1
	Sediment slucing by new gates			-2		-2	+1	-1	-1		-2		-1	-	+1	-1	-	-1
	Compartmented reservoir with new flushing gates			-2		-2	+1	-1	-1		-2		-1	-	+1	-1	-	-1
c. Countermeasures for Sediment Inflow from Other Tributaries	Sediment storage dam fro sediment removal			-1			+	-	-		-			-	+	-		-
	Hydraulic dredging in reservoir			-1			+				-		-	-	+	-		
	Dry excavation in reservoir	-1		-2	-		+	-2	-2	-			-1	-1	+2	-1		-1
	Managing of sediments within reservoir by water releasing from the intake						+							-1				
	Re-allocation of reservoir storage capacity				-1			-1	-1				-3	-3	+1	-1		-1
d. Watershed Conservation	Community-based soil conservation		+2		+	+1	+1	-		+1					+1	-		
e. No Action	Do nothing for sedimentation problem		-3	-1	-	-	-2			-	-2			-1	-2	-2	-	

Note) "-": Negligible negative impact, "-1": Minor negative impact, "-2": Medium negative impact, "-3": Significant negative impact.
"+": Negligible positive impact, "+1": Minor positive impact, "+2": Medium positive impact, "+3": Significant positive impact.

Table 2.7.4 Evaluation of Candidate Project Components

(1) Countermeasures for Sediment Deposits and Garbage at Intake

Candidate Project Components	Negative Impact			Positive Impact	Evaluation
	Pre-construction	Construction	Operation	All Stages	
Modification of the intake		-1		+1	○
Relocation of the intake	-	-2		+1	△
Garbage trapping structure at intake		-1	-	+	○
Garbage trapping structure at Keduang river	-	-1	-	+1	○
Hydro-suction sediment removal system		-1	-1	+1	○
Hydraulic dredging	-		-1	+1	○

(2) Countermeasures for Sediment Inflow from Keduang River

Candidate Project Components	Negative Impact			Positive Impact	Evaluation
	Pre-construction	Construction	Operation	All Stages	
Keduang river sediment bypass	-2	-2	-2	+2	×
Sediment sluicing by new gates	-1	-1	-2	+2	△
Compartmented reservoir with new flushing gates	-1	-2	-2	+2	△

(3) Countermeasures for Sediment Inflow from Other Tributaries

Candidate Project Components	Negative Impact			Positive Impact	Evaluation
	Pre-construction	Construction	Operation	All Stages	
Sediment storage dam for sediment removal	-	-1	-1	+	○
Hydraulic dredging in reservoir	-		-2	+	○
Dry excavation in reservoir	-2		-2	+1	△
Managing of sediments within reservoir by water releasing from the intake			-1	+1	○
Re-allocation of reservoir storage capacity	-3	-2	-1	+1	×

(4) Countermeasues for Watershed Conservation

Candidate Project Components	Negative Impact			Positive Impact	Evaluation
	Pre-construction	Construction	Operation	All stages	
Community-based soil conservation	-	-		+2	○

－: Negligible negative impact, －1: Minor negative impact, －2: Medium negative impact, －3: Significant negative impact
+: Negligible positive impact, +1: Minor positive impact, +2: Medium positive impact, +3: Significant positive impact
○: Good, △: Fair, ×: Not Recommended

Table 3.4.5 Description of Impact Factor and Conceivable Impacts of Priority Project Components

Stage	Impact factor / Conceivable impact	(1) Sediment Storage Reservoir with New Gate	(2) Watershed Management in Keduang catchment	(3) Periodic Maintenance Dredging	Environmental Elements to be affected and its nature (positive or negative)
1) Impact factor (Impact producing activities)					
Pre-construction	Socialization of project component to local people	○	○	○	
	Employment of laborers (local and outsider) for construction works	○	○		
	Site clearance for mobilization and construction works	○			
	Procurement of spoil bank area for disposal of excavated/dredged materials	○		○	
Construction	Construction works (mobilization of works and construction machinery, construction work of new structures, etc.)	○			
	Large scale of earth works (excavation, closure dike construction, improvement of terrace, etc)	○	○		
	Establishment of base camp for construction and civil works	○	○	○	
	Transportation and dumping of excavated materials	○			
Operation and Maintenance	Operation of sediment storage reservoir with New Gate	○			
	Promotion of agro-forestry and cropping system improvement		○		
	Functioning of improved/newly formed terrace		○		
	Operation of dredging work			○	
2) Conceivable impacts					
Pre-construction	People's unrest and/or opposition for proposed structure	○			Socio-culture (Negative)
	Impact of land acquisition for structural measure (spillway)	○			Socio-economy (Negative)
	Impacts of site clearance for mobilization and construction works	○			Socio-economy (Negative)
Construction	Increase of income by working as construction worker	○	○		Socio-economy (Positive)
	Impacts of construction works, earth works and transportation (noise, dust, emission gas, turbid water flow, traffic accident, etc.)	○			Air quality, Noise and Vibration, Terrestrial biota, etc. (Negative)
	Inconvenience of local traffic and impacts on economic activity	○			Traffic condition (Negative)
	Impacts on groundwater and well water use	○			Groundwater (Negative)
Operation and Maintenance	Impacts of sluicing of flood water on downstream reaches of Bengawan Solo river (fishery, inland navigation and water use, etc.)	○			River environment Socio-economy and culture (Negative)
	Impacts of dumping of dredged material	○		○	Socio-economy (Negative)
	Change of water level in sediment storage reservoir	○			Reservoir environment (Negative)
	Mitigation of sediment deposits around the river mouth of Keduang river	○	○		Reservoir sedimentation (Positive)
	Lengthening of lifetime of the Wonogiri dam reservoir	○	○		ditto
	Mitigation of blockage at intake facility			○	ditto

Note) "○" means that there would be a relationship between project component and impact factor / conceivable impact.
Source: JICA Study Team

Table 3.5.1 Result of Groundwater Survey at Domestic Well

Area	No.	Name of well owner	Ground elevation (MSL+m)	Depth of well bottom (GL-m)	(1) Data of September, 2006			(2) Data of December, 2006			Defference between Sep. and Dec. (m)	Water use of groundwater
					Groundwater level (GL-m)	Groundwater elevation (MSL+m)	Depth of groundwater in well (m)	Groundwater level (GL-m)	Groundwater elevation (MSL+m)	Depth of groundwater in well (m)		
Dusun Petir	1	Tridjem	128.17	8.88	7.56	120.61	1.32	8.62	119.55	0.26	-1.06	Domestic use and plant watering
	2	Sayem	133.27	10.46	7.76	125.51	2.70	8.77	124.50	1.69	-1.01	Domestic use
	3	Darno	136.78	10.86	9.36	127.42	1.50	10.13	126.65	0.73	-0.77	Domestic use and plant watering
	4	Ramto/Mariyem	132.99	9.03	7.43	125.56	1.60	8.54	124.45	0.49	-1.11	Domestic use and plant watering
	5	Warino	137.09	11.70	8.02	129.07	3.68	7.49	129.60	4.21	0.53	Domestic use
	6	Yatmin	136.39	11.52	8.43	127.96	3.09	9.54	126.85	1.98	-1.11	Domestic use, plant watering and livestock
	7	Ladi	138.02	9.26	7.08	130.94	2.18	8.26	129.76	1.00	-1.18	Domestic use
	8	Rmarno	138.87	11.92	9.67	129.20	2.25	11.35	127.52	0.57	-1.68	Domestic use
	9	Heru	135.77	13.23	9.97	125.80	3.26	11.55	124.22	1.68	-1.58	Domestic use
	10	Sarwono	133.33	18.03	11.90	121.43	6.13	15.19	118.14	2.84	-3.29	Domestic use
	11	Saginem	138.43	11.16	9.70	128.73	1.46	10.24	128.19	0.92	-0.54	Domestic use and livestock
		Min.	128.17	8.88	7.08	120.61	1.32	7.49	118.14	0.26	-3.29	
		Max.	138.87	18.03	11.90	130.94	6.13	15.19	129.76	4.21	0.53	
		Ave.	135.37	11.46	8.81	126.57	2.65	9.97	125.40	1.49	-1.16	
Pokoh Kidul	12	Sugimin	140.98	14.46	7.65	133.34	6.82	8.44	132.54	6.02	-0.80	Domestic use
	13	Lamidi	141.74	13.24	9.50	132.24	3.74	10.51	131.23	2.73	-1.01	Domestic use
	14	Sardjono	140.96	-	2.83	138.13	-	-	-	-	-	Domestic use, Taking by hand pump.
	15	Sudiono	140.53	20.28	8.88	131.65	11.40	9.40	131.13	10.88	-0.52	Domestic use
	16	Chamdi	140.50	10.08	7.28	133.22	2.80	8.61	131.89	1.47	-1.33	Domestic use
		Min.	140.50	10.08	2.83	131.65	2.80	8.44	131.13	1.47	-1.33	
		Max.	141.74	20.28	9.50	138.13	11.40	10.51	132.54	10.88	-0.52	
		Ave.	140.94	14.52	7.23	133.71	6.19	9.24	131.70	5.28	-0.91	
Karangtalun	17	Mino	140.973	10.30	8.69	132.28	1.61	9.65	131.32	0.65	-0.96	Domestic use and livestock
	18	Tuguimin	139.598	10.81	9.61	129.99	1.20	10.23	129.37	0.58	-0.62	Domestic use
	19	Yanto	143.517	13.35	12.2	131.32	1.15	12.9	130.62	0.45	-0.70	Domestic use and livestock
	20	Sukiman	140.799	14.03	11.09	129.71	2.94	11.64	129.16	2.39	-0.55	Domestic use
	21	Kardi	137.048	8.91	5.84	131.21	3.07	6.19	130.86	2.72	-0.35	Domestic use and livestock
		Min.	137.05	8.91	5.84	129.71	1.15	6.19	129.16	0.45	-0.96	
		Max.	143.52	14.03	12.20	132.28	3.07	12.90	131.32	2.72	-0.35	
		Ave.	140.39	11.48	9.49	130.90	1.99	10.12	130.27	1.36	-0.64	

Source: JICA Study Team
Date of Survey: (1) September 26th - 27th, 2006, (2) December 12th, 2006.
Location of well inventory is shown on Figure 3.5.1.

Table 3.7.1 Environmental Management Plan

a) Pre-Construction Stage

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Management	Environmental Actions/Efforts	Locations of Environmental Management	Environmental Management Institutions			Cost Component
						Initiator	Supervisors	Report Recipients	
a) Land Acquisition and Resettlement	Temporary usage of land for construction works	- Number of anxious local people, and - Frequency and number of public complaint	To minimize the impact of public anxiety	**Socio-Economic Approach** - To socialize the project activities and possibility of land acquisition, - Appropriate land compensation for temporary usage. **Institutional Approach** - Involvement of local community to coordination meeting.	Pokohkidul and Pondoksari villages	BBWS Bengawan Solo	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization, Land compensation if any.
b) People's Unrest and Conflict / Opposition	Socialization of project activities and implementation schedule	- Number of anxious local people, and - Frequency and number of public complaint	To minimize the impact of public unrest and conflict / opposition for Project	**Socio-Economic Approach** - To socialize the project activities, benefits and impacts. **Institutional Approach** - Involvement of local community to coordination meeting.	All the local governments in Wonogiri Regency.	BBWS Bengawan Solo	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization
c) Job Opportunity	Recruitment for construction works	- Number of hired workers form local people	To enhance / improve livelihood of local people, especially project affected people	**Socio-Economic Approach** - To identify and hire local people as construction workers, - To give priority on project affected people for recruitment	All the local government in Wonogiri reservoir basin	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization and Identification of employee

b) Construction Stage

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Management	Environmental Actions/Efforts	Locations of Environmental Management	Environmental Management Institutions			Cost
						Initiator	Supervisors	Report Recipients	Component
a) Groundwater	Excavation works for construction of spillway	Depth of groundwater drawdown in domestic well	To minimize impacts of well water drawdown on water use	**Socio-Economic Approach** - To socialize the project activities and possibility of drawdown of groundwater in domestic well, - Compensation by alternative water supply **Technical Approach** - Adoption of appropriate methodology to minimize groundwater drawdown for excavation work	Sub-village Petir, Pokohkidul village	BBWS Bengawan Solo, Contractor	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	Cost for Socialization and Compensation for alternative water supply
b) Air Quality	Construction works, especially earth works and transportation of excavated materials	Concentration of Dust (TSP), NO_2, SO_2, CO and Hydrocarbon	To minimize impacts of emission gas and dust due to construction works on air quality	**Socio-Economic Approach** - To socialize the project activities and schedule of construction work, - To give priority on project affected people for recruitment **Technical Approach** - Road watering, - Sheet covering for excavated materials while transportation by trucks, - Minimizing period of earth works	Pokohkidul and Pondoksari villages	BBWS Bengawan Solo, Contractor	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	Cost for Socialization and technical measures for minimizing dust
c) Noise Pollution	Construction works, especially excavation work for spillway	Noise level	To minimize impacts of construction machines to generate noise pollution	**Socio-Economic Approach** - To socialize the project activities and schedule of construction work, - To give priority on project affected people for recruitment **Technical Approach** - Establishment of noise mitigation wall, if necessary	Sub-village Petir, Pokohkidul village	BBWS Bengawan Solo, Contractor	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	Cost for Socialization and technical measures for minimizing noise pollution

d) Vibration	Construction works, especially excavation work for spillway	Vibration level (amplitude and peak velocity)	To minimize impacts of construction machines to generate vibration	**Socio-Economic Approach** - To socialize the project activities and schedule of construction work, - To give priority on project affected people for recruitment **Technical Approach** - Arrangement of construction machines, - Establishment of ditch in-between construction site and settlement area, if necessary	Sub-village Petir, Pokohkidul village	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization and technical measures for minimizing vibration
e) Terrestrial Flora and Fauna	Site clearance, especially cutting of vegetation	Area of site clearance and kind of vegetation	To minimize the area of vegetation cutting and disturbance of habitat of terrestrial fauna	**Technical Approach** - Minimizing site clearance required for project facilities, - Release of fauna species, when some individuals were caught during civil works	Pokohkidul and Pondoksari villages	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	-
f) Protected Species	Earth works for terracing and side ditches, etc. for Watershed Management	Habitat disturbance of protected species	To minimize impacts of earth works on habitat of protected species	**Socio-Economic Approach** - To socialize the project activities and protected species inhabiting in Keduang river basin **Technical Approach** - Release of protected species, when some individuals of them were caught during civil works	Keduang river basin	BBWS Bengawan Solo, Local farmers	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization
g) Livelihood Change	Recruitment for construction works	-Increase of income level	To enhance / improve livelihood of local people, especially project affected people	**Socio-Economic Approach** - To identify and hire local people as construction workers, - To give priority on project affected people for recruitment	Local people in Wonogiri reservoir basin and nearby areas	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization and Identification of employee

h) Traffic and Transportation	Transportation of excavated materials	Nos. of project-related vehicles for transporting excavated materials	To minimize impacts of vehicles on local traffic and transportation, including traffic jam, accident, noise pollution, etc.	**Socio-Economic Approach** - To socialize the project activities and schedule of construction work, - To give priority on project affected people for recruitment **Technical Approach** - Education of drivers to be hired by the Project on driving manner, - Construction or stock yard and temporary road for transporting excavated materials	Pokohkidul and Pondoksari villages	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization and technical measures for minimizing impacts
i) Public Health	Waste water and garbage from base camp of construction work as well as dust, noise and vibration	Complaints and health problem of local people near construction base camp	To minimize impacts on sanitary condition and health problem	**Socio-Economic Approach** - To socialize the project activities and schedule of construction work, - To give priority on project affected people for recruitment **Technical Approach** - Development of drainage system and garbage stock yard and its treatment at base camp of construction work, - Same management measure mentioned at c) Noise pollution and d) Vibration	Pokohkidul and Pondoksari villages	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for Socialization and technical measures for minimizing impacts

c) Post-Construction Stage (Operation and Maintenance Stage)

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Management	Environmental Actions/Efforts	Locations of Environmental Management	Environmental Management Institutions			Cost Component
						Initiator	Supervisors	Report Recipients	
a) Water Quality	Sluicing (release of turbid water) from sediment storage reservoir	Water quality, especially SS of Bengawan Solo river	To minimize impacts on water quality and aquatic organisms, especially fish	**Socio-Economic Approach** - To socialize schedule of sluicing to downstream areas along Bengawan Solo river **Technical Approach** - Arrangement of timing and duration of sluicing corresponding to the environmental monitoring result on water quality and impacts on fish species in downstream stretch of Bengawan Solo river	Downstream of Bengawan Solo river until confluence with Madiun river	BBWS Bengawan Solo	- Bapedalda, Central Java Province	- Bapedalda, Central Java Province - Bapedalda, Regency's of Wonogiri, Sukoharjo, Kranganyar, Sragen and Kota Surakarta	Cost for Socialization and technical measures for minimizing impacts
b) Economic Activities of Downstream Reaches	Sluicing (release of turbid water) from sediment storage reservoir	Water quality, especially SS and discharge of Bengawan Solo river	To minimize impacts on water quality and discharge of Bengawan Solo river	**Socio-Economic Approach** - To socialize schedule of sluicing to downstream areas along Bengawan Solo river **Technical Approach** - Arrangement of timing and duration of sluicing corresponding to the environmental monitoring result on water quality and impacts on sand mining, inland navigation, water use, fishery in the downstream stretch of Bengawan Solo river **Institutional Approach** - Involvement of sand miner, Operator of inland navigation, etc. along to coordination meeting	Downstream of Bengawan Solo river until confluence with Madiun river	BBWS Bengawan Solo	- Bapedalda, Central Java Province	- Bapedalda, Central Java Province - Bapedalda, Regency's of Wonogiri, Sukoharjo, Kranganyar, Sragen and Kota Surakarta	Cost for Socialization and technical measures for minimizing impacts

c) Historical and Cultural Heritage	Sluicing (increase of discharge)	Discharge of Bengawan Solo river	To minimize the increase of discharge of Bengawan Solo river	**Socio-Economic Approach** - To socialize schedule of sluicing to downstream areas along Bengawan Solo river, -Advance announcement of sluicing when conducting sluicing.	Regencies of Wonogiri, Sukoharjo, Kranganyar, Sragen and Kota Surakarta	BBWS Bengawan Solo	- Bapedalda, and Agency on Tourism, Central Java Province	- Bapedalda, and Agency on Tourism, Central Java Province	Cost for socialization and announcement on sluicing
d) Pubic Health	Release of garbage from sediment storage reservoir	Complaints and local people along downstream reaches of Bengawan Solo river	To minimize impacts of release of garbage	**Socio-Economic Approach** - To socialize schedule of sluicing to downstream areas along Bengawan Solo river, - Campaign for proper treatment of garbage to reduce dumping garbage into Keduang river.	Regencies of Wonogiri, Sukoharjo, Kranganyar, Sragen and Kota Surakarta	BBWS Bengawan Solo	- Bapedalda, and Agency on Public Health, Central Java Province	- Bapedalda, and Agency on public health, Central Java Province	Cost for socialization of sluicing, and campaign to reduce garbage disposal

Source: JICA Study Team

Table 3.7.2 Environmental Monitoring Plan

a) Pre-Construction Stage

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Monitoring	Method and Data Analysis, Location, Timeframe and Monitoring Frequency	Environmental Monitoring Institutions			Cost Component
					Initiator	Supervisors	Report Recipients	
a) Land Acquisition and Resettlement	Temporary usage of land for construction works	- Number of anxious local people, and - Frequency and number of public complaint	To observe the magnitude of anxiety and adverse impact	**Monitoring Method:** - Survey by means of questionnaire, interview and focused group discussion (FGD) **Monitoring Location:** - Desa Pokohkidul and Pondoksari and other villages、 if necessary **Monitoring Frequency:** - Once at preparation of construction works and once during construction stage	BBWS Bengawan Solo	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring survey and reporting
b) People's Unrest and Conflict / Opposition	Socialization of project activities and implementation schedule	- Number of anxious local people, and - Frequency and number of public complaint	To observe the magnitude of anxiety and the possibility of oppositions	**Monitoring Method:** - Survey by means of questionnaire, interview and focused group discussion (FGD) **Monitoring Location:** - Desa Pokohkidul and Pondoksari and other villages, if necessary **Monitoring Frequency:** - Once during pre-construction stage, - Once a year during all through the construction stage	BBWS Bengawan Solo	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring survey and reporting
c) Job Opportunity	Recruitment for construction works	- Number of hired workers form local people	To observe the number of local people hired by the Project, and change of income and livelihood of hired people	**Monitoring Method:** - Survey by means of questionnaire, interview and focused group discussion (FGD) **Monitoring Location:** - The area of Wonogiri basin and nearby areas, focusing on Desa Pokohkidul and Pondoksari **Monitoring Frequency:** - Once during pre-construction stage, - Once a year during all through the construction stage	BBWS Bengawan Solo	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring survey and reporting

Source: JICA Study Team

b) Construction Stage

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Monitoring	Method and Data Analysis, Location, Timeframe and Monitoring Frequency	Environmental Monitoring Institutions			Cost
					Initiator	Supervisors	Report Recipients	Component
a) Groundwater	Excavation works for construction of spillway	Depth of groundwater drawdown in domestic well	To measure groundwater level and its fluctuation and adverse impact on well water use of local people	**Monitoring Method:** - Field investigation and inventory of domestic wells **Monitoring Location:** - Desa Pokohkidul, covering the same locations (wells) as those of this EIA study, at least. **Monitoring Frequency:** - Once a month, during excavation works for spillway construction, - Continuous monitoring by automatic recorder at selected domestic wells	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring groundwater level, analysis and reporting
b) Air Quality	Construction works, especially earth works and transportation of excavated materials	Concentration of Dust (TSP), NO_2, SO_2, CO and Hydrocarbon	To measure the change of air quality (emission gas and dust) and adverse impact on local people	**Monitoring Method:** - Sampling of air and laboratory analysis **Monitoring Location:** - Desa Pokohkidul and Pondoksari, covering the same locations as those of this EIA study, at least. **Monitoring Frequency:** - Once during construction stage, at peak level of construction work	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for sampling, laboratory analysis and reporting
c) Noise Pollution	Construction works, especially excavation work for spillway	Noise level	To measure noise and level and adverse effect on local people	**Monitoring Method:** - Field investigation and analysis **Monitoring Location:** - Desa Pokohkidul, covering the same locations as surveyed and predicted locations of this EIA study, at least. **Monitoring Frequency:** - Once during construction stage, at peak level of construction work	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for field investigation, analysis and reporting
d) Vibration	Construction works, especially excavation work for spillway	Vibration level (amplitude and peak velocity)	To measure vibration level and adverse effect on local people	**Monitoring Method:** - Field investigation and analysis **Monitoring Location:** - Desa Pokohkidul, covering the same locations as surveyed and predicted locations of this EIA study, at least. **Monitoring Frequency:** - Once during construction stage, at peak level of construction work	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for field investigation, analysis and reporting

e) Terrestrial Flora and Fauna	Site clearance, especially cutting of vegetation	Area of site clearance and kind of vegetation	To identify impacts on terrestrial flora and fauna	**Monitoring Method:** - Field investigation and inventory survey **Monitoring Location:** - Desa Pokohkidul, covering the same locations as inventoried location of this EIA study, at least. **Monitoring Frequency:** - Once during operation and maintenance stage after the project facilities are constructed	BBWS Bengawan Solo,	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for inventory survey, analysis and reporting
f) Protected Species	Earth works for terracing and side ditches, etc. for Watershed Management	Habitat disturbance of protected species	To identify impacts on Projected species	**Monitoring Method:** - Field investigation and interview survey with local people **Monitoring Location:** - Watershed of Keduang River, focusing on habitat of Porcupine (*Hystrix brachyuran)* that are identified to inhabit in the Keduang watershed. **Monitoring Frequency:** - Once a year during watershed conservation activity (terracing)	BBWS Bengawan Solo, Local farmers	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for field investigation and interview survey and reporting
g) Livelihood Change	Recruitment for construction works	-Increase of income level	To observe the number of local people affected by site clearance for Project facilities	**Monitoring Method:** - Survey by means of questionnaire, interview and focused group discussion (FGD) **Monitoring Location:** - The area of Wonogiri basin and nearby areas, focusing on Desa Pokohkidul and Pondoksari **Monitoring Frequency:** - Once a year during all through the construction stage - Once after the Project facilities are constructed and sediment releasing is done.	BBWS Bengawan Solo,	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring survey and reporting
h) Traffic and Transportation	Transportation of excavated materials	Nos. of project-related vehicles for transporting excavated materials	To observe increase of local traffic and traffic accidents, etc. during construction works	**Monitoring Method:** - Field investigation of local traffic and traffic accidents **Monitoring Location:** - Village roads in Desa Pokohkidul and Pondoksari, and Kota Wonogiri **Monitoring Frequency:** - Once during construction stage, at peak level of construction work	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for field investigation, analysis and reporting
i) Public Health	Waste water and garbage from base camp of construction work as well as dust, noise and vibration	Complaints and health problem of local people near construction work	To observe the occurrence of health problem	**Monitoring Method:** - Survey by means of questionnaire, interview and focused group discussion (FGD) **Monitoring Location:** - Desa Pokohkidul and Pondoksari and nearby settlement areas, if necessary **Monitoring Frequency:** - Once a year during all through the construction stage	BBWS Bengawan Solo, Contractor	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	- Bapedalda, Central Java Province - Bapedalda, Wonogiri Regency - Local Governments in Wonogiri Regency	Cost for monitoring survey and reporting

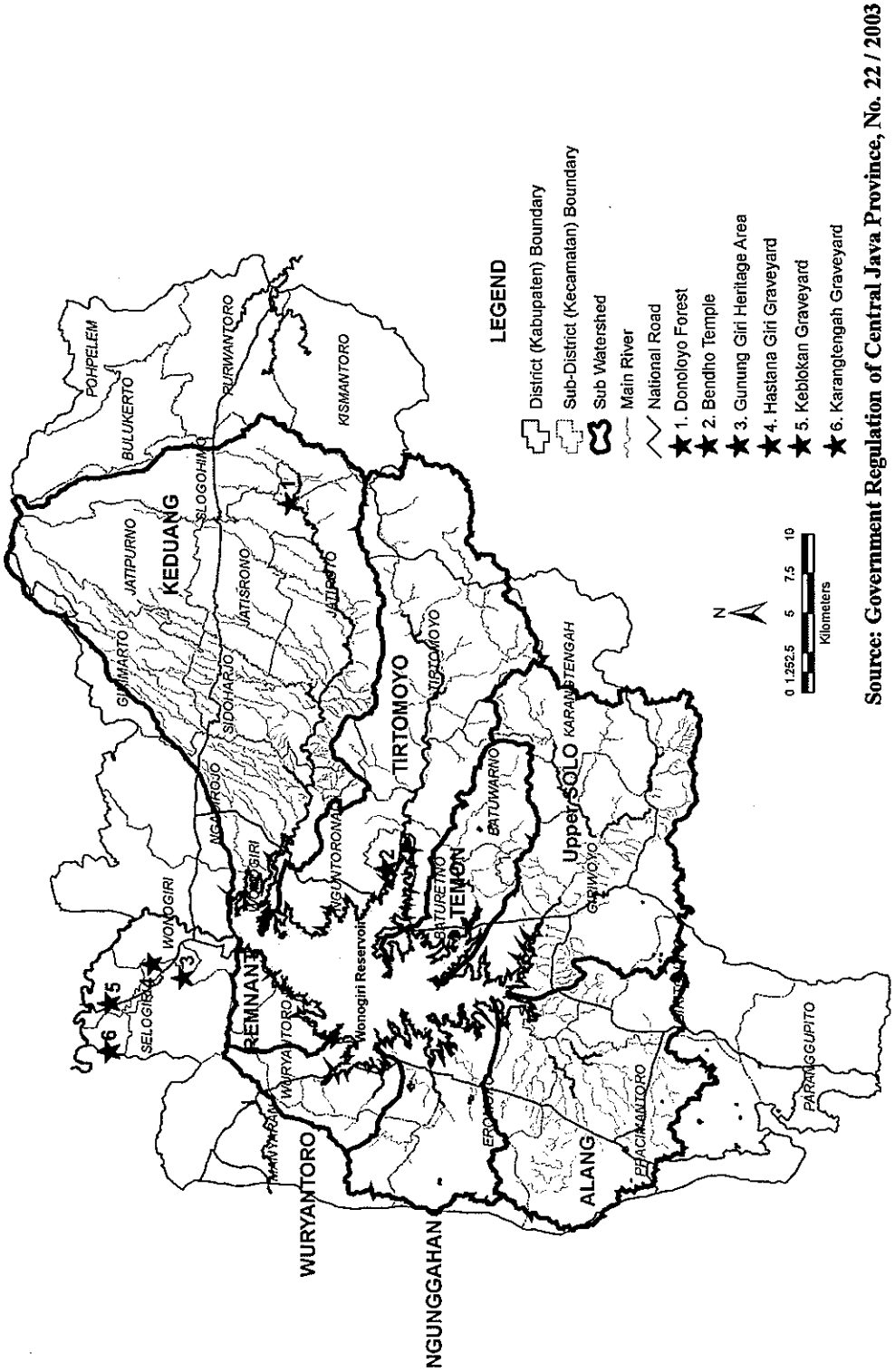
Source: JICA Study Team

c) Post-Construction Stage (Operation and Maintenance Stage)

Type of Impacts	Source of Impacts	Impact Parameters	Purpose of Environmental Monitoring	Method and Data Analysis, Location, Timeframe and Monitoring Frequency	Environmental Monitoring Institutions			Cost
					Initiator	Supervisors	Report Recipients	Componen
a) Water Quality	Sluicing (release of turbid water) from sediment storage reservoir	Water quality, especially SS of Bengawan Solo river, and impacts on fish	To measure the change of water quality during sediment release and observe the impacts on fish	**Monitoring Method:** - Water sampling and laboratory analysis **Monitoring Location:** - Downstream reaches of Bengawan Solo river, including 1) Downstream of Wonogiri dam, 2) Colo weir, 3) Jurug bridge, and 4) Tangen bridge. **Monitoring Frequency:** - Several times during operation and maintenance stage at sediment releasing	BBWS Bengawan Solo,	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	-Bapedalda, Central Java Province -Bapedalda, Wonogiri Regency -Local Governments in Wonogiri Regency	Cost for wat sampling, analysis and reporting
b) Economic Activities of Downstream Reaches	Sluicing (release of turbid water) from sediment storage reservoir	Water quality, especially SS and discharge of Bengawan Solo river	To survey the adverse impacts on downstream reaches of Bengawan Solo river	**Monitoring Method:** - Interview survey with local people, including sand miner, boat operator, PDAM, PJT-I, and local fisherman **Monitoring Location:** - Downstream reaches of Bengawan Solo river until the confluence with the Madiun River. **Monitoring Frequency:** - Several times during operation and maintenance stage at sediment releasing	BBWS Bengawan Solo	-Bapedalda, Central Java Province	-Bapedalda, Central Java Province -Bapedalda, Regency's of Wonogiri, Sukoharjo, Kranganyar, Sragen and Kota Surakarta	Cost for monitoring survey and reporting
c) Historical and Cultural Heritage	Sluicing (increase of discharge)	Discharge of Bengawan Solo river	To survey adverse impacts on *Kungkum*, a traditional custom related to Bengawan Solo river	**Monitoring Method:** - Interview survey with local people who participate in *Kungkum* custom **Monitoring Location:** - Downstream reaches of Bengawan Solo river until the confluence with the Madiun River. **Monitoring Frequency:** - Once while *Kungkum* is done.	BBWS Bengawan Solo	-Bapedalda, and Agency on Tourism, Central Java Province	-Bapedalda, and Agency on Tourism, Central Java Province	Cost for monitoring survey and reporting
d) Pubic Health	Release of garbage from sediment storage reservoir	Complaints and local people along downstream reaches o Bengawan Solo river	To observe the magnitude of garbage release and complaints about garbage, and adverse impact	**Monitoring Method:** - Observation and measurement about the degree of garbage release through new gate, - Interview survey with the people working in the river channel as sand miner, boat operator, fisherman, etc. **Monitoring Location:** - Downstream reaches of Bengawan Solo river until the confluence with the Madiun River. **Monitoring Frequency:** - Once after sediment releasing is done.	BBWS Bengawan Solo	-Bapedalda, and Agency on Public Health, Central Java Province	-Bapedalda, and Agency on public health, Central Java Province	Cost for monitoring survey and reporting

Source: JICA Study Team

Figure



Source: Government Regulation of Central Java Province, No. 22 / 2003

Figure 2.4.1 Location Map of Protected Area in Kabupaten Wonogiri

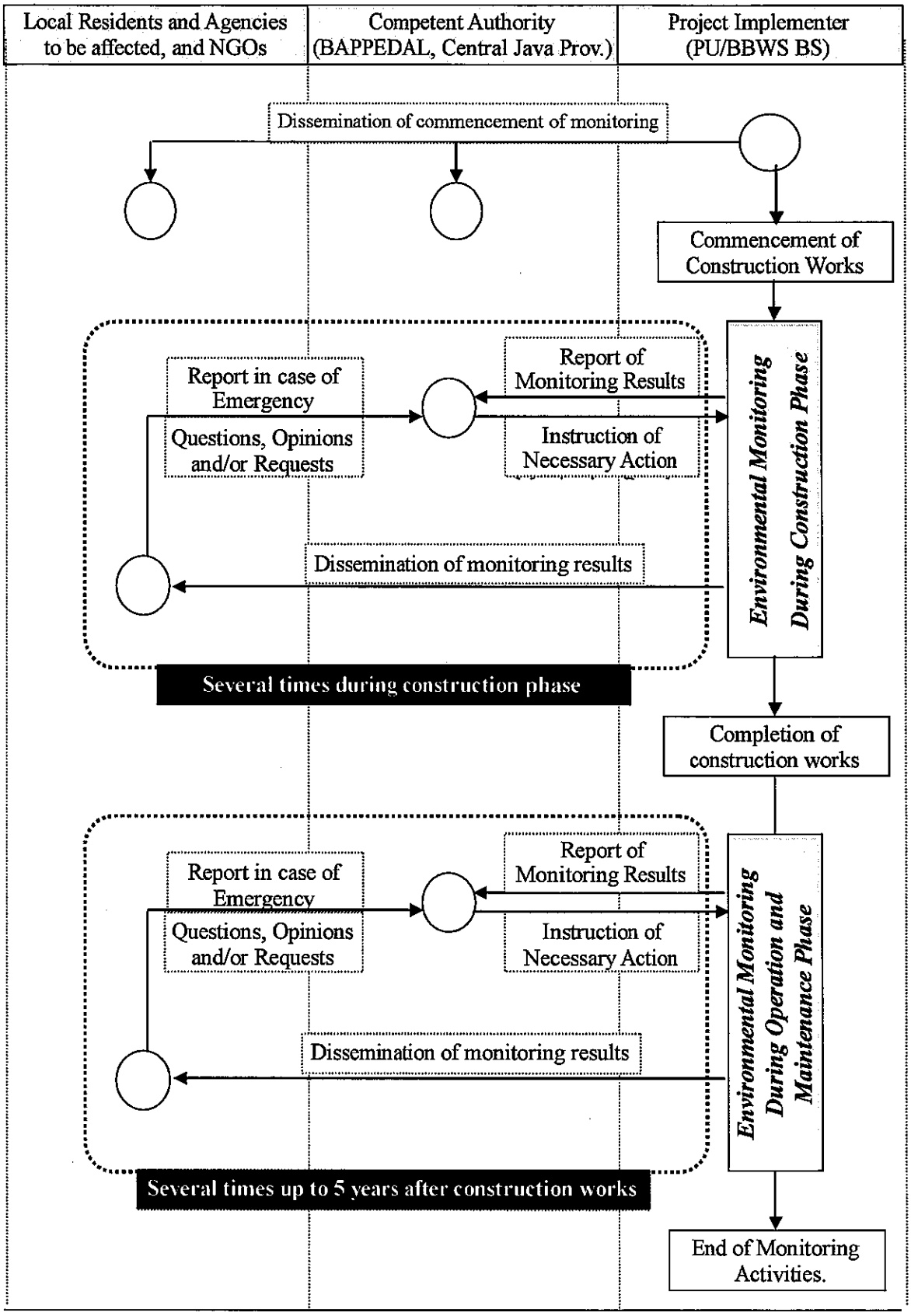
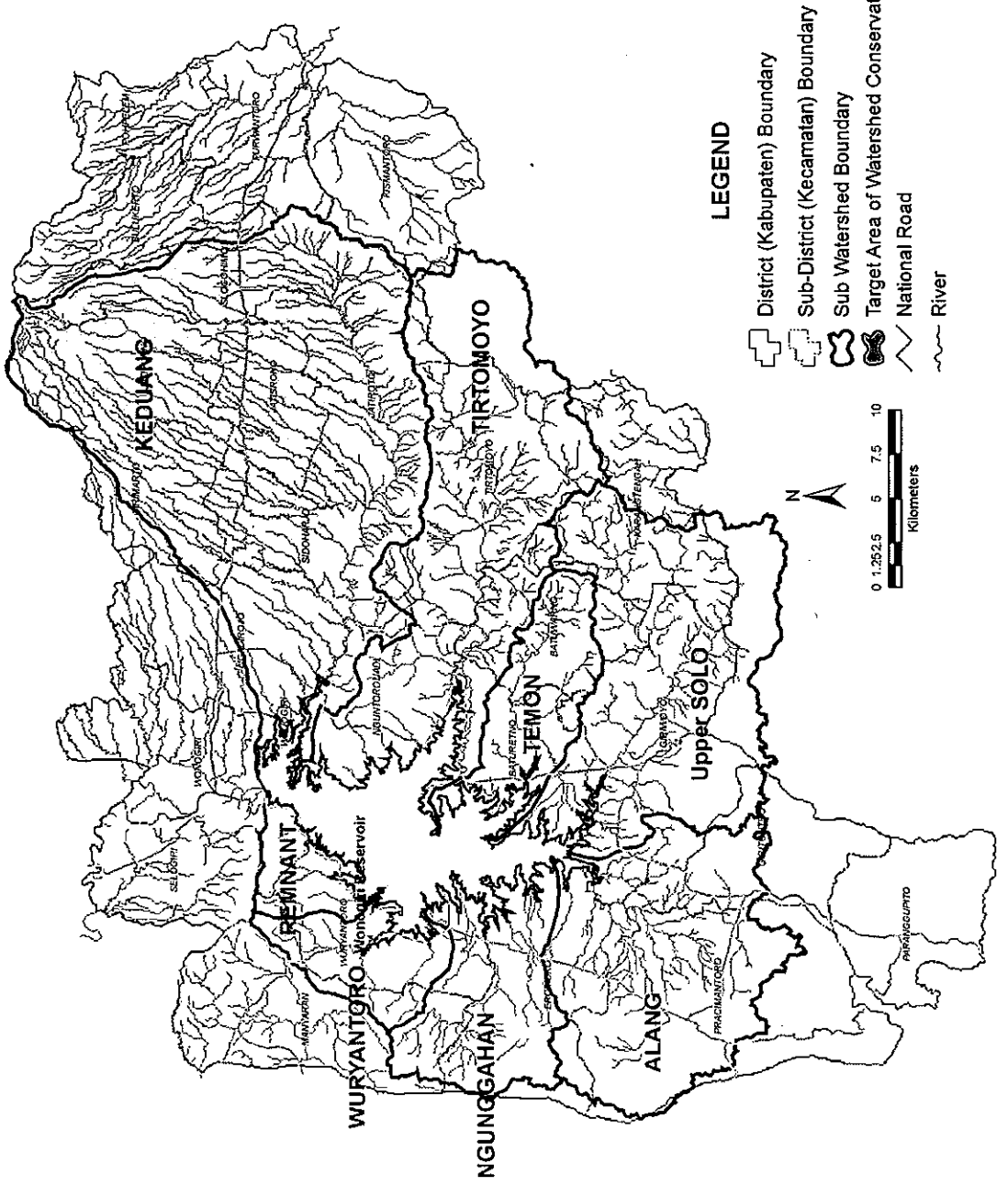
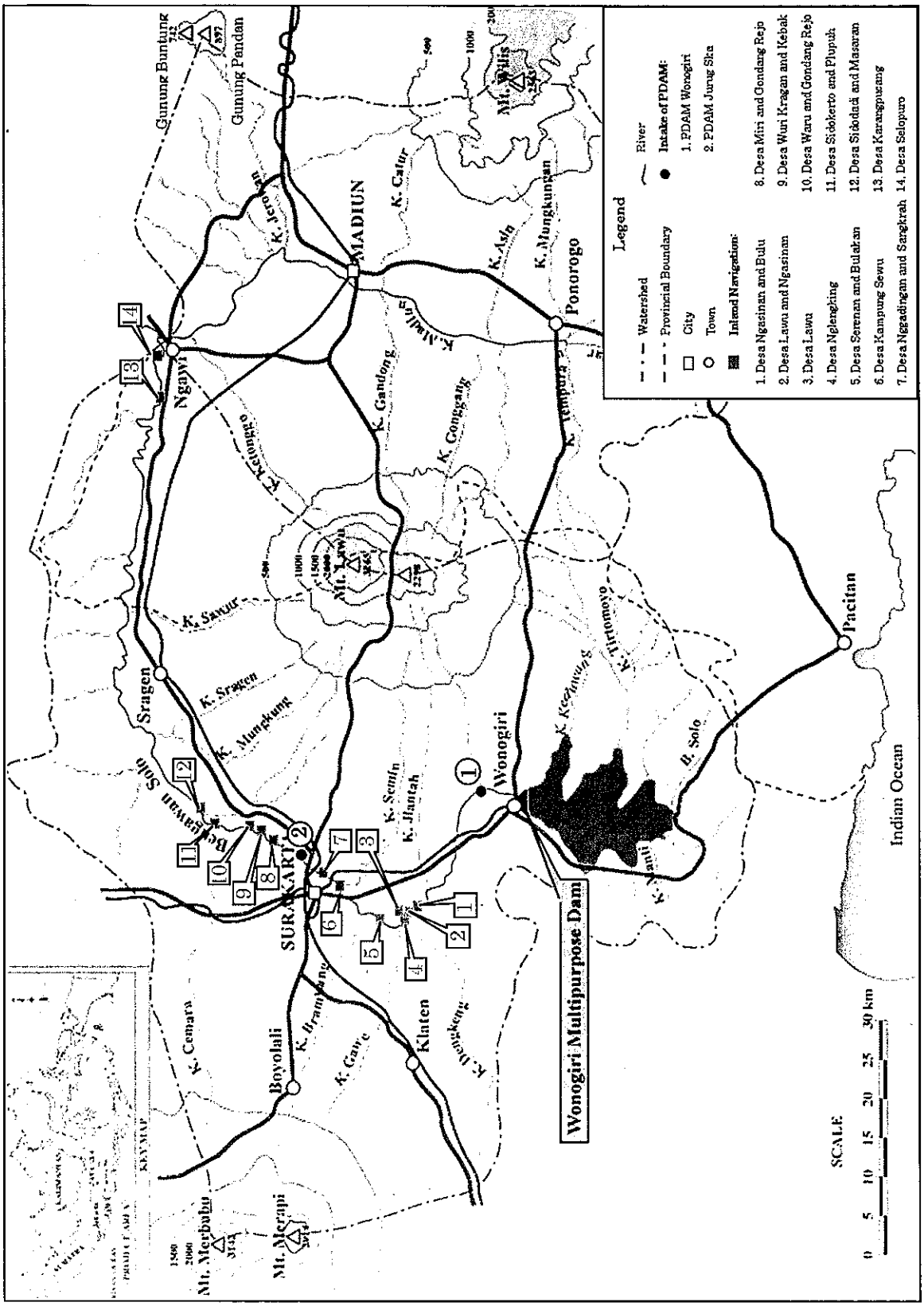


Figure 2.8.1 Procedural Flow of Environmental Management



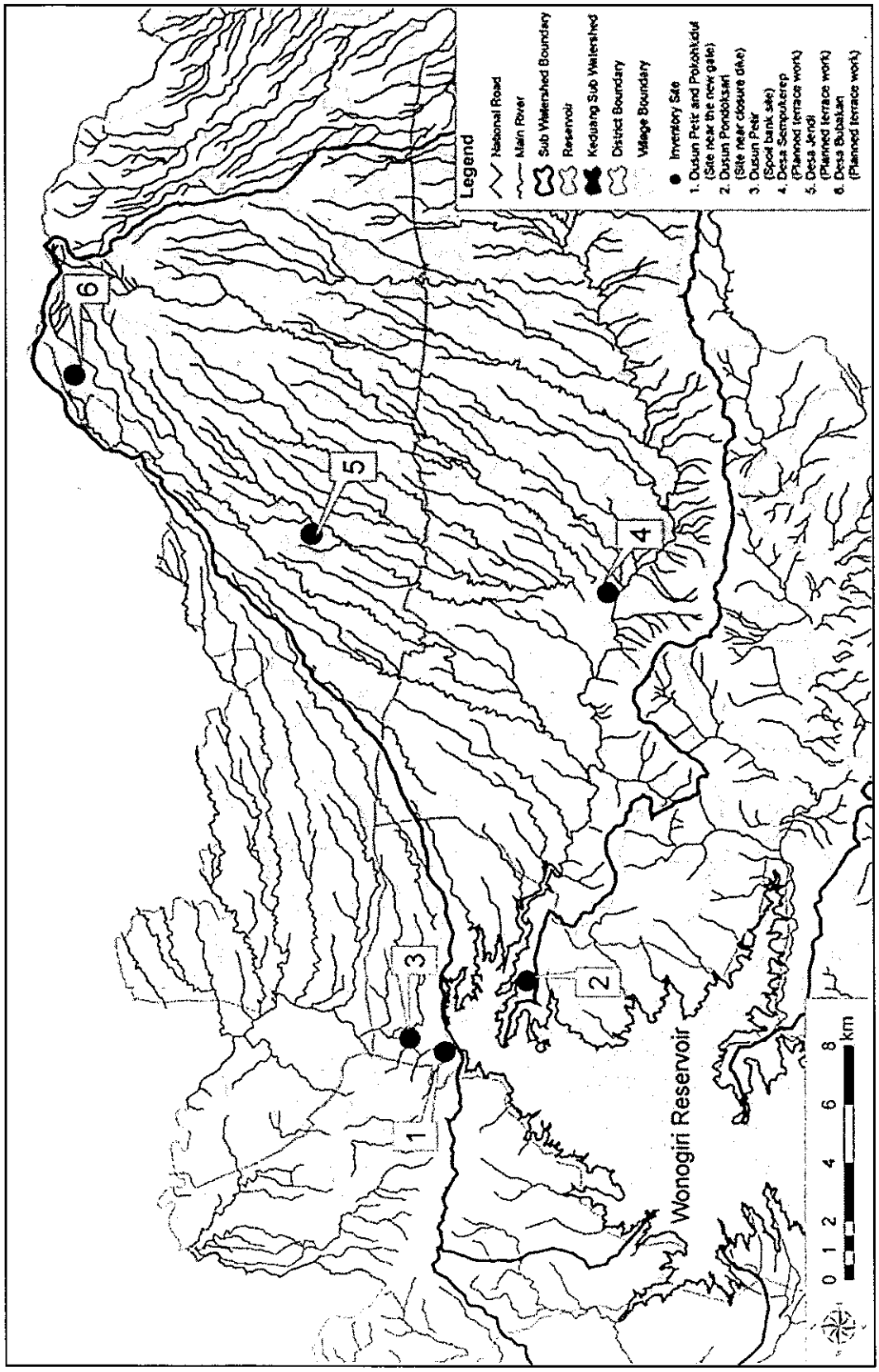
Source: JICA Study Team

Figure 3.4.1 (2) Location Map of Priority Project Components (Target Area of Watershed Conservation)



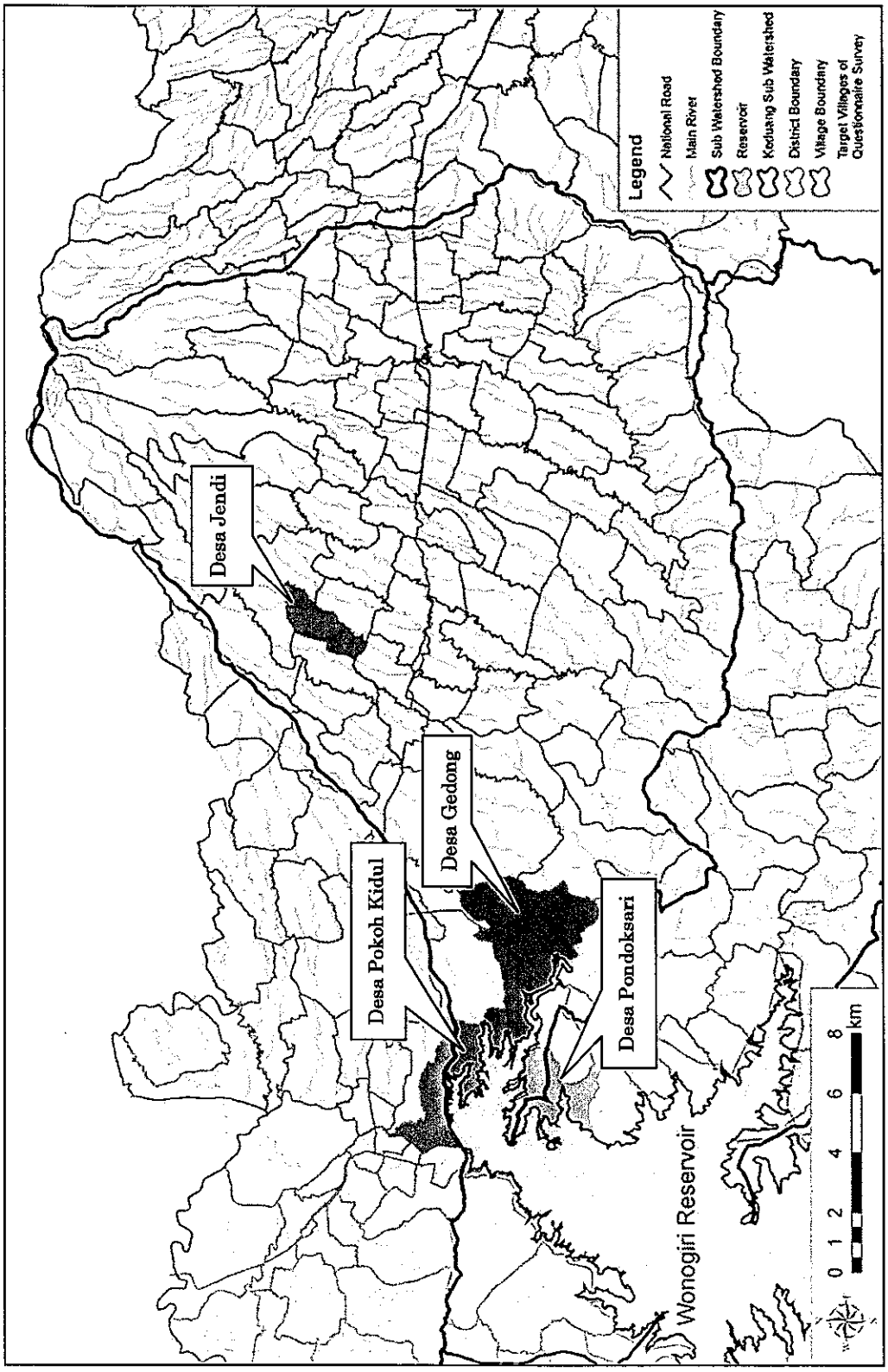
Source: JICA Study Team

Figure 3.5.6 Location of Inland Navigation and Water Intake Point of PDAM (Municipality Water Supply)



Source: JICA Study Team

Figure 3.5.8 Inventory Survey Location of Terrestrial Flora and Fauna



Source: JICA Study Team

Figure 3.5.12 Location of Target Village of Questionnaire Survey on Socio-economic Conditions Inventory Site of Terestrial Flora and Fauna