4-3. Environmental and Social Considerations

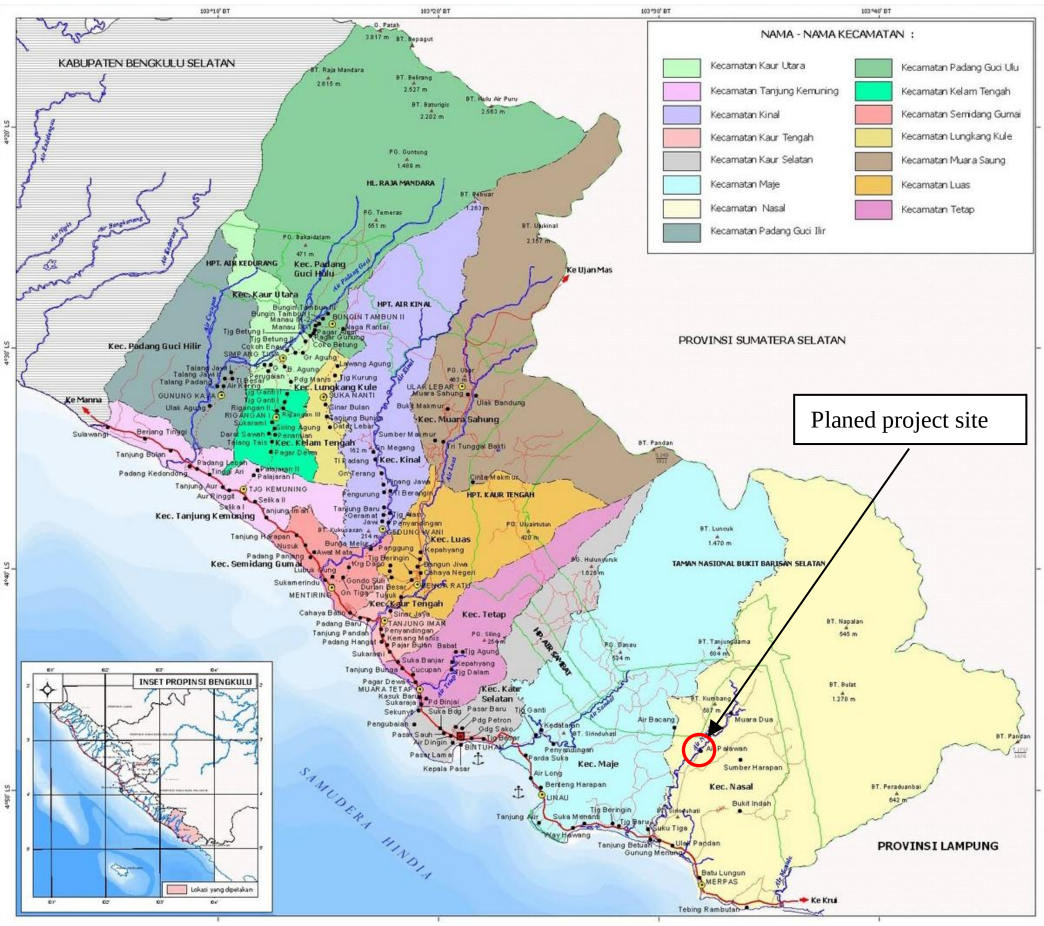
4-3-1. Environmental and Social impact assessment

4-3-1-1. Outline of Project component

The Nasal micro hydropower plant is located in:

- Air Palawan village, sub-district Nasal, Kaur district, Bengkulu province, South Sumatra

Kaur district is located between Latitude 4°15'8.21" S to 4°55'27.77" S and Longitude 103°15'8.76" E to 103°46'50.12" E, about 250km east from Benkulu city, where 15 districts - 191 villages exist in the area of about 256,000ha. The planned project site is located in the middle watercourse of Nasal river in the Nasal sub-district, most southeast areas of Kaur district. The area of the Nasal sub-district is 59,937 ha and 17 villages exist.



Source: Feasibility Study Report[33]

Figure 4-37 District boundaries around the planned project site

The project component of Nasal is shown in Figure 4-38 and is categorized as diversion type hydroelectricity.

To the intake weir (at the elevation of 131m), there is forestry road which connects to a paved road in the vicinity. The forestry road end at halfway. From there some forest exists at the route. On the way, there are some trees which are to be cut when installing access roads

[33] Feasibility Study, PT. Indonesia Citra Lestari, 2012

Water for power generation from intake weir goes through settling basin and transferred to head tank (at the elevation of 125m) by water way with a length of 2,875m (gradient: 0.00043). From the head tank, the water is transferred to the power plant by a penstock with a length of 135m (at the elevation of 49m).

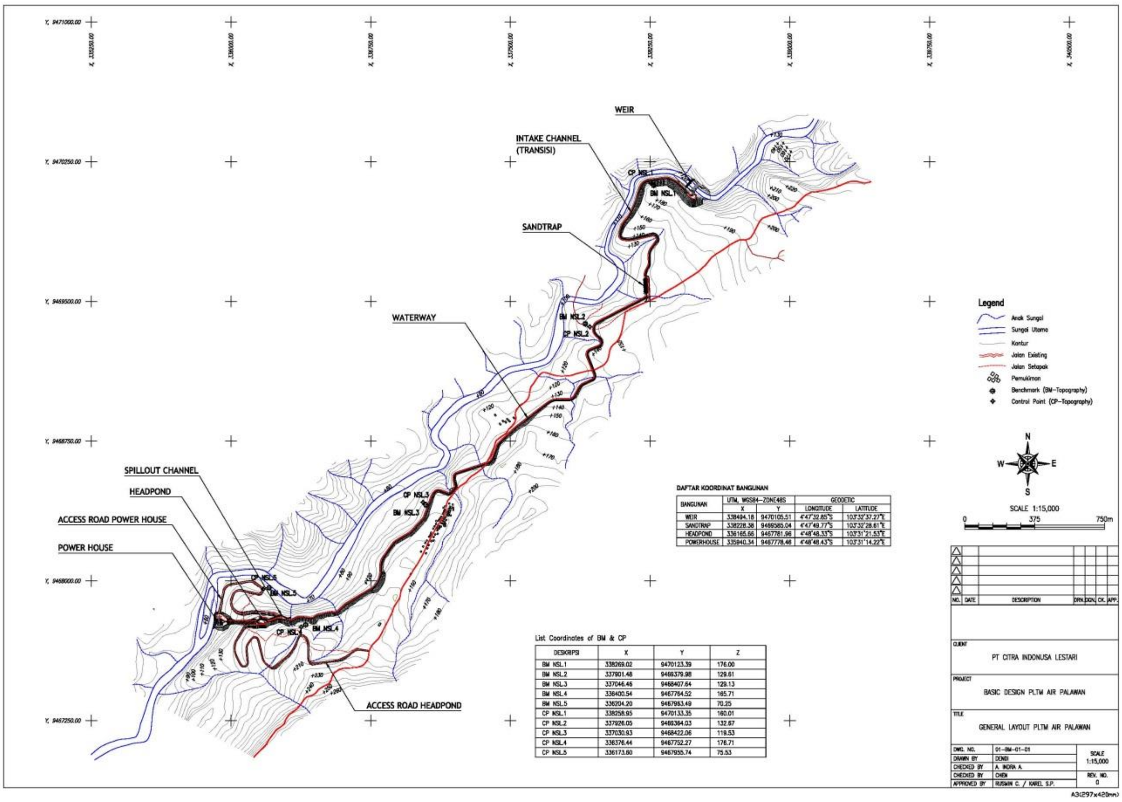


Figure 4-38 The project component of Nasal

4-3-1-2. Baseline of environmental and social conditions.

(1) Geography and geology

1) Geology of Indonesian archipelago

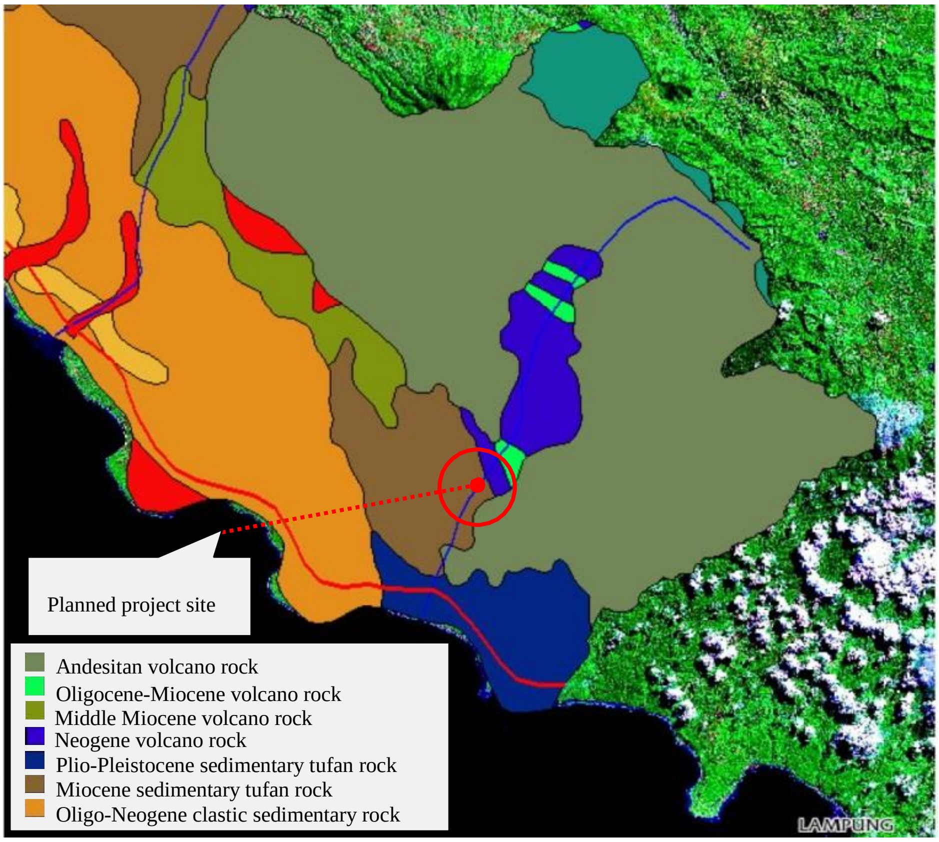
The Indonesian archipelago occupies the part of earth surface having the most complex form and structure.

The geology of the Indonesian archipelago consists of 4 types, namely: Andesite unit, Ignimbrite (Tufa Toba) from the Pleistocene era, river deposit from the Recene era and talus deposit from the Recene era. The andesite and ignimbrite units are separated by an unconformity located under the river deposit and along the river.

Geology of Bengkulu province is dominated by Barisan Mountains base rock, and the morphology can be divided into five (5) such as Lowlands Unit, Unit Wavy Hills, Highlands Unit, Unit and Unit Mountains Volcanic Cones.

2) Geological condition at the location of the Nasal micro hydropower project

According to the geological map prepared by the Center for Marine Survey of Natural Resources (PSSDAL), Coordinating Agency for Surveys and Mapping (BAKOSURTANAL), the geology of the planned project site mainly consists of Andesitan volcano rock, Oligo-Miocene volcano rock, middle Miocene volcano rock, Neogene volcano rock, Plio-Pleistocene sedimentary tufan rock, Miocene sedimentary tufan rock and Oligo-Neogene clastic sedimentary rock (See Figure 4-39).



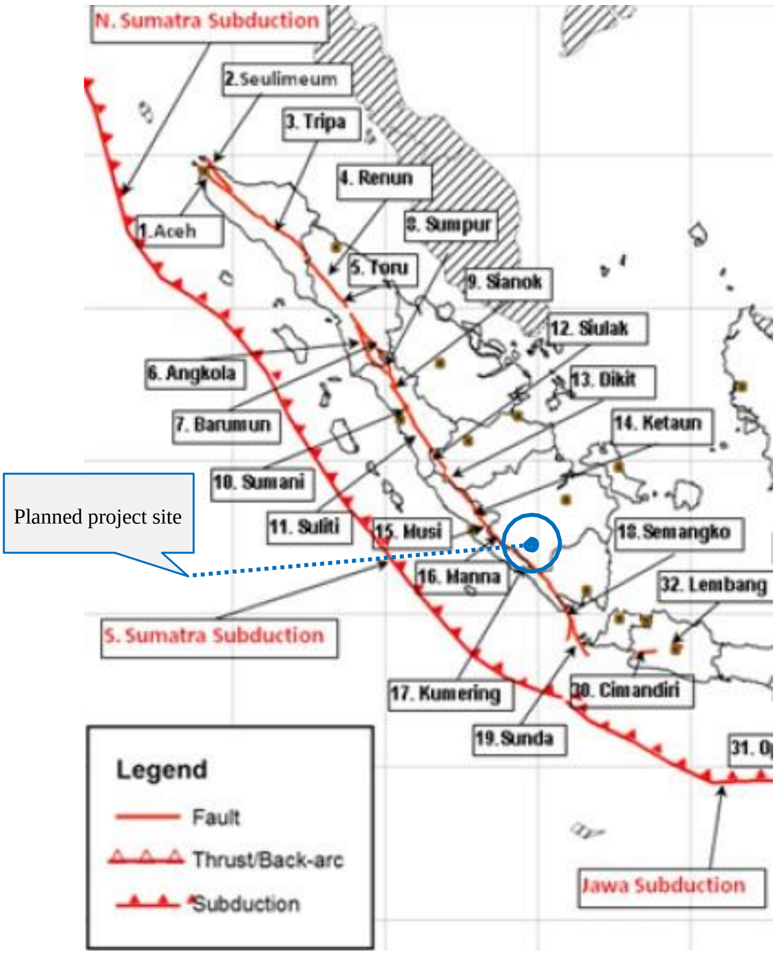
Source: Feasibility Study Report

Figure 4-39 Geology of the planned project site

According to the Figure 4-39, the geology of the planned project site is mainly tuff rock, which is soft compared to other ground substance. Un-consolidated tuff rock tends to contain ground water, which causes liquidity that would be a course of ground water. This leads to be a slide plane on land slide. Therefore, understanding of hardness of the ground or possibility of landslide by boring exploration is necessary upon construction of the structure.

3) Risk of Earthquake at the Nasal micro hydropower project site

Figure 4-40 shows the earth crust around the planned project site. According to the figure, a fault lays near to the planned project site and a seduction is expressed at an offshore area in the figure. Therefore, detailed study of geological structure by boring exploration and designing/evaluation of structure against earthquake is necessary.



Source: Feasibility Study Report

Figure 4-40 Earth crust around the planned project site

(2) Meteorology and Hydrology

1) Climate

Averaged observation data (Air temperature, Humidity, Wind speed and Solar radiation percentage) at the closest meteorological station to the planned project site, Baai Bengkulu, and averaged observation data of precipitation at Cape of Good Hope (Semidang Gumay district), Kanpil Linau (Maje district), Diperta Kaur (South Kaur district) are shown in Table 4-57 respectively. The area is located in the tropical climate zone, which is high-temperature and humidity, and its annual precipitation exceeds 2,500mm. Monthly averaged data (see Table 4-58) does not show big difference, suggesting the steady climate condition through a year.

Table 4-57 Climate around the planned project site

Index	Unit	Average	Observed location	Observation
Air temperature (Max)	℃	30.7	Baai Bengkulu	2006-2010
Air temperature (Min)	℃	23.6		
Solar radiation	%	67.1		
Humidity	%	84.1		
Wind speed	km/hour	4.76		
Precipitation	mm/year	2,592	Tanjung Harapan (Semidang Gumay district)	2001-2010
			Kanpil Linau (Maje district)	2006-2010
			Diperta Kaur (South Kaur district)	2007-2010

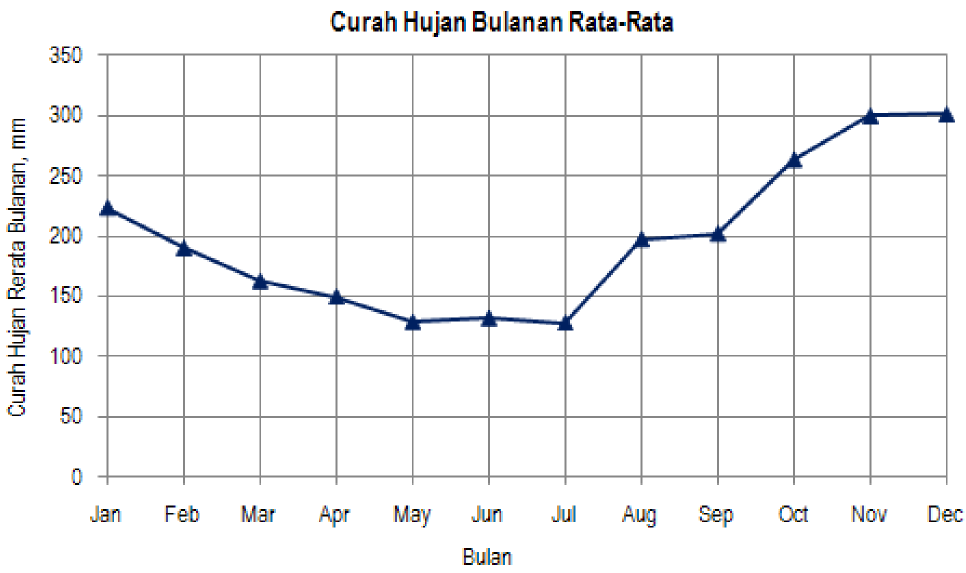
Source: Feasibility Study Report

Table 4-58 Climate around the planned project site (Monthly average)

Unsur Iklim	Temperature		Kelembapan Udara	Penyinaran Matahari	Kecepatan Angin
	Maks.	Min			
Bulan	°C	°C	%	%	km/jam
Jan	30.16	23.50	83.74	52.60	4.14
Feb	30.82	23.66	82.36	59.60	4.62
Mar	30.66	23.52	84.24	62.40	4.64
Apr	30.94	23.94	84.02	71.40	4.88
May	31.46	23.90	83.92	75.20	4.90
Jun	31.06	23.84	85.00	72.80	4.94
Jul	30.84	23.36	83.60	73.00	3.94
Aug	30.84	23.14	82.80	77.20	4.70
Sep	30.36	23.38	83.60	70.20	5.22
Oct	30.68	23.54	84.40	66.00	5.24
Nov	30.48	23.70	85.00	60.40	4.68
Dec	30.28	23.64	86.20	64.40	5.16

Source: Feasibility Study Report

Monthly transition of averaged precipitation calculated using observed data is shown in Figure 4-41. The climate is roughly divided into two, wet season from August to January and dry season from February to July. However, monthly precipitation exceeds 100mm even in dry season.



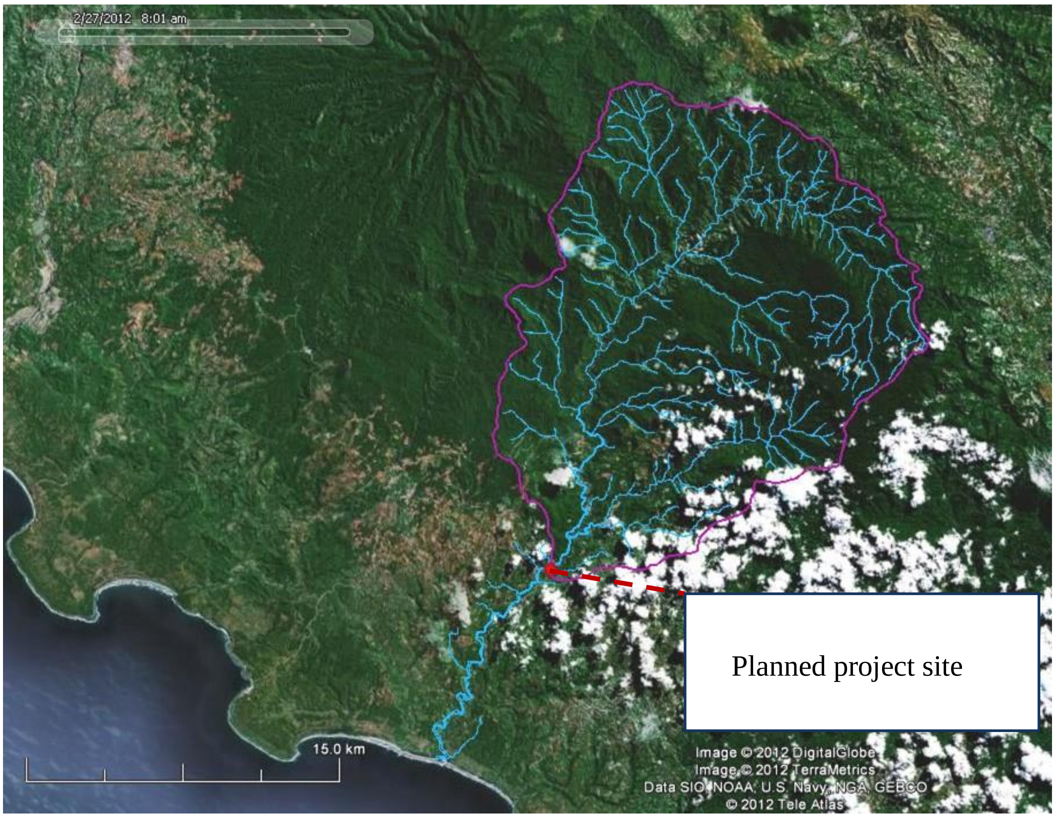
Refer to Table 4-57 for observed period

Source: Feasibility Study Report

Figure 4-41 Time series of monthly averaged precipitation

2) The river catchment area

The Nasal watershed includes the Nasal River and its tributaries as shown in Figure 4-42. The total area of the Nasal watershed upstream of the planned project site is 307.93 km2.

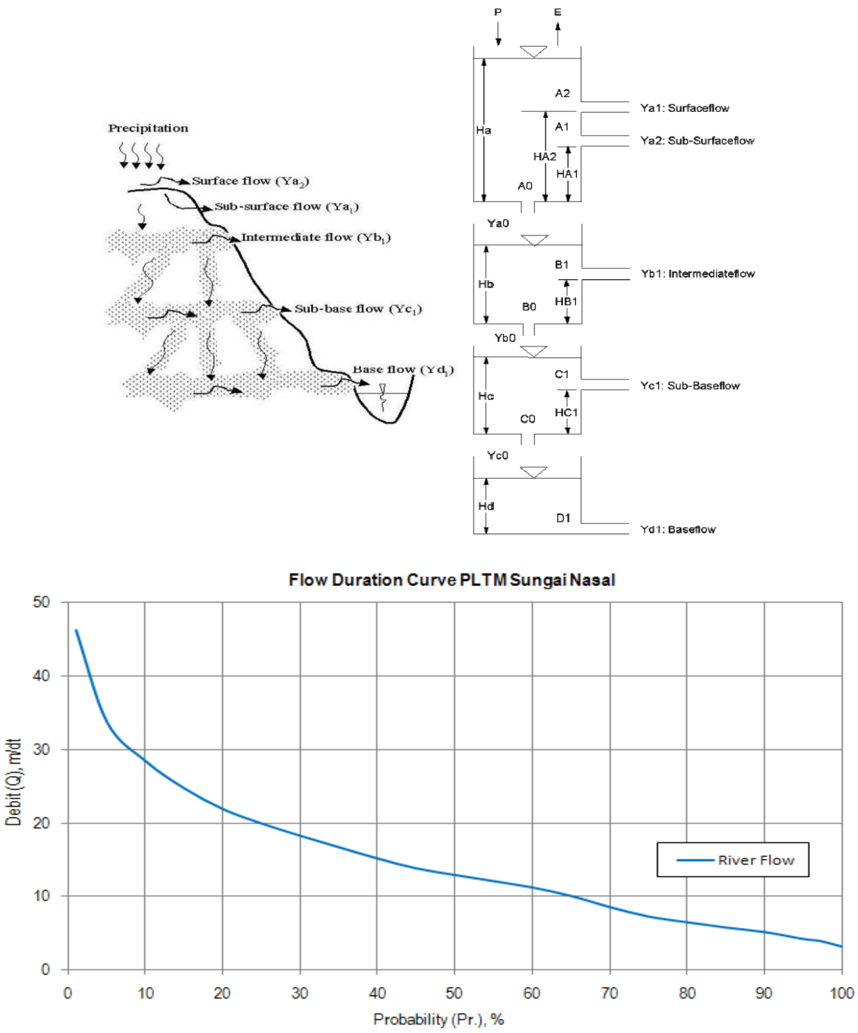


Source: Feasibility Study Report

Figure 4-42 Catchment area of Nasal river and project site

3) Hydrology

Hydrology data is very important in the detailed planning of a hydroelectric power station. In the Feasibility Study Report, flow rate in 50-year probability of Nasal river is calculated using precipitation data introduced in above section 2) and rainfall runoff-tank model. Obtained flow rate in 50% probability is 12.94m^3/s (catchment area: 307.93km2). The flow rate in the Besai micro hydropower project, closer to the Nasal planned project site, is 21.1 m^3/s (catchment area:414km^2) and the one in reference area, east side of the Nasal planned project site, is 30.00 m^3/s (catchment area:578km^2), suggesting the appropriateness of the obtained data in the Nasal planned project site.



Source: Feasibility Study Report

Figure 4-43 Image of the Tank model and flow rate in Nasal river

The minimum flow rate to maintain the ecosystem of the target river (ecological flow) is obtained using the methodology of Montana (1976) and the minimum flow rate of the catchment area in the planned project site is determined as follows.

- Averaged river flow in 2001-2010 (calculated from precipitation): 15.38 m^3/s
- Flow rate is calculated using the equation, 10% x Annual flow, which corresponds to "Fair or

degrading" specified in Table 4-57, as follows: 15.38 m^3/s x 10% = 1.54 m^3/s

- Methodology by Nippon Koei Co., Ltd. uses the ratio 0.3/100 km^2 x catchment areas. Therefore, in the catchment area of the Nasal planned project site is: 0.3m^3/s x 307.93/100km^2=0.92m^3/s
- Comparing the two flow rates mentioned above, the smaller value is used as a minimum flow rate: 0.92m^3/s

Table 4-59 Appropriate flow rates to maintain the ecosystem

Condition	Discharge
Optimum Range	60 – 80% x Annual flow
Outstanding	40% x Annual flow
Excellent	30% x Annual flow
Good	20% x Annual flow
Fair or degrading	10% x Annual flow
Poor	10% x Annual flow
Severe degradation	< 10% x Annual flow

Source: Feasibility Study Report (methodology of Montana, 1976)

This value, 0.92m^3/s, is smaller than the 100%-probability flow rate obtained in Figure 4-43, meaning minimum flow rate to maintain the ecosystem is secured.

Sedimentation volume of intake dam is estimated as 167 m3/day and flushing of the sediment in the dam will be performed every two weeks.

(3) Population

Table 4-60 shows population in Kaur district by statistics data of Bengkulu city. The area of Kaur district is 225,600ha (2,556km^2) and therefore the population density is 46.10 individuals/km^2 in 2009.

Table 4-60 Population in Kaur district

Year	2009	2008	2006
Male (individuals)	60,660	59,761	55,950
Female (individuals)	57,161	55,407	51,523
Total (Individuals)	117,821	115,168	107,473

Source: Statisticss of Bengkulu city, 2010

Air Parawan village in the Nasal sub-district will directly be affected by the planned project. There are 275 households in the village, 1,530 individuals (Male: 810, Female: 720, statistics in 2012) are living.

(4) Living/livelihood

1) Agriculture

Multipurpose plantations in the planned project site and its surroundings have already been managed for a long time. The types of crops cultivated at the project site are coffee, palm, rubber, cacao and pepper.

2) Livestock

Usually livestock is maintained as an income source. However, big-scale livestock was not recognized in the field reconnaissance survey. Goat, pig and fowl (chicken, duck) were observed in the field reconnaissance.

3) Education and culture

The air Parawan village is Muslim community, which has two mosques, one primary school and one junior high school. A medical clinic with maternity nurse also exists. Resettlement for all facilities by the planned project is not necessary.

(5) Land Use

The project area is used as farmlands.

(6) Water use

According to the results field reconnaissance and interviews with the operators, water for drinking and irrigation is used from spring wells. Therefore, there are no utilization of water for irrigation water, drinking water, water of living in the upstream of the weir and water-reducing section in the planned project site.

(7) Cultural heritage

There is no cultural heritage around the planned project site.

(8) Minority and indigenous people

People living in the Air Parawan village are Muslim and a small number of Christian (7 individuals by the statistics in 2012) are living in a village in the upper stream of Air Parawan. Although the Christian village will not be affected by the planned project, the representatives were invited to the stakeholder meeting held in 2012 for the explanation of the project.

4-3-1-3. Confirmation of Systems and Organizations Relevant to Environmental and Social Considerations

(1) Laws and References Relevant to Environmental Considerations (Environmental Impact Assessment, Disclosure etc.)

1) Environmental Assessment Act

(A) "Low No. 32/2009.Environmental Protection and Management" is enacted in 2009

"Low No. 23/1997 Environmental Management". In the Article 1 of "Low No. 32/2009. Environmental Protection and Management", it is said that project/activity which may have a serious impact to environment requires an Environmental Impact Assessment (EIA; AMDAL in Indonesia) and project/activity which doesn't have a serious impact to environment requires an Environmental Management Procedure/Environmental Monitoring Procedure (UKL/UPL).

According to the project owner, the required procedure would be the UKL/UPL, since the scale of the project is small. And the UKL/UPL would be approved shortly. According to the additional interview conducted at the beginning of December 2013, the UKL/UPL would be approved within this year. And in the another additional interview in the middle of January 2014, the project owner answered that although the UKL/UPL was not approved yet, it would be obtained and approved.

(B) Government Regulation about Environmental Impact Assessment No.27/1999

The procedure of AMDAL is determined in "Government Regulation about Environmental Impact Assessment No.27/1999" on the basis of Environmental Management Law 1997. Although Environmental Conservation and Management law was established in 2009, the procedure is still effective.

(C) State Minister of Environment Decree No.11/2006, Type of Business and/or Activity Plan requiring AMDAL

In "State Minister of Environment Decree No.11/2006, Type of Business and/or Activity Plan requiring AMDAL" enacted in 2006, the project or the activity that requires AMDAL is determined. Regarding to a dam, whose height of dam body is over 15m, AMDAL is required.

(D) State Minister of Environment Decree No.11/2010 about Environmental Management and Monitoring policy and document relevant to implementation of Environmental Management

This determines the guidelines of making UKL/UPL document.

(E) Public Participation and Disclosure in the Environmental Impact Assessment process

Article 33-35 in "Government Regulation about Environmental Impact Assessment No.27/1999" determines the procedure of disclosure of information about environmental impact to the public. The details are described in "State Minister of Environment Decree No.8/2006".

(F) Related Organizations

Organizations related to AMDAL are listed below.

- The competent organ of project/activity
- AMDAL committee：Established in National, Provincial, District/city level.
- Approval authority: Minister, Governor, regent/mayor.

(G) Procedure of Environmental Impact Assessment

Procedure of Environmental Impact Assessment is shown in Figure 4-44

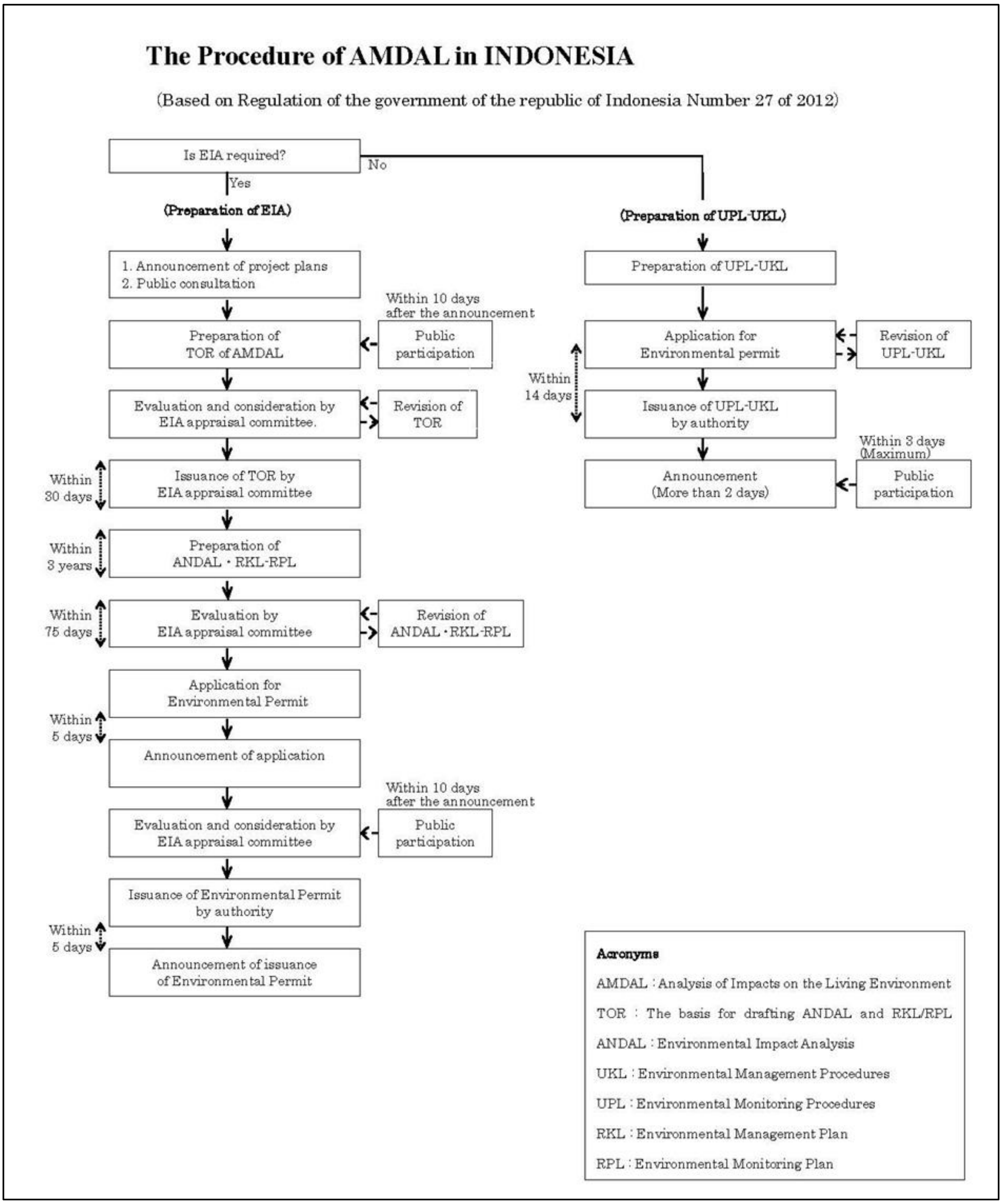


Figure 4-44 Procedure of Environmental Impact Assessment

(2) Laws and Regulations relevant to land acquisition and resettlement

1) Laws and Regulations relevant to land acquisition

(A) Presidential Regulation No. 36/2005 Land acquisition for Implementation of Public Interest

(B) Presidential Regulation No. 65/2006. Amendment of Presidential Regulation No.36/2005

(C) Decree of the Head of National Land Agency（BPN） No.3/2007. Guidelines for Implementation of Presidential Regulation No.36/2005 on Land acquisition for the Implementation of Public Interest as amended by Presidential Regulation No.65/2006

2) Land acquisition Committee

Land acquisition for public facilities construction is to be conducted by the City/District Land acquisition Committee under the Mayor/Regent Decision in cases where the land needed for public facilities is located within a single district. The City/District Land acquisition Committee consists of 9 persons at most as follows (Article 14 of the Head of the National Land Board (BPN) Regulation No.3/2007)

- A District Secretary as both Head and Member
- A Functionary from local government as Vice Head and Member
- The Head of the District Land Office or any functionary appointed as Secretary and Member
- A Head of agency/office/board in the city/district level related to the implementation of land acquisition or any functionary appointed, as a member
- In case where the land for public facilities is located in two cities/districts or more within one province, A Provincial Secretary should be in charge of Head of Land acquisition committee. (Articles 15 of Head of National Land Board (BPN) Regulation No.3/2007)

In order to establish these Land acquisition Committees for the Project, the Project Owner shall submit a request letter to the Governor and Regent for establishment prior to the commencement of land compensation procedures.

3) Land Value Appraisal

The land value appraisal is to be done by a Land Value Appraisal Agency that is to be stipulated by the Regent / Mayor. In the case of the absence of Land Value Appraisal Agency in or around the respective city / district, the Regent / Mayor is to establish a land Value Appraisal Team, which consists of the following organizations. (Articles 25 and 26 of Head of National Land Board (BPN) Regulation No.3/2007)

- Agent of the institution responsible for construction and /or plantations.
- Agent from the institution of Land and Building Tax Service
- Experts or persons with experience in land value appraisal.
- Academic person with the ability to conduct appraisals of land, building, plantations and/or other objects built on the land.

The land value appraisal is conducted based on Taxed-Object Selling Value (NJOP) or market price by taking into consideration the NJOP price of the current year, as well as the following items
(Article 28 of Head of National Land Board (BPN) Regulation No.3/2007)

- Location and area of land
- Land status
- Land entitlement
- Synchronization between land and existing spatial planning or city planning
- Facilities and infrastructure available
- Any other factors for increasing land price/value.

Appraisal of building and plantation prices is to be done by government staff of the district government that is responsible for buildings and farming/landscaping, respectively.
(Article 10 of President Regulation No.65/2006, and Article 29 of Head of National Land Board (BPN) Regulation No.3/2007)

4) Land Compensation Procedure

Land Compensation including resettlement will be conducted using the following standard procedures and/or coordinated by the Land acquisition Committee (Article 7 of President Regulation No.36/2005 as amended by Article 6 of President Regulation No.65/2006 and Article 14 of Head of National Land Board (BPN) Regulation No.3/2007):

- Provide explanations or dissemination to the people (Public Counseling)
- Conduct a research and inventory survey on land, buildings, plantations, and any other objects built on the land, of which rights are to be dispossessed or delivered (Inventory Survey)
- Conduct research on legal status of land, of which rights are to be dispossessed, as well as supporting documents (Research on Land Status)
- Announce the outcome of the research and inventory survey, as referred to in (b) and (c) above, in the document. (Announcement of Research and Inventory Results)
- Receive the appraisal results on land from the Land Value Appraisal Agency/Team and government staff responsible for conducting appraisal on the buildings, plantations and/or any other objects built on the land. (Land Value Appraisal)
- Determine the amount of compensation for the land in document, of which rights are to be dispossessed. (Determination of Compensation)
- Make an official report on the dispossession or delivery of the rights (Report Preparation of Dispossession of Land Rights)
- Witness the process of compensation delivery to the landowners (Compensation Payment)
- Make an official report on the dispossession or delivery of the rights (Report Preparation of Dispossession of Land Rights).
- Administer and document all land acquisitions-related documents and submit them to the Project Implementer who requires the land, and also to the District Land Office. (Administration

and Documentation of Land Compensation)

- In the case where no agreement is achieved from the discussion, the Land acquisition Committee should report/deliver the problems raised as well as several solution proposals to the Regent (Bupati) of the related district (Decision for Settlement)

The Provincial Land acquisition Committee, on the other hand, is to facilitate/conduct the following tasks (Article 15 of Head of National Land Board (BPN) Regulation No.3/2007)

- Give explanations and guidelines for the land acquisition procedures in the related districts.
- Coordinate and synchronize the land acquisition procedures in the two districts.
- Provide considerations to the Governor for the purpose of decision making regarding the form and amount of compensation, proposed by the Mayor (Bupati) of related districts. Supervision and control upon the land acquisition procedures in the related districts.
- Procedure of Land acquisition process in Indonesia

Procedure of Land acquisition process in Indonesia is shown in Figure 4-45

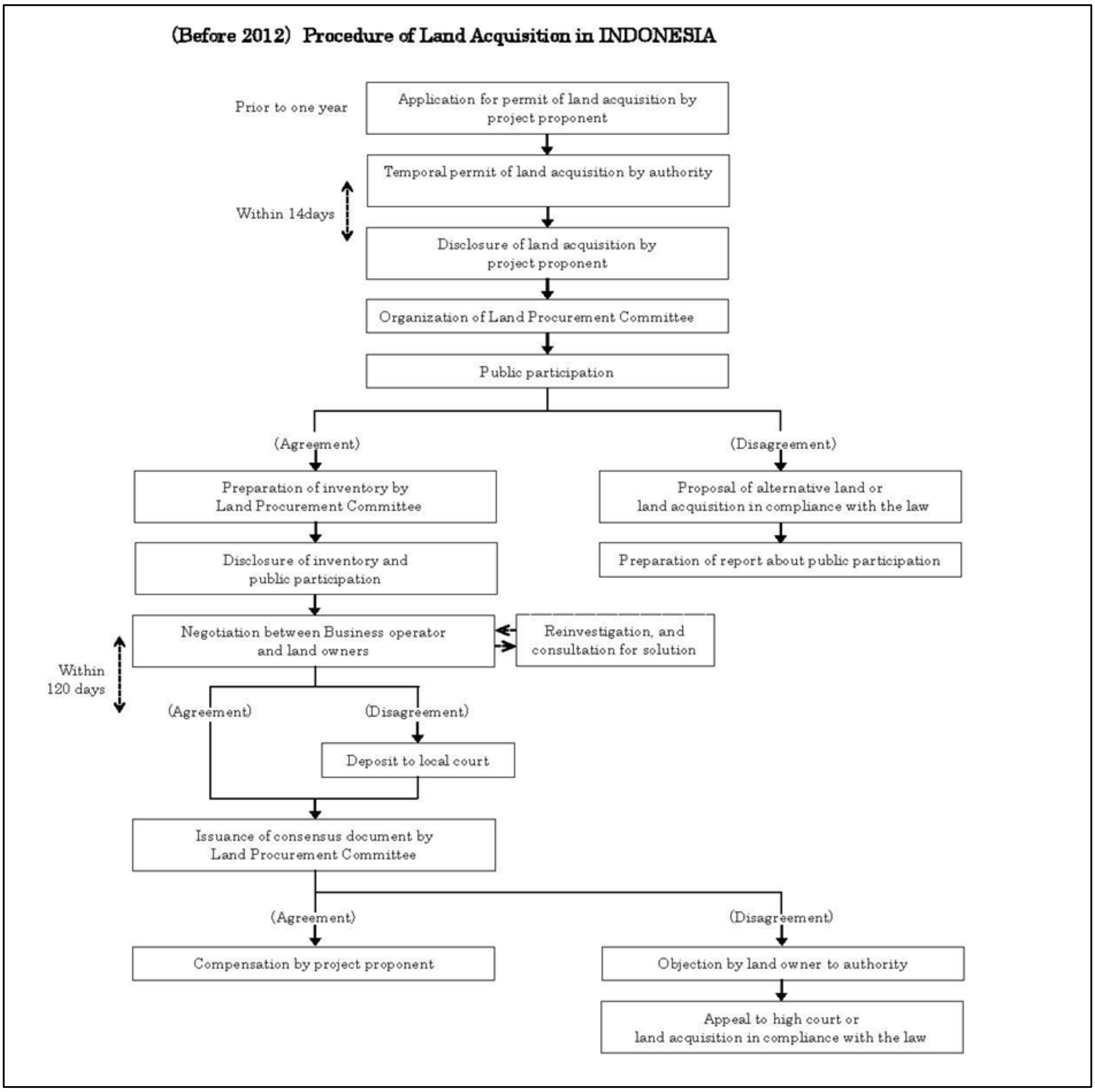


Figure 4-45 Procedure of Land acquisition [34]

5) Gaps of Indonesian Laws and JICA Guideline (Apr. 2010)

Table 4-61 shows a comparison between JICA guidelines and relevant laws and regulations in Indonesia and Table 4-62 shows policies to deal with the gap between JICA guidelines and relevant laws and regulations in Indonesia.

[34] Presidential Decree No.36/2006 and Head of National Land Agency Decree No.3/2007
In indoneisa new law on land acquisition was promulgated on 2012, but this project took procedures in accordance with the old law because it was planned before 2012. Therefore the figure was prepared in accordance with the old law.

Table 4-61 Comparison between JICA guidelines and relevant laws and regulations in Indonesia

Item	JICA guidelines / OP4.12	Relevant laws and regulations in Indonesia.
Preparation of RAP	Preparation of RAP based on the appropriate participation of PAPs. In preparing RAP, consultations must be held with the affected people and their communities based on sufficient information shall be available to them in advance.	In Indonesia land law, there is no description regarding preparation of the RAP and no description regarding responsibility of project owner neither. Preparation of LAP is required by land acquisition law No.2 of 2012 (enforced on January 2012) but the preparation of RAP is not required.
Livelihood recovery support	Host countries must make efforts to enable people affected by projects and improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites.	There is no description in the Indonesia land law. It is same in land acquisition law No.2 of 2012 (enforced on January 2012).
Support for squatters	Support for squatters must be provided.	The owner of the religious or legal owner of the building affected are entitled to compensate for the loss. It is same as land acquisition law No.2 of 2012 (enforced on January 2012).
Calculation of compensation	Prior compensation, at full replacement cost, must be provided as much as possible.	Compensation value is calculated based on the market price calculated by land evaluators as third party or NJOP.
Support for socially vulnerable	Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the	There is no description in the Indonesia land law. It is same as land acquisition law No.2

	poor, and ethnic minorities, all members of which are susceptible to environmental and social impacts and may have little access to decision-making processes within the community.	of 2012 (enforced on January 2012.).
Public participation	Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood.	Information about land acquisition and project summary should be opened to the public within 14 days after approval. In addition, consultation with land owners involved in land acquisition is required, and it is necessary to inform the public through the media and website consultations. In land acquisition law No.2 of 2012 (enforced on January 2012.), public consultation is required in 60 business days of the business development stage.
Complaint handling	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.	There is no description in the Indonesia land law. In land acquisition law No.2 of 2012 (enforced on January 2012.), objection may be filed with the district court within 14 business days.
Monitoring	Appropriate follow up plan such as environmental management plan, the environmental monitoring plan should be prepared and cost and sources and method should be planned. Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders.	There is no description in the Indonesia land law. In land acquisition law No.2 of 2012 (enforced on January 2012.), monitoring and evaluation of the performance of Acquisition of Land in the Public Interest shall be made by the government and Monitoring and evaluation of the results of the handover of the Acquisition of Land in the Public Interest shall be made by the Land Administrator.

Table 4-62 Policies to deal with the gap between JICA guidelines and relevant laws and regulations in Indonesia.

Gap confirmed	Policies
Preparation of RAP	Confirm project owner to prepare RAP.
Livelihood recovery support.	Impact on livelihood due to land acquisition is insignificant, therefore, comprehensive support such as road maintenance and power supply etc. are planned. Negotiations regarding the reacquisition price for the alternative land, its mediation and commission fee between the project owner and the land owners will be performed under the supervision of the regional government based on the Land Acquisition Law. Since establishment of Complaint handling mechanism is planned, further livelihood recovery support will be discussed incase individual requirement is raised.
Support for the squatters	Basically, support for the squatters will be provided.
Calculation of compensation	The amount of compensation is decided through negotiation with land owners and local government agencies. It is regarded as market price.
Support for socially vulnerable	Support will be provided as necessary.
Public participation	Public participation is implemented as meeting/presentation of UKL/UPL and public consultation on land acquisition.
Grievance	The project owner will provide consulting services.
Monitoring	Monitoring will be implemented in accordance with Environmental Monitoring Plan described in the UKL / UPL, ensuring transparency and certainty by reporting to the relevant authorities and consultation with a professional consultant.

4-3-1-4. Analysis of Alternatives (Including Without Project Scenarios)

(1) Alternatives

In Indonesian Laws there are no obligations to consider alternative plans in the UKL/UPL procedure. However, geographical conditions and locations of residence area of the local people were considered upon selection of the target area.

(2) Zero Option

If this project is not implemented, the community and the area will not be benefited by following positive impact of this project such as:

- It can improve and open up new employment opportunities for the population, especially in Air Parawan village.
- It can improve living standards of the population and contribute positively to economic growth and development in Kaur district.

4-3-1-5. Scoping and TOR of Environmental and Social Considerations

(1) Scoping

Result of Scoping of Nasal Micro Hydropower Project is shown in Table 4-63

Table 4-63 Result of Scoping of Nasal Micro Hydropower Project

Item		Impact	Rating		Result
			Pre-/Construction Phase	Operation Phase	
Pollution Control	1	Air Quality	B-	B-	**Construction phase**: Although production of exhaust gas and dust are expected from operation of construction machinery and vehicles, affected term and area are limited. **Operation phase, Operation Phase**: Exhaust gas will be generated by vehicles.
	2	Water Quality	B-	B-	**Construction phase**: Impact such as sediment discharge from the construction site, outflow of oil from construction machinery or vehicles, etc. and drainage from accommodation for construction are expected. **Operation phase**: Development of a river section such as reduction of flow speed and volume are expected caused by installation of weir and water-intake.
	3	Waste	B-	D	**Construction phase**: Generation of waste dump and scrap material are expected. **Operation phase**: Generation of waste is not expected.
	4	Soil Pollution	B-	D	**Construction phase**: There is a possibility of soil pollution caused by the outflow of oil from construction machinery or vehicles etc. **Operation phase**: Not expected
	5	Noise and Vibration	B-	B-	**Construction phase**: Generation of noise and pollution caused by operation of construction machinery and vehicles is expected. **Operation phase**: Operation of the power plant will generate noise. Also traffic of relevant vehicles generates noise and vibration.
	6	Odor	D	D	**Construction phase・Operation phase**: Generation of odor is not expected.
Natural Environment	7	Protected Area	D	D	**Construction phase・Operation phase**: There are no protected are in the project area. There is Buki Barisan Selatan National Park about 6km away.
	8	Ecosystem	C	C	**Construction phase**: Impact on ecosystem due to construction work is expected, but the extent is unknown at the present moment. **Operation phase**: Impact on animals due to noise generated by traffic is expected, but the extent is unknown at the present moment.
Social Environment	9	Resettlement	B-	D	**Pre-Construction phase**: In association with land acquisition of the project site, resettlement is expected.
	10	Poverty	D	D	**Pre-Construction phase・Operation phase**: There are no poverty in affected persons of resettlement.
	11	Indigenous or minority people	D	D	There are no indigenous or minority people around the project site.
	12	Local economy, such as employment or	B-/B+	B-/B+	**Pre-Construction phase**: Change of livelihood caused by resettlement is expected and decline of income caused

Item	Impact		Rating		Result
			Pre-/Construction Phase	Operation Phase	
		livelihood.			by land acquisition is expected. **Construction phase :** Local workers are employed for implementation of this project. **Operation phase :** Loss of livelihood or decline of income in association with resettlement and land acquisition may cause poverty. /Increase of employment for operation and maintenance is expected.
	13	Land use and utilization of local resources	B-	B-	**Pre-Construction phase・Operation phase :** Installation of facilities such as waterway may cause change of land use.
	14	Water use	B-	B-	**Construction phase :** Impact on water use caused by flow in of earth and sand in the river is expected. **Operation phase :** Impact to the water use due to the creation of the decreased flow section and installation of the waterway is expected.
	15	Existing Infrastructure and social service	B-	B-/B+	**Construction phase :** Increase of traffic at construction phase is expected. **Operation phase :** Increase of traffic is expected./ Infrastructure service may improve because of the supply of electricity to the local community.
	16	Social Institutions and local decision making institution	B-	D	**Pre-Construction phase :** Impact to local decision making institution is expected during resettlement and compensation procedure. **Operation phase :** Increase of a social institution is expected due to implementation of the project.
	17	Misdistribution of benefits and compensation	B-	B-	**Pre-Construction phase・Operation phase :** Feeling of unfairness may caused by resettlement and land acquisition. Although the supply of electricity will increase the benefit, in case there will be misdistribution of supply, it will increase feelings of unfairness.
	18	Local Conflicts of Interest	B-	B-	**Pre-Construction phase・Operation phase :** Certain extent of loss will expected among residents involved in resettlement and land acquisition, it may cause local conflict. And, misdistribution of electricity supply may cause local conflicts.
	19	Cultural Heritage	D	D	There is no historical, cultural, archeological heritage.
	20	Landscape	B-	B-	**Construction phase :** Change of landscape is expected due to cut of trees etc. **Operation phase :** Installation of relevant facilities will change the landscape.
	21	Gender	D	D	**Construction phase・Operation phase:** There are no impacts expected.
	22	Children's Right	D	D	**Construction phase・Operation phase :** There is no impacts expected.
	23	Infectious Disease such as HIV/AIDS	B-	D	**Construction phase :** There is a possibility of distribution of infectious disease caused by import of construction workers. **Operation phase :** There is no impact expected.
	24	Work conditions (Including work safety)	B-	B-	**Construction phase :** There is a possibility of an accident and distribution of infectious disease caused by import of construction workers. **Operation phase :** There is a possibility of accidents during operation and maintenance.

Item	Impact		Rating		Result
			Pre-/Construction Phase	Operation Phase	
Other	25	Accidents	B-	B-	**Construction phase：** There are possibilities of accidents during construction works and traffic accidents relevant to construction vehicles. **Operation phase：** There are possibilities of accidents during operation and maintenance phase and traffic accidents relevant to construction vehicles.
	26	Cross-boundary impacts and Climate Change	D	D	**Construction phase：** Although there is generation of CO_2 due to construction machinery and relevant vehicles, the impact is temporal and local. Therefore, there is no impact on climate change expected. **Operation phase：** Generation of CO_2 due to generation of electricity is relatively small to other power generation method. Therefore, there is no impact on climate change expected.

A+/-: Significant positive/ negative impact is expected.

B+/-: Positive/negative impact is expected to some extent

C+/-: Extent of the positive / negative impact is unknown. (Further examination is needed, and impact may be clarified as the study progresses.)

D: No impact is expected

(2) TOR of Environmental and Social Consideration

TOR of Nasal Mini Hydropower Project is shown in Table 4-64.

Table 4-64 TOR of Nasal Mini Hydro Power Project

Category	Environmental Item		Survey Item	Survey Method.
Pollution Control	1	Air Quality	1) Relevant environmental standards, etc. 2) Meteorology 3) Current status of air quality 4) Traffic	①Obtaining existing document ②Field survey
	2	Water Quality	1) Relevant environmental standards, etc. 2) Current status of water quality	①Obtaining existing document ②Field survey ③Interview survey
	3	Waste	1) Relevant environmental standards, etc. 2) Method of waste disposal	①Obtaining existing document ②Interview survey
	4	Soil Pollution	1) Relevant environmental standards, etc. 2) Management of construction machinery.	①Obtaining existing document ②Interview survey
	5	Noise and Vibration	1) Relevant environmental standards, etc. 2) Current status of noise and vibration 3) Traffic	①Obtaining existing document ②Field survey ③Interview survey
	6	Odor	1) Relevant environmental standards, etc. 2) Current status of odor	①Obtaining existing document ②Field survey ③Interview survey
Natural Environment	7	Protected Area	1) Relevant environmental standards, etc. 2) Current protected area	①Obtaining existing document ②Interview survey
	8	Ecosystem	1) Current status of ecosystem 2) Appearance of rare species	①Obtaining existing document ②Field survey ③Interview survey
Social Environment	9	Resettlement	1) Relevant environmental standards, etc. 2) Status of residents affected by land acquisition and involuntary resettlement 3) Affected property	①Obtaining existing document ②Field survey ③Interview survey
	10	Poverty	1) Existence of poor people in affected resident	①Obtaining existing document ②Interview survey
	11	Indigenous or minority people	1) Status of indigenous or minority people	①Obtaining existing document ②Interview survey
	12	Local economy, such as employment or livelihood.	1) Status of local economy	①Obtaining existing document ②Interview survey
	13	Land use and utilization of local resources	1) Status of land use	①Obtaining existing document ②Field survey ③Interview survey。
	14	Water use	1) Status of water use	①Obtaining existing document ②Field survey ③Interview survey

Category	Environmental Item		Survey Item	Survey Method.
	15	Existing Infrastructure and social service	1) Status of existing infrastructure	①Obtaining existing document ②Field survey ③Interview survey
	16	Social Institutions and local decision making institution	1) Current status of social institutions and organizations	①Obtaining existing document ②Interview survey
	17	Misdistribution of benefits and compensation	1) Status of local economy 2) Livelihood of affected residents	①Interview survey
	18	Local Conflicts of Interest	1) Status of local economy 2) Livelihood of affected residents	①Interview survey
	19	Cultural Heritage	1) Status of cultural heritage	①Obtaining existing document ②Interview survey
	20	Landscape	1) Status of scenic spot	①Obtaining existing document ②Field survey ③Interview survey
	21	Infectious Disease such as HIV/AIDS	None	None
	22	Work conditions (Including work safety)	None	None
Other	27	Accident	None	None
	28	Cross-boundary impacts and Climate Change	None	None

4-3-1-6. Result of Environmental and Social Survey

(1) Pollution Abatement (Air Quality, Water Quality, Waste)

1) Air Quality and Noise

The result of the noise survey in the planned project site is shown in.

Table 4-65 Result of noise survey

Number	Survey location	Noise (dBA)	Standard
1	Planned construction site	49	70 (industry)
2	Resident area	52	55 (residential area)

Standard：Decree of the Minister of Environment No. Kep- 48/MENLH/1996, 2006

Source: UKL / UPL

2) Water Quality

Water quality data are not listed in the UKL/UPL and it is not obtained according to the interview with the project owner. It is necessary to obtain the water quality data before implementation of the construction as a baseline data for the monitoring by conducting a literature survey or field survey.

3) Waste

Waste in this region is gathered and disposed by the regional government.

(2) Natural environment

1) National Park

National park closest to the planned project area is Buki Barisan Selatan National Park. The park is about 6km away.

Figure 4-46 National Park Location Map of North Sumatra

2) Protected Areas

There is no protected area. Confirmation on protected area described in "Reproduced from Indonesia Protected Areas Map (The Department of Forestry, December 2001) and hearing from local residents during field survey have conducted.

3) Natural Conservation forest

Location of natural conservation forest around the planned project area is shown in Figure 4-47. The planned project area does not include natural conservation forest.

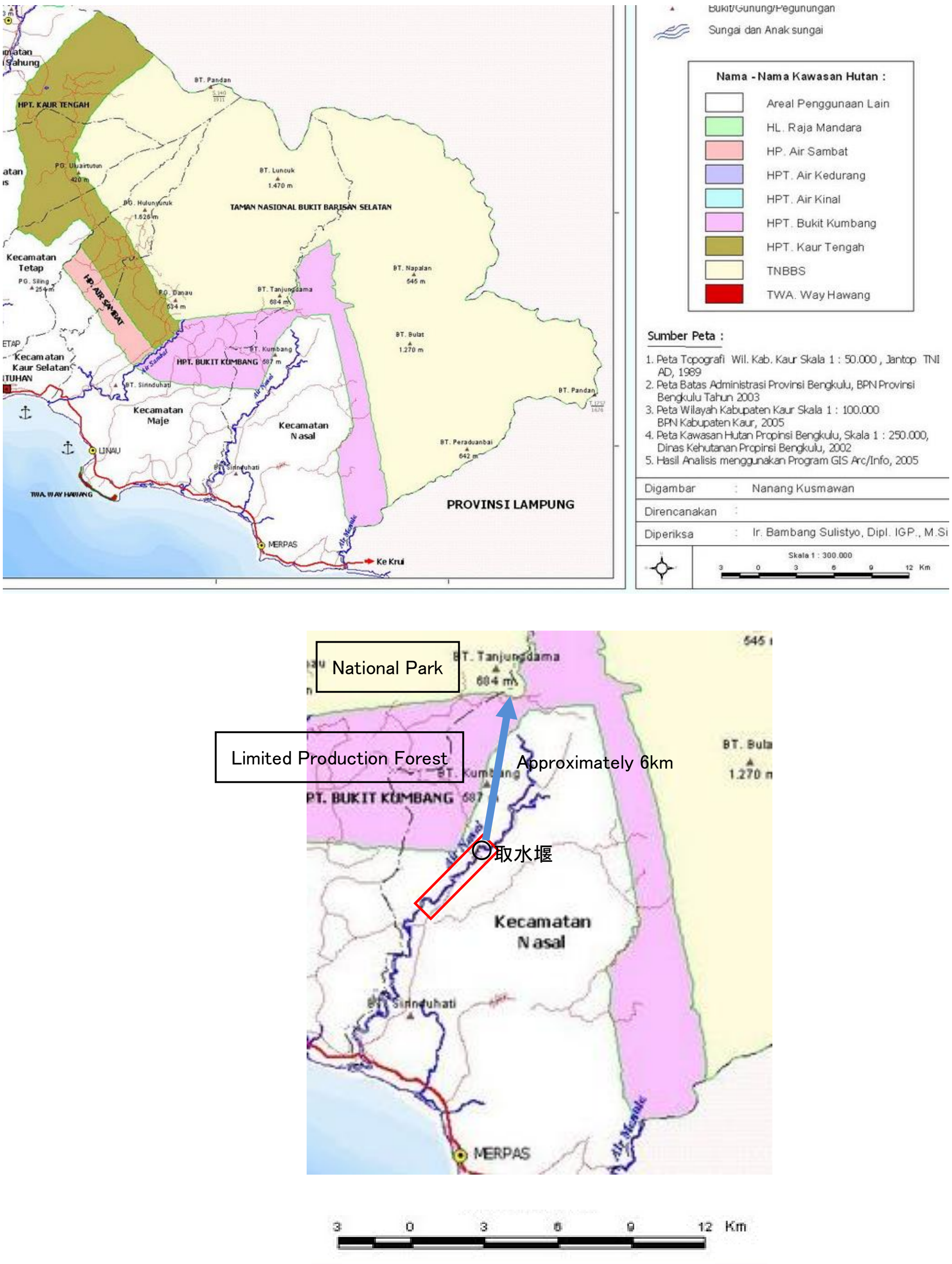


Figure 4-47 Natural conservation forests around planned project area

4) Ecosystem

(A) Rare Species

Out of species confirmed in UKL/UPL and hearing with local residents during field survey (conducted in March, 2013), rare species concerned with the domestic law of Indonesia (Government Regulation No.7/1999) or IUCN red list are shown in Table 4-66 below.

During the field survey conducted in March 2013, Siamang *Symphalangus syndactylus* was observed and pigtailed macaque was observed at outside of the project site. According to the interview with local resident, there is eyewitness information about pigtailed macaque *Macaca nemestrina and* Sumatran tiger *Panthera Tigris*. Regarding Sumatran Tiger, a plurality of the villagers said that traces such as footprints are confirmed in the very low frequency such as about once a year.

The project site is consisted with secondary forest and cultivated land and there is a Limited Production Forest around the North and East side of the project site and, furthermore, there is a National Park at 6km North and East side. Those rare species, mainly inhabit at this National Park and they are species with wide home range[35]. Therefore, those rare species were observed at the project site which locates marginal regions of the Limited Production Forest. Since the project site is mainly consisted with secondary forest and cultivated land and affected area is limited, the impact due to project implementation is expected as insignificant.

Table 4-66 Rare species inhabit in the project area

No.	Classification	Scientific name	Local name	English name	Category
1	Birds	*Nisaetus bartelsi*	Elang	Javan Hawk-eagle	IUCN Rank：EN Protected species in domestic law.
2	Mammals	*Panthera tigris*	Harimau	Sumatran tiger	IUCN Rank：CR Protected species in domestic law
3	Mammals	*Helarctos malayanus*	Beruang	Malaysian sun bear	IUCN Rank：VU Protected species in domestic law
4	Mammals	*Symphalangus syndactylus*	Siamang	Siamang	IUCN Rank :EN
5	Mammals	*Macaca nemestrina*	Beruk	Pig-tailed macaque	IUCN Rank：VU

Source：UKL/UPL

(B) Vegetation

The vegetation around the project site was classified into the following 5 types. Most areas around are cultivated land where trees, including Para rubber tree (*Hevea brasiliensis*), coffea (*Coffea canephora var. Robusta*), Oil palm (*Elaeis*) is planted.

Most of the cultivated land consisted of high tree of rubber tree, low tree of coffea, and there are peppers on the bark of the rubber tree. Therefore, there are various plants in cultivated land, such as Agra-forestry, monoculture plantation is small. Therefore cultivate land looks like land with relatively abundant biodiversity and actually there are various animals inhabiting. At gradual slope, upland rice is planted, but it doesn’t occupy large areas. In the open grassland environment, there are plants of

[35] Dolly Priatna, Yanto Santosa, Lilik B. Prasetyo and Agus P. Kartono. ome range and movements of male translocated problem tigers in Sumatra.Asian Journal of Conservation Biology, July 2012. Vol. 1 No. 1, pp.20-30. “http://pin.primate.wisc.edu/factsheets/entry/siamang”, “http://pin.primate.wisc.edu/factsheets/entry/pigtail_macaque”

Cyperaceae or Oenothera are observed. In limited area around steep slope in the most upstream of the project area, there are forests with relatively abundant biodiversity and exhibit developed forest type. There are high tree of Dipterocarpaceae and tree fern comprise a forest zone with relatively abundant biodiversity. In the forest, there are Melastomataceae, *Pandanus* sp. and Bambusoideae are observed. Regarding vegetation along riverside, there were some traces of disturbance at the time of the flood but there are little environment such as a stony riverbed and there are little vegetation which is specific to the river. Around residents such as village and roadside, there are some decorative plant species planted but it is very limited. Most of the roads in the project area are not paved, it becomes a bare land environment.

Table 4-67 Type of Vegetation

No.	Type	Notes
1	Secondary forest	Natural forest or secondary forest with relatively abundant biodiversity.
2	Cultivated land, orchard, etc.	Forest dominated by cultivated plant, Agroforest, upland rice in some part.
3	River	Nasal river and its riverside.
4	Residential Area	House, place of worship, school, graveyard etc.
5	Road	Including unpaved road.

Source: Prepared by JICA Study Team

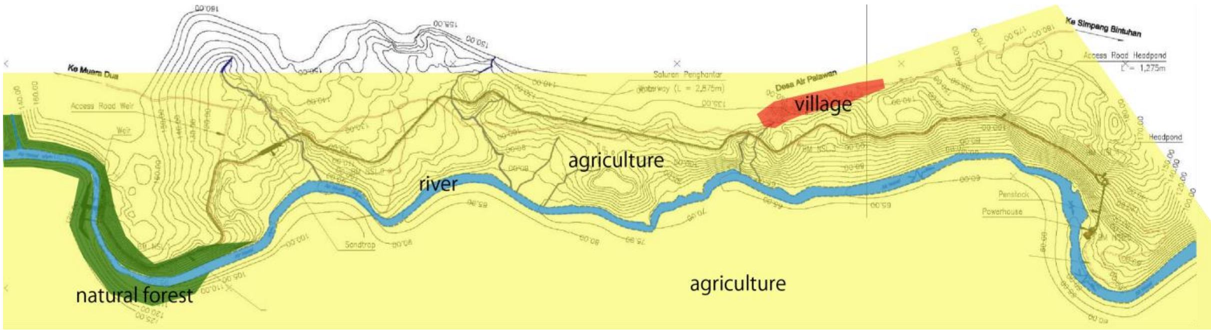


Figure 4-48 Vegetation Distribution Map for The Project Site

Source: Prepared by JICA Study Team

 Secondary Forest	 Cultivated land (Rubber tree and coffee)
 Cultivated land (Paddy rice)	 River
 Resident	 Road (unpaved)

Figure 4-49 General Condition around the Project Site

 Cyperaceae	 *Celosia* sp.
 *Oenothera* sp.	 *Allamanda* sp.
 Bambusoideae	 *Ficus* sp.

Figure 4-50 Vegetation observed during the field survey (conducted in April, 2013)

Plant of Melastomataceae

Pandanus sp.

Coffea. canephora var. robusta

Oryza sativa

Piper nigrum

Elaeis sp.

Havea brasiliensis

Musa sp.

Figure 4-51 Vegetation observed during the field survey (conducted in April, 2013)

(C) Fauna

(a) Mammal

During the field survey (conducted in April, 2013), Siamang (*Symphalangus syndactylus)*, Cynomolgus monkey (*Macaca fascicularis*) and Pig (*Sus scrofa*) were observed. Wild pig inhabits widely and trace such as footprints or mud wallow were observed often. According to the hearing from residents, Pigtailed macaque (*Macaca nemestrina*) and Sumatran Tiger (*Panthera tigris*) are observed occasionally. Pigtailed macaque was confirmed during the field survey at the outside of the project area. Regarding Sumatran Tiger, a plurality of the villagers said that traces such as footprints are confirmed in the very low frequency such as about once a year. As livestock, cat and dog were observed and got information about cattle breed.

Those rare species, mainly inhabit at this National Park and they are species with wide home range . Therefore, those rare species were observed at the project site which locates marginal regions of the Limited Production Forest. Since the project site is mainly consisted with secondary forest and cultivated land and affected area is limited, the impact due to project implementation is expected as insignificant.

Siamang (*Symphalangus syndactylus*)

Cynomolgus monkey (*Macaca fascicularis*)

Footprint of wild pig

Pig (*Sus scrofa*)

Figure 4-52 Mammals observed during the field survey (conducted in April, 2013)

(b) Amphibious

During the field survey (conducted in April, 2013), sound of frogs was heard around the pond near the village, but the spices were not identified. In this area, important amphibious are not confirmed and frog observed daily according to the hearing.

Figure 4-53 Pond in which frog confirmed during field survey (conducted in April, 2013) inhabit

(c) Reptile

During the field survey (conducted in April, 2013), reptiles are not confirmed.

According to the hearing, Equatorial spitting cobra (*Naja sumatrana*), Reticulated python (*Python reticulatus*) and Water monitor (*Varanus salvator*) are inhabit normally.

(d) Bird

During the field survey (conducted in April, 2013), a kind of swiftlet (*Collocalia* sp.) was observed frequently and widely, also, Brown throated sunbird (*Anthreptes malacensis*) and White-breasted Woodswallow (*Artamidae* sp.) were observed in the forest. Along Nasal river, Butorides striatus (*Buteorides striatus*) and Kingfisher (*Alcedo* sp.) were observed. As livestock, Chicken has been bred.

Chicken

Swiftlet (*Collocalia* sp.)

Figure 4-54 Bird observed during the field survey (conducted in April, 2013)

Brown throated sunbird (*Anthreptes malacensis*)

Excrement trace regarded as by Kingfisher (Alcedo sp.)

Figure 4-55 Bird observed during the field survey (conducted in April, 2013)

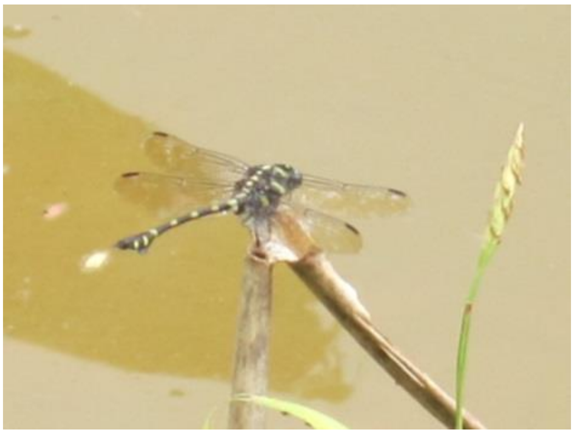
(e) Insect

During the field survey (conducted in April, 2013), common insects of Hemiptera, Odonata, Diptera, Coleoptera, Hymenoptera, Lepidoptera and Orthoptera were observed.

Acrididae

Acrididae

Zygoptera



Gomphidae

Figure 4-56 Insects observed in field survey (conducted in Apr. 2013)

Nymphalidae

Hydrophilidae

Xylocopa sp.

Scaritinae

Papilionidae

Formicidae

Figure 4-57 Insects observed in field survey (conducted in Apr. 2013)

(f) Aquatic Life

During the field survey (conducted in April, 2013), aquatic insect such as water strider and mayfly etc. and snail of Pleuroceridae family were observed.

According to the hearing from resident, river around the project area is fast-flowing, therefore, fish are very few and fishery is not performed.

Water strider(Hemiptera)

Mayfly(Schistonota)

Snail(Pleuroceridae)

Mayfly(Schistonota)

Figure 4-58 Aquatic life observed during the field survey (conducted in April, 2013)

(3) Cultural Heritage

As a result of information collection and field reconnaissance, there is no historical architecture.

(4) Landscape

The landscape around the planned project site is shown in Figure 4-59 and Figure 4-60. Landscape from the existing road and the village is cultivated land and secondary forest, and river surface cannot be seen.

Both sides of river bank are steep secondary forest and the scenery from the surrounding area is limited.

Figure 4-59 Landscape around the planned project site: trail to the weir

(View around the weir from upper stream)

Figure 4-60 Landscape around the planned project site: water way

(5) Labor environment

Sources of income of the resident on the planned project site and its surroundings are dry land agriculture and plantation agriculture.

(6) Living areas of indigenous people

Based on the interview on the field survey (March, 2013), indigenous people do not live and valuable places for indigenous people do not exist in the vicinity of the planned project site.

4-3-1-7. Environmental Impact Assessment

Table 4-68 Result of Environmental Impact Assessment of Nasal

Item	Impact		Assessment based on Scoping result		Assessment based on survey results		Results
			Pre-/Construction phase	Operation phase	Pre-/Construction phase	Operation phase	
Pollution Control	1	Air Quality	B-	B-	B-	B-	**Construction phase**：Although production of Exhaust gas and dust are expected from operation of construction machinery and vehicles, affected term and area are limited. **Operation phase, Operation Phase**：Exhaust gas will be generated by vehicles.
	2	Water Quality	B-	B-	B-	B-	**Construction phase**：Construction work will be implemented at dry season to minimize the sediment discharge from construction sites. Appropriate care will be taken to avoid outflow of oil from construction machinery or vehicles, etc. Drainage from accommodation for construction are expected to very small and processed by soil infiltration. Therefore, impact is considered as minor. **Operation phase**：Although development of a river section such as reduction of flow speed and volume are expected caused by installation of weir and water-intake, the detention flow section is limited at the upper stream of the weir and reduced flow volume section is a toneless water way. Therefore, impact is considered as minor.
	3	Waste	B-	D	B-	D	**Construction phase**：Excavated earth are backfilled or utilized as earth fill to minimize the surplus and waste are processed in accordance with local policy. Therefore, the impact is expected as minor. **Operation phase**：Daily generation of waste is not expected. At the maintenance stage there is some waste may generate. Generated waste will be processed properly. Therefore, the impact is expected as minor.
	4	Soil Pollution	B-	D	B-	D	**Construction phase**： Although there is a possibility of soil pollution caused by the outflow of oil from construction machinery or vehicles etc., appropriate management effort will be taken. Therefore, impact is considered as minor. **Operation phase**：Not expected
	5	Noise and Vibration	B-	B-	B-	B-	**Construction phase**：Generation of noise and pollution caused by operation of construction machinery and vehicles is expected, but the term and area are limited. Therefore, the impact is expected as minor.

Item	Impact		Assessment based on Scoping result		Assessment based on survey results		Results
			Pre-/Construction phase	Operation phase	Pre-/Construction phase	Operation phase	
							Operation phase: Although operation of the power plant will generate noise, but there are no residents around the site. The impact of noise and vibration is minor because increase of traffic is limited.
	6	Odor	D	D	D	D-	**Construction phase・Operation phase:** Generation of odor is not expected.
	7	Protected Area	D	D	D	D	**Construction phase・Operation phase:** There are no protected area around the project area.
Natural Environment	8	Ecosystem	C	C	B-	B-	**Construction phase:** According to UKL/UPL, Government Regulation No.7 and the result of hearing from local resident during field survey (April, 2013), rare species such as Sumatran Tigar, Siamang were confirmed. However, considering limited land use change, etc., impacts due to project implementation is expected as insignificant. The river there are no migratory fish confirmed and a number of species are small. Therefore, the impact is expected as minor. **Operation phase:** Impact on animals due to noise generated by traffic is expected. According to UKL/UPL, Government Regulation No.7 and the result of hearing from local resident during field survey (April, 2013), rare species such as Sumatran Tigar, Siamang were confirmed. However, considering limited land use change, etc., impacts due to project implementation is expected as insignificant.
	9	Resettlement	B-	D	B-	B-	**Pre-Construction phase:** In association with land acquisition of the project site, no household will be resettled.
Social Environment	10	Poverty	D	D	D	D	**Pre-Construction phase・Operation phase:** There are no poor people in affected persons of resettlement.
	11	Indigenous or minority people	D	D	D	D	There are no indigenous or minority people around the project site.
	12	Local economy, such as employment or livelihood.	B-/B+	B-/B+	B-/B+	B-/B+	**Pre-Construction phase:** Change of livelihood caused by resettlement is expected and decline of income caused by land acquisition is expected. Construction phase: Local workers are employed for implementation of this project. **Operation phase:** Loss of livelihood or decline of income in association with resettlement and land acquisition may cause poverty. /Increase of employment for operation and maintenance is expected.
	13	Land use and utilization of local resources	B-	B-	B-	B-	**Pre-Construction phase・Operation phase:** Installation of facilities such as waterway may cause change of land use.
	14	Water use	B-	B-	B-	B-	**Construction phase:** Although impact of water use caused by flow in of earth and sand in the river is expected, the term is limited. Therefore, the impact is expected as minor. **Operation phase:** Water is not used in the reduced flow section, impact on water use is expected as minor.
	15	Existing	B-	B-/B+	B-	B-/B+	**Construction phase:** Increase of traffic at construction

Item	No.	Impact	Assessment based on Scoping result: Pre-/Construction phase	Assessment based on Scoping result: Operation phase	Assessment based on survey results: Pre-/Construction phase	Assessment based on survey results: Operation phase	Results
		Infrastructure and social service					phase is expected. But measures such as security training for driver will minimize the impact. **Operation phase：** Increase of traffic is expected to very small extent. / Infrastructure service may improve because of the supply of electricity to the local community.
	16	Social Institutions and local decision making institution	B-	D	B-	D	**Pre-Construction phase：** Impact to local decision making institution is expected during resettlement and compensation procedure. **Operation phase：** Increase of a social institution is expected due to implementation of the project.
	17	Misdistribution of benefits and compensation	B-	B-	B-	B-	**Pre-Construction phase・Operation phase：** Feeling of unfairness may be caused by land acquisition. Although the supply of electricity will increase the benefit, in case there will be misdistribution of supply, it will increase feelings of unfairness.
	18	Local Conflicts of Interest	B-	B-	B-	B-	**Pre-Construction phase・Operation phase：** Certain extent of loss will expected among residents involved in resettlement and land acquisition, it may cause local conflict. And, misdistribution of electricity supply may cause local conflicts.
	19	Cultural Heritage	D	D	D	D	There is no historical, cultural, archeological heritage.
	20	Landscape	B-	B-	B-	B-	**Construction phase：** Change of landscape is expected due to cut of trees etc. **Operation phase：** Installation of relevant facilities will change the landscape.
	21	Gender	D	D	D	D	**Construction phase・Operation phase:** There are no impacts expected.
	22	Children's Right	D	D	D	D	**Construction phase・Operation phase：** There is no impacts expected.
	23	Infectious Disease such as HIV/AIDS	B-	D	B-	D	**Construction phase：** There is a possibility of distribution of infectious disease caused by import of construction workers. Therefore, hygiene instruction is completed. **Operation phase：** There is no impact expected.
	24	Work conditions (Including work safety)	B-	B-	B-	B-	**Construction phase：** There is a possibility of an accident and distribution of infectious disease caused by import of construction workers. **Operation phase：** There is a possibility of accidents during operation and maintenance.
	25	Accidents	B-	B-	B-	B-	**Construction phase：** There are possibilities of accidents during construction works and traffic accidents relevant to construction vehicles. Therefore, safety guidance is completed. **Operation phase：** There are possibilities of accidents during operation and maintenance phase and traffic accidents relevant to construction vehicles. Therefore, safety guidance is completed.
Others	26	Cross-boundary impacts and Climate Change	D	D	D	D	**Construction phase：** Although there is generation of CO_2 due to construction machinery and relevant vehicles, the impact is temporal and local. Therefore, there is no

Item	Impact		Assessment based on Scoping result		Assessment based on survey results		Results
			Pre-/Construction phase	Operation phase	Pre-/Construction phase	Operation phase	
							impact on climate change expected. **Operation phase**：Generation of CO_2 due to generation of electricity is relatively small to other power generation method. Therefore, there is no impact on climate change expected.

A+/-: Significant positive/negative impact is expected
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of the positive / negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progress)
D: No impact is expected

4-3-1-8. Mitigation Measures and Expense for Implementation of Mitigation Measures

Mitigation measures will be taken in accordance with “4-3-3-3 Environmental Management Plan” which is described in the following section. The expense for the implementation of mitigation measures will be borne by the project owner.

4-3-1-9. Monitoring Plan

Monitoring is planned in the UKL/UPL as summarized in Table 4-3-13. From the viewpoint of the result of the environmental impact assessment shown avobe and the Environmnetal Management Plan introducet later, however, it is considered that items and monitoring frequecy shall be reconsidered. Therefore, those are modified and proposed as a monitoring form attached as Appendix N4-6.

Table 4-69 Monitoring Plan for Nasal

Environmental Item	Monitoring items	Locations	Frequency of monitoring	Implemanter
【Pre-Construction Phase】				
Social Environment	Agreement/consensus based on communal discussions	Vllages around the project site	Once	Project owner
	Issuance of a letter of agreement	Vllages around the project site	Once	Project owner
	Opinion about compensation	Vllages around the project site	Once	Project owner
	Negative opinion to the Project	Vllages around the project site	Once	Project owner
【Construction Phase】				
Air Quality	PM, Nox, Sox	Vllages around the project site	Once	Project owner
Noise	Noise level	Vllages around the project site	Once	Project owner
Ecosystem	Flora, fauna and water biota	The project site and along the Nasar River near the project	Once	Project owner
Social Environment	Number of local laborers	Vllages around the project site	Once	Project owner
	Negative opinion to the Project	Vllages around the project site	Once	Project owner
【Operaton Phase】				
Noise	Noise level	Vllages around the project site	Once	Project owner
Social Environment	Number of local laborers	Vllages around the project site	Once	Project owner
	Negative opinion to the Project	Vllages around the project site	Once	Project owner

4-3-1-10. Stakeholder Meeting

Public consultations were held one time (2 February 2012).

4-3-2. Land acquisition and Resettlement

4-3-2-1. Necessity of Land acquisition and Resettlement

Land acquisition and spatial plan at the planned project site is approved by local government and national government. All affected landowners will receive compensation based on the acquisition cost. According to the interview with the project owner in the middle of January 2014, unit cost for land acquisition based on the reacquisition cost and compensation was determined from the practical accomplishment of the other micro hydropower project by the same project owner implemented in the same Bengkulu province and negotiations with landowners are underway.

Road maintenance will be conducted by the project owner as the Cooperate Social Responsibility (CSR). During construction, the impact caused by vehicles during construction should be considered. Positive impacts of the project are employment of local people, road maintenance, tax income, promotion of local economy and so on.

At the beginning of December 2013, employment of local people would be planned to progress the project as much as possible, though it is not stated in the contract such as MOU with the local people.

(1) Land acquisition

The total area for the project is 40 ha of which the detail designs such as the locations of land cut and landfill are now in progress. Land use map of each landowner is now under preparation.

(2) Land Tenure and Ownership

The status of land ownership in the planned project area is (a) community owned (adat) land, (b) titled land, and (c) untitled land.

According to the information at the beginning of December 2013, almost of all land owners do not have a certificate of the land due to traditional land allocation including settlement without authorization.

Before conducting the negotiation for land acquisition, the project owner will determine each land owner and its area between the landowner under the supervision of local government (District Land Office of Kaur) and undertake the certification procedure of the land by the local government instead of each landowner. The necessary cost for the procedure will be secured by the project owner.

4-3-2-2. Scale and Area of Land acquisition and Resettlement

(1) Scale of land acquisition

Detailed planning regarding the planned project site was now underway at the time on March 2013. Therefore the inventory survey of the land necessary to be acquired for the project is not conducted yet. However the procedure of the land acquisition was explained from the project owner as follows in the interview of the field survey.

According to the interview at the time of the middle of January 2014, the project owner has prepared a distribution map of houses and land and the inventory survey is now under preparation. As the cost of land acquisition, the land owner secured the budget, 6,000,000,000RP for 40ha, based on the experience and the result from the other micro power project implemented by the project owner in the same state.

- Determination of the land: necessary land will be determined (owner, area) based on the detailed design
- Inventory survey (soil type, crops, obstacle, economic condition, water use and electric demand, etc.) will be conducted together with land owner under the supervision of the local government.
- Representative from Air Parawan village approve the inventory
- Certificate of each land ownership is issued by the local government based on the inventory. The necessary cost is secured by the project owner.
- Negotiation for determination of acquisition cost and compensation price between landowners and the project owner is performed based on the current market price, under the supervision of

the local government.

- Acquisition cost and compensation price is paid to each land owner under the supervision of the local government.

(2) Impact of land acquisition

The land for agriculture will be lost by the land acquisition. The project owner will compensate the fee for alternative land based on the reacquisition cost, registration fee, cost for lost product and trees and mediation of alternative land acquisition.

(3) Resettlement

The resettlement by the planned project does not occur.

(4) Affected households

Number of affected landowners are not determined yet, because inventory survey is not conducted. The necessary land is all cultivated land. The land owners will procure other land after the compensation is performed.

(5) Affected trees

Affected land is all cultivated and compensation for the loss of trees and crops will be secured.

4-3-2-3. Concrete Measure for Compensation and Support

The process of compensation follows government procedures, and a "Land acquisition Committee", which aims to improve living standards and incomes, is established.

A practical procedure is described in Section 4-3-2-2.

Compensation value is decided in consultation with land owner and project owner, therefore, it is comparable to market price (i.e. re-acquisition price).

4-3-2-4. Complaint Procedure

The project owner will establish a grievance mechanism for the project.

4-3-2-5. Implementation System

The targeted land for acquisition for the planned project is used as cultivated field. The project owner will be responsible for compensation for relinquishment of the land, under supervision by the local government.

4-3-2-6. Implementation Schedule

According to the schedule specified in the Feasibility Study Report, the land acquisition procedure is planned to be started after detailed design study is completed. In the interview with the project owner on March 2013, it was said that negotiation for land acquisition would be started in the middle of 2013.

At the beginning of December 2013, negotiations with the landowners seem to be still underway.

4-3-2-7. Expense and Financial Resources

(1) Land acquisition

1) Compensation cost

According to the Feasibility Study Report and document from the project owner at September 2013 regarding project cost, 6,000,000,000RP (for 40Ha of unit price 1,500,000,000RP/Ha) is estimated as a cost for land acquisition. And it has already been secured for enforcement in 2013, according to the interview with the project owner.

According to the interview with the project owner at the beginning of December 2013, appropriation source for the cost has been covered by an equity finance (obtaining of funds by new share of bond flotation).

2) Environmental management and monitoring cost.

During the construction period, debt from financial institutions and self-finance will be appropriated. After construction, revenue from electricity sales will be appropriated.

4-3-2-8. Monitoring System and Monitoring Form by Executing Agency

According to the Environmental Management Plan provided by the project owner, environmental management plan and monitoring plan are specified based on the analysis of impact by the project during pre-construction phase, construction phase and operation phase, respectively. As the monitoring structure, the project owner as the implementer and the related department, such as environment, life and health, city planning, transportation and work of the Kaur district office and the associated villages as supervisors are listed. Since a monitoring form is not specified in the UKL/UPL, it is attached in the Appendix N4-6 as a proposal, based on the result of the environmental impact assessment and the Environmental Management Plan.

4-3-2-9. Public Consultation

The public consultation was held 1 time on 2 February 2012 and implementation of the project and conducting the land acquisition has been agreed.

At the meeting, representatives of the local residents and a community leader attended. Consensus building on land acquisition was questioned, and the legal procedure and provision of reasonable compensation upon land acquisition was explained by the project owner. Contribution to the local community by the project such as utilization of the local workforce in the project was also explained (See Appendix N4-5 for the record of the agreement).

4-3-3. Others

4-3-3-1. Draft Monitoring Form

・See Appendix N4-6.

4-3-3-2. Environmental Check List

・See Appendix N4-7.

4-3-3-3. Environmental Management Plan

The Environmental Management Plan provided by the project owner, environmental management plan and monitoring plan are specified based on the analysis of the impacts by the project during pre-construction phase, construction phase and operation phase, respectively. And environmental management and monitoring is planned mainly targetting to minimize the impact to the mental aspects of the residents. In this report, physical aspects such as landscape, waste, soil pollution and cost resiponsibility are added and proposed as a modified Environmental Management Plan as shown in Table 4-3-14.

Table 4-70 Proposed Environmental Management Plan

No	**Impacts**	**Sources of Potential Impact**	**Benchmark**	**Management Effort**	**Implementing Organization**	**Supervision Organization**	**Cost responsibility**
Pre-Construction Phase							
9	Resettlement	Local residents may assume that the local government is the owner of the project.	1) Feasibility for compensation of the land 2) Reality of smooth land acquisition 3) Complaints from local people	1) Determination of price by consensus building 2) Conducting guidance on acquisition procedure 3) Compensation based on the area, agreement for compensation and cost. 4) Less affected people 5) Compensation for land acquisition	1) Project owner 2) Land acquisition committee 3) Related organization Kaur district	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
12	Local economy, such as employment or livelihood.	Field survey will offer local residents an opportunity to work as local laborer.	Feasibility for compensation cost	1) Engage local residents as much as possible. 2) Explanations will be provided to the public in the vicinity of the site about the plans and the types and kinds of labor needed.	Project owner	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
13	Land use and utilization of local resources	Construction of access road and operator house may change physiographies and land use around the project site.	Transition of land use	Report to the local government	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) Land management office of district and associated villages	Contractor
16	Social Institutions and local	Changing peoples` thinking through interacting with local	-----	Developing an appropriate "land acquisition plan"	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) Land management office of district	Project owner

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
	decision making institution	government officers, local residents and others in the land acquisition procedure				and associated villages	
17	Misdistribution of benefits and compensation	Can occur among residents, workers, government officers, and local politicians	-----	Developing an appropriate "land acquisition plan"	Project owner	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
18	Local Conflicts of Interest	Can occur among residents, workers, government officers, and local politicians	Daily activities	Developing an appropriate "land acquisition plan"	Project owner	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
Construction Phase							
1	Air Quality	1) Generation of dust 2) Gas emission by operation of vehicles and equipment during the construction work.	1), 2) - National/local guideline - IFC guideline values for ambient air quality (General/ 2007)	1) Sprinkle the area with water. Covering of loading material on transportation, depending on the route condition 2) Regular maintenance of vehicles and equipment	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Contractor
2	Water Quality	1) Degradation of water quality 2) Impact to aquatic biota	1) Water quality standard 2) Recognition by the local resident	1) Consideration of construction way to heavy rain 2) Stage construction 3) Drilling and stockpiling 4) Strategic distribution of material yard 5) Drainage system	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Contractor
3	Waste	1) Waste from construction 2) General wastes by workers 3) Harmful waste	1) - 3) Waste management guideline	1), 2) Disposal with regular waste collection system Proper disposal of non-recycle waste 3) Consignment with waste disposal sector	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Contractor
4	Soil pollution	1) Discharge of oil and chemical substances	1), 2), 3) Soil quality standard and	1) Proper stock of oil and chemical substances	Contractor/Consultant	1) Kaur local government, environment, life/health, city	Contractor

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
		from construction 2) Improper waste disposal 3) Gas emission and dust from construction	drinking water standard	Countermeasure to infiltration of ground water 2) Prohibition of disposal at improper location 3) Monitoring of ground water from existing well when soil pollution is found.		planning, transportation related department 2) District and associated villages	
5	Noise and Vibration	1) Generation of noise and vibration of construction machinery 2) Generation of noise and vibration from transportation of workers and materials	1), 2) Noise and vibration standard IFC guideline values for noise (General/ 2007)	1), 2) Optimization of construction schedule Construction during daytime Usage of low noise /vibration equipment Traffic control plan Speed limitation	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Contractor
8	Ecosystem	1) Loss of flora 2) Impact to aquatic biota	1) Loss of flora 2) Landslide 3) Complaint from the local resident 4) Transition of aquatic biota	1) Clearing of bushes and tree cutting shall be limited and minimized. 2) Turbid water should not be discharged to the river. 3) Recovery of lost or changed vegetation is considered as much as possible. 4) Regular interview with local resident	Project owner	1) Kaur local government, environment, city planning, transportation related department 2) District and associated villages	Project owner
12	Local economy, such as employment or livelihood.	Involvement of people in the construction activities will increase incomes.	Feasibility of payment to the workers	Recruit local residents as much as possible.	Project owner	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
13	Land use and utilization of local resources	Construction of access road and operator house may change physiographies and land use around the project site.	-----	Construction taking into consideration of existing land contours.	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
14	Water use	Impact to the	General activity of	1) Stage construction	Project owner	1) Kaur local government,	Project owner

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
		downstream area	the user of water	2) Drilling and stockpiling 3) Strategic distribution of material yard 4) Drainage system		environment, life/health, city planning related department 2) District and associated villages	
15	Existing Infrastructure and social service	1) Degradation of aesthetic value of the area 2) Traffic jams caused by increased vehicles during construction	1) Complaint 2) Mobility	1) Guidance to the workers regarding aesthetic arrangement 2) Arrangement of construction machinery 3) Arrangement of excavation equipment 4) Maintenance of access road 5) Provision of access road to the local community	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
18	Local Conflicts of Interest	Impact to social intercommunication	Maintenance of social relationship	1) Prioritization of local community 2) Guidance to workers regarding respect to local culture	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
20	Landscape	Degradation of landscape	Adequateness of activity	Minimize excavation and stock	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
23	Infectious Disease such as HIV/AIDS	Migrate of worker may cause infectious disease.	-----	1) Regular medical check-up at worker's camp 2) Hygiene instruction to workers	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Contractor
24	Work conditions (Including work safety)	1) Labor accidents 2) Diseases caused by air pollutants, water pollutants, and noise of construction work	1) Labor accidents - Handling heavy loads - Working at heights - Electric shocks 2) Environment pollution - Ambient Air Quality Standards	1) Labor accidents - Prepare a manual for labor accident prevention, including safety education and training - Provide workers with appropriate protective equipment such as helmets, depending on the construction way - Install fire extinguishers in fire handling places	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Contractor

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
			- Noise level standards - Waste management rule - IFC guideline value for ambient air quality (General/ 2007) and noise (General/ 2007)	- Inspect and ensure that any lifting devices such as cranes are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the period of construction. - Use equipment that protects against electric shocks. 2) Environment pollution - Observe related standards and provide workers with appropriate equipments such as masks, ear plugs, etc.			
25	Accidents	Traffic accidents	Number of accidents	- Observation of traffic regulations, installation of traffic signs, and education on safe driving - Training safe operation of vehicles. - Informing vehicle schedules to the surrounding villages	Contractor/Consultant	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Contractor.
Operation Phase							
1	Air Quality	1) Exhaust gas from vehicles used for mobilization of equipment and workers 2) Dust from road	1), 2) - Ambient air quality standards - IFC guideline values for ambient air quality (General/ 2007)	1), 2) - Comply of speed limit - Thoughtful consideration to local resident by education to workers and staff	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
2	Water Quality	Improvement of water quality	Ambient water standards	Optimization of maintenance	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
5	Noise and Vibration	1) Generation of noise and vibration by	-----	1) Monitoring of noise and vibration 2)	Project owner	1) Kaur local government, environment, life/health, city planning	Project owner

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
		operation of the plant 2) Generation of noise and vibration from transportation of maintenance materials		- Appropriate planning for traffic control - Speed limitation		related department 2) District and associated villages	
8	Ecosystem	Generation of noise and vibration of vehicles which influence to fauna	-----	1) Monitoring of noise and vibration 2) - Appropriate planning for traffic control - Speed limitation	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
12	Local economy, such as employment or livelihood.	Improvement of income	Working condition Economic condition	Introduction of new job	Project owner.	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
13	Land use and utilization of local resources	Change of land use	Transition of land use	Improved transportation will maintain land use and utilization	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
15	Existing Infrastructure and social service	1) Increased electric power supply 2) Economic growth in the community	1) Electric demand 2) Livelihood pattern	1), 2) Optimization of the operation	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner
17	Misdistribution of benefits and compensation	Misdistribution among residents, workers, government officers, and local politicians	-----	Establishment of consultation section for any grievance	Project owner	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
18	Local Conflicts of Interest	Social jealousy among the local population.	Change of local tradition	Establishment of consultation section for any grievance	Project owner.	1) Kaur local government, environment, life/health, city planning related department 2) District and associated villages	Project owner
20	Landscape	Existence of related facilities.	Degree of cleanliness and aesthetic	Strategic arrangement of materials and equipment	Project owner.	1) Kaur local government, environment, life/health, city planning, transportation related	Project owner

No	Impacts	Sources of Potential Impact	Benchmark	Management Effort	Implementing Organization	Supervision Organization	Cost responsibility
			environment			department 2) District and associated villages	
24	Work conditions (Including work safety)	Potential for accident arising during operation of the facility	Number of accidents during operation of facility.	Regular safety training	Project owner.	1) Kaur local government, environment, life/health, city planning, work related department 2) District and associated villages	Project owner
25	Accidents	Traffic accidents	Number of accidents	- Installation of protective fence - Installation of sign board - Safety training - Informing vehicle schedules to the surrounding villages	Project owner	1) Kaur local government, environment, life/health, city planning, transportation related department 2) District and associated villages	Project owner

4-3-4. Quantitative analysis of emission-reduction

4-3-4-1. Explanation of emission-reduction scheme of GHG

(1) CDM

1) Purpose

The purpose of CDM' is to achieve sustainable development for developing countries, so called host countries (Non Annex I countries), to contribute the ultimate purpose of Kyoto protocol and United Nations Framework Convention on Climate Change, and to support the achievement of numerical goals for Annex I countries(developed countries which are obliged to conduct emission-reduction of GHG). In order to achieve above objectives, emission-reduction projects in which Annex I countries are involved in host country are conducted, and emission credits called CER are issued based on the achieved emission-reduction.

Annex I countries can utilize CER for the achievements of numerical goals of Kyoto Protocol. By enhancing the liquidity with these credits, it can be applied to the framework of market mechanism of international credit emission deals, and as a result, it is possible to decrease the overall costs to achieve the numerical goals.

2) Summary and Structure

CDM has various conditions and considerations, so it is necessary to consider them from the planning phase of projects. Also, various reviews and exemptions are required for CER issuance, and third parties conduct them in a precise manner.

To execute projects, participants create Project Design Document (PDD) which explains important technical and structural information regarding projects. From the contents of PDD, whether CDM is qualifiable or not and the calculation of emission reduction is precise or not are judged and evaluated. This process is called "Validation", and projects which pass "Validation" are registered along with the right procedure through the CDM Executive Board. At the time of project registration, the approval process varies depending on the country even though it is possible to be registered without the involvement of Annex I countries. After registration, project participants execute CDM projects and conduct necessary monitoring to calculate their emission reduction.

Regarding monitoring results, independent reviews are conducted periodically, and the emission reduction by registered CDM projects will be determined later. This process is called "Verification". Designated Operational Entity (DOE) conducts it by following procedures ; Emission reduction amount is verified by giving assurances in writing from DOE based on the verified results. After "Verification", the equivalent amount of CER which DOE verified is issued from the CDM Executive Board. CER are issued after paying CDM operation costs, and then the credit amounts are transferred or distributed to project participants and the Party's accounts.

3) Implementation Status of CDM

As of December 2012, the number of registered CDM projects reached 5,383, and the number of countries where the projects were registered hit 74 . CDM projects in early time were mainly high GWP (Global Warming Potential) projects such as collection and dismantlement of HFC and collection of marsh gas from coal mines and waste dumps. However, the number of CDM projects on renewable energy such as energy conservation, hydro power, and wind power is on the increase recently.

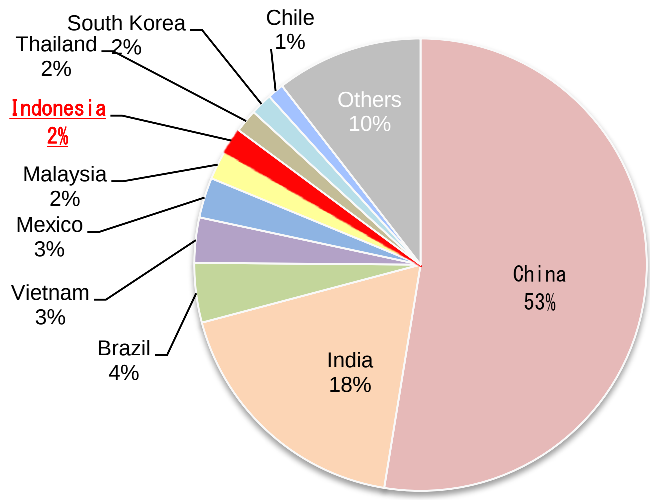


Figure 4-61 Registered Projects by the CDM Executive Board: Breakdown of Host Country

Source：OECC, Kyoto Mechanism Information Platform

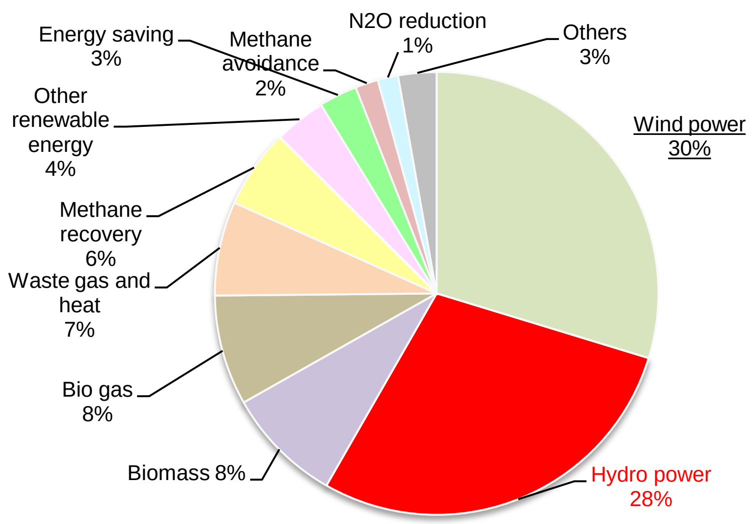


Figure 4-62 Registered Projects by the CDM Executive Board: Breakdown of Sectors

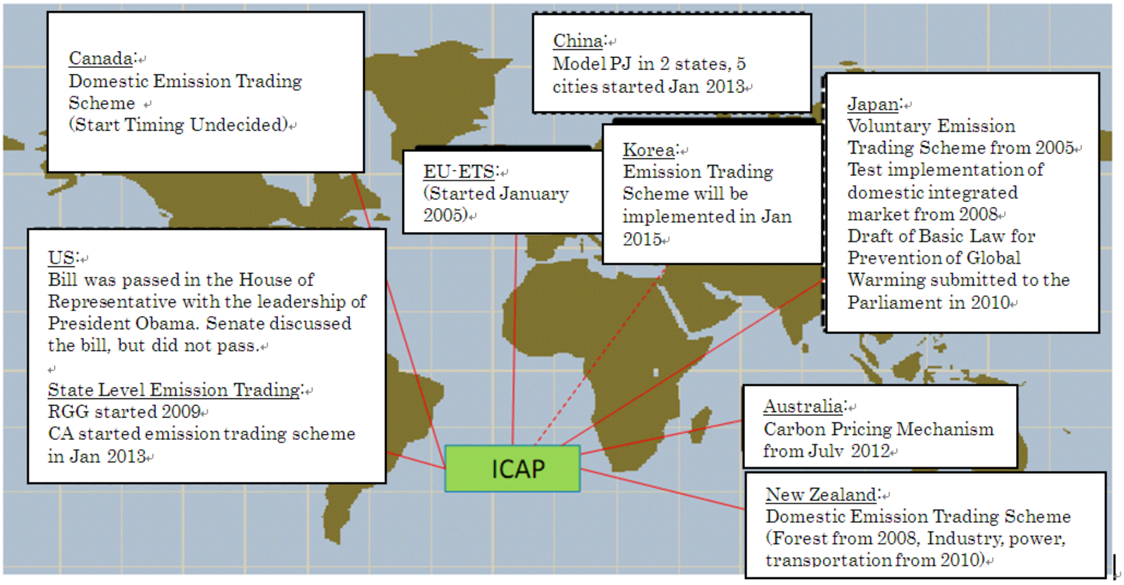
Source：OECC, Kyoto Mechanism Information Platform

Because of various conditions and considerations for CDM projects, there are some risks as such as "Validation Risk" in which the project cannot pass CDM reviews to be "validated". Also, there is "Register Risk" in which the CDM Executive Board does not approve as CDM. In addition, there are "Technical Risk" in which the projects do not produce planned emission reduction due to the technical factor and "Delivery Risk" in which the necessary amounts of emission credits are not delivered despite of execution of emission credit sale's contract. These various risks need to be considered.

(2) Emission Trading Systems except CDM

Main emission-reduction scheme of GHG is currently CDM, and it is mainly used by EU market. However, the introduction of emission-reduction scheme of GHG in countries outside of EU is increasing. Below chart shows the current status of progress and implementation of overseas carbon credit trading. Also, key countries from EU, some states from US and Canada, and New Zealand set up International Carbon Action Partnership (ICAP) and start to create rules which link each country's framework internationally.

Figure 4-63 Progress and Implementation of Overseas Carbon Credit Trading



Source：Ministry of the Environment "http://www.env.go.jp/"

4-3-4-2. Problems of CDM and expectation of structuring JCM/BOCM

(1) Problems of CDM

Regarding CDM applications, many problems are being pointed out, and business operators of small hydro power projects and people involved in global warming countermeasures in Indonesia recognize below problems.

- The application process of CDM is complex and takes time and cost. It does not befit small projects.
- Even though CDM is applied by spending time and cost, current market price of CDM is quite low. The system of CDM is not easy to use. .
- Because of absence of Indonesian DOE and limited number of foreign DOE, there is a long waiting line for reviews.

(2) Problem consciousness toward CDM in Indonesia

In September 2011, Indonesian government drew up National Action Plan which aims at cutting 26% emission of greenhouse effect gas by 2020, comparing with the situation of taking no action (the business as usual situation). At the same time, the task force to check up domestic emission-credit trades was established, and various approaches to achieve the emission-reduction goal are being conducted. In the light of these efforts, it seems that new mechanism which replaces CDM is needed.

(3) Purpose of structuring JCM/BOCM

1) Purpose of JCM/BOCM

To contribute emission-reduction globally, Japanese government proposes JCM/BOCM between two nations to structure a framework of technical transfer and response measures which flexibly keep pace with the conditions of developing countries.

JCM/BOCM quantitatively evaluates Japanese contributions toward the spread and countermeasures of technique, products, service, and infrastructure regarding emission-reduction of GHG in developing countries for its realized emission-reduction. Those contributions will be utilized for the achievements of Japanese emission-reduction goal. Currently, Japanese government and developing countries in Asia are discussing the possibility of JCM/BOCM structure.

2) Expectations toward JCM/BOCM

Some business operators in Indonesia state that it is quite helpful if the process of application in JCM/BOCM can be simple and they can gain some earnings from credits. Compared with CDM, the process of JCM/BOCM is assumed to be simpler, therefore, the scheme of JCM/BOCM is being considered beneficial for people involved in global warming countermeasures and business operators of renewable energy in Indonesia. The meaning of structuring a realistic scheme of JCM/BOCM which meets local business operators' needs is significant to build up the win-win relationship between Indonesia and Japan, which would like to develop global warming countermeasures.

4-3-4-3. Calculation of emission-reduction of greenhouse effect gas in three projects in this preparatory survey

(1) Calculation method of emission-reduction of greenhouse effect gas

The methodology to set up calculations of emission-reductions of greenhouse effect gas by small hydro power generations in JCM/BOCM has not been determined yet. However, the same kind of approach as CDM is assumed to be taken. That is to say, assumed annual emission reduction is calculated as the product of assumed annual electric power supply and Grid's emission factor as follows;

Assumed annual emission reduction ＝ Assumed annual electric power supply × Grid's emission factor

Assumed annual electric power supply is the amount of annual power supply to the grid, and the emission factor of its grid for the calculation is the emission factor that Indonesian government set to each grid. The emission factor of each grid is referred from the below chart.

Table 4-71 Each Grid's Emission Factor in Indonesia

Each Grid	Emission Factor in 2010
Sumatra	0.748
Minahasa-Kotamobagu	0.319
South and West Sulawesi	0.601
Jamali	0.741
Khatulistiwa	0.748
Barito	1.003
Mahakam	0.820
Batam	0.568

Source：National Council on Climate Change, Carbon Trading Mechanism Division Website ”

(2) Calculation of emission-reduction of greenhouse effect gas in three projects in this preparatory survey

1) Assumed annual emission reduction of Nasal project

Assumed annual electric power supply of Tournauli project is 53,753MWh, and its grid emission factor is 0.748t-CO2/MWh. Therefore, assumed annual emission reduction is calculated as below.

40,207tons ＝53,753MWh × 0.748t-CO2/MWh

40,207tons of greenhouse effect gas expected to be reduced from the product of assumed annual electric power supply of 53,753MWh and its grid emission factor which of 0.748t-CO2/MWh.

4-3-4-4. Deliberation to sell emission credit

(1) Concerns regarding selling CDM

Buyers of CDM are limited in effect to players in EU countries. In addition, CDMs which are not registered at this moment cannot be amortized within the scheme of EU. At the same time, the price of CER is currently fluctuating under the price of 0.3 euro per ton. From these reasons, there are many problems in purchase and sale of emission credit by using the framework of CDM. Therefore, it is difficult to sell emission credit from the three projects as CDM.

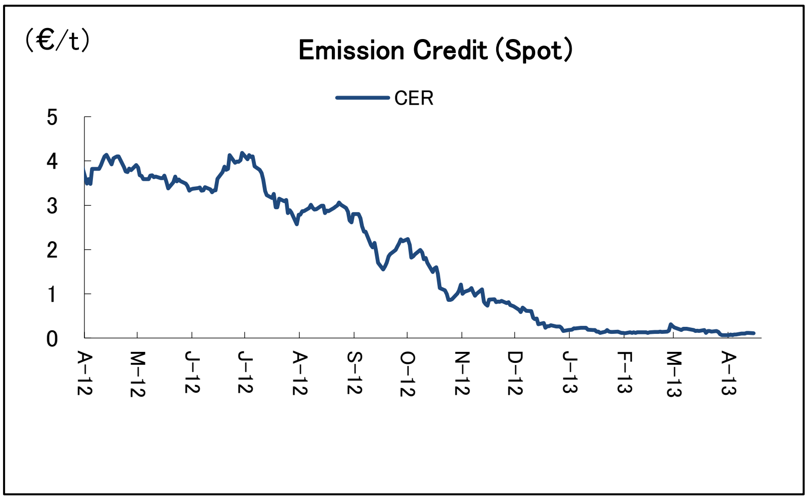


Figure 4-64 Emission Credit's Price Movement in the Last 12 Months

Source：Bloomberg

(2) JCM/BOCM as a new selling method

For now, the framework and prices of emission credit in JCM/BOCM in which Japanese government proposes have some uncertainty. However, it is assumed that Japanese government is a credit buyer in this framework as this scheme is a bilateral one between 2 countries. So JCM/BOCM is expected to be the new form of emission credit trading. The likelihood of introducing the bilateral emission credit trading is enhanced because Japanese government already entered into Memorandum Of Understanding (MOU) with Mongolian and Bangladesh government. The Japanese government is considering entering into MOU with Vietnamese, Indonesian, and Indian governments, and there is a high likelihood that JCM/BOCM scheme is structured in those countries. In this scheme of emission credit trading, the significant amount of emission credit is considered to be sold. If the execution of JCM/BOCM with Indonesian government is realized, it becomes possible to sell emission credit arising from three projects surveyed, resulting in the increase of the profitability of the projects.

4-3-5. Conclusion

The Nasal small hydropower plant is located in Benkulu province, Kaur district, Nasal sub-district, Air Parawan village, South Sumatra.

Area of the planned Nasal micro hydropower plant is mostly covered with shrubs and multi-purpose plantation. The site is located on the left side in the middle stream of the Nasal river. The area is mostly covered with un-maintained second forest and plantation field for mainly coffee production.

The construction of the Nasal micro hydropower plant is estimated to last for over two years and the lifetime of the plant is estimated at thirty years.

This project will cause negative environmental and social impacts, however, all impacts will not be significant. Although land acquisition is necessary for the project, compensation of the loss will be secured. And resettlement of the resident is not occurring. The community is welcoming the project because of its positive impacts.

With proper implementation of the environmental management plan and monitoring plan, the negative impacts will be reduced/minimized, and the positive impact will be maximized.

Chapter.5 Outline of Conditions and Issues in the Finance Mechanism with Energy Fund

5-1. Outline and Purpose of the Fund Establishment

5-1-1. Purpose for utilizing the fund

5-1-1-1. Outline of existing fund

(1) Definition of the infrastructure fund and energy fund

In this report, energy fund is a type of infrastructure funds investing into the energy assets including power plants. Infrastructure fund is categorized as one of the alternative investments along with private equity and real estate as opposed to traditional investments targeting stocks, bonds, and exchange. The characteristics of infrastructure fund are laid out below.

- ✓ Stable return is expected based on the stable cash flow attributed to the characteristics of the infrastructure business
- ✓ Low elasticity of demand and low correlation with traditional assets (stocks, bonds, etc)
- ✓ Risk profile varies depending on the stage of the project development

Table 5-1 Characteristics of Infrastructure Fund Compared to Other Types of Funds

	Infrastructure Fund	Venture Fund	Buy-out Fund	Real Estate Fund
Investment Terms	Super-long (10 year & up)	About 3 years	5 to 10 years	About 5 years
Source of Return	Income gain	Capital gain	Income gain + Capital gain	Income gain + Capital gain
Level of Expected Return	Relatively low but stable income-type return expected	High return can be expected from successful IPO (possible zero return on the other hand)	Reasonable return expected from combination of income gain and capital gain	Relatively low but stable susceptive to macro economy (economic cycle, market demand /supply

The source of return of the infrastructure fund is the income gain from the stable cash flow, often invested for super-long period of more than 10 years. Comparison with other alternative fund is shown in the Table 5-1.

Table 5-2 Infrastructure Assets as Investment Target

Economic Infrastructures	Utility	Power, Renewable Energy, Gas Pipeline, Water and Sewage, Communication, etc
	Transportation	Toll road, Bridges, Tunnels, Airports, Ports, Railways, etc
	Others	Warehouses, Parking, etc
Social Infrastructures		Education Facilities, Hospitals, Prisons, Residential Facilities, etc

Source: OECD report[36]

The assets that infrastructure fund targets are divided into economic and social infrastructures as shown in the Table 5-2. Energy fund targets power, renewable energy, gas pipeline, etc in the utility category of economic infrastructures.

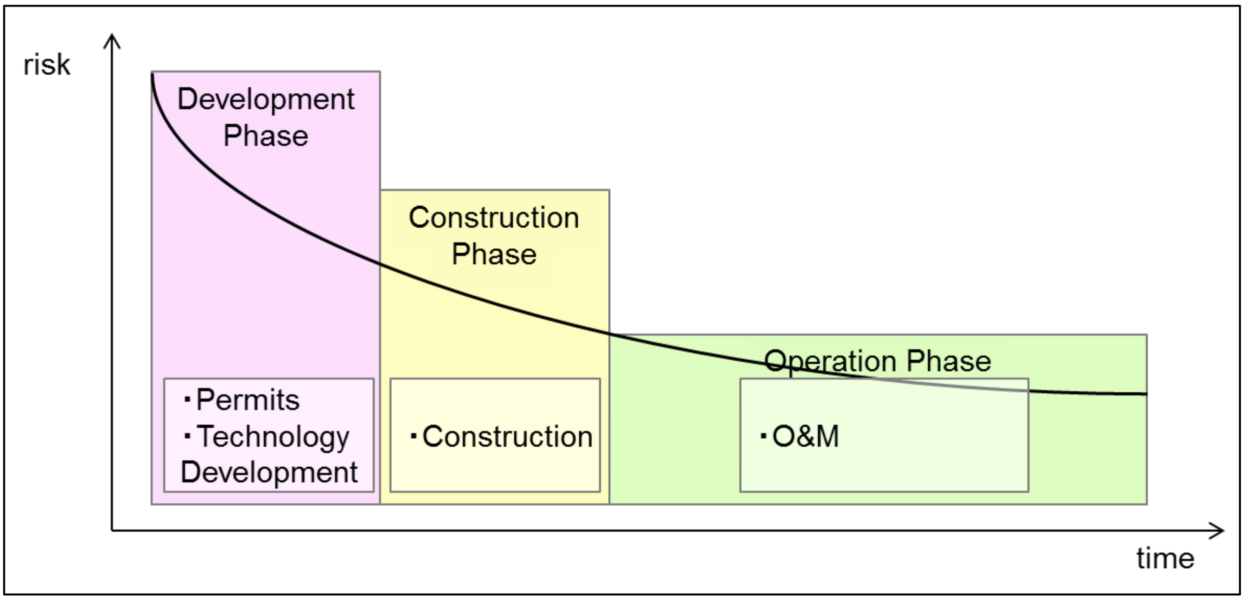


Figure 5-1 Relationship between Development Stages and Risks

Risk of the investment of infrastructure fund or energy fund varies widely depending on the development stage of the investment. In the development phase, risk of not being able to obtain permits and risk of the technology not reaching commercialized level exist while construction phase bears completion risk. Once the construction is completed and operation started, then the risk is relatively low, but the operation risk exists.

36 Inderst, G. (2009), "Pension Fund Investment in Infrastructure", OECD Working Papers on Insurance and Private Pensions, No. 32, OECD publishing, © OECD.

(2) Outline of existing funds

In utilizing funds, there are three perspectives: strategically focusing on particular geographical area, investing into other funds, and focusing on particular area of investment targets. Therefore, the same perspectives are used in outlining existing energy funds.

In terms of targeted geographical area, there are four categories: global, multiple regional, single regional, and nation focus.

- Asia Pacific (India, China)
- Asia Pacific (Southeast Asia)
- Asia Pacific (South Korea, Australia, Others)
- North America
- Central and South America
- Europe (including Russia)
- Middle East
- Africa

From investor's perspective, when the fund invests into other funds, diversification is enhanced at the expense of transparency of invested portfolio. If the investors have strategic purposes in relation to investees such as co-investment, it would be better to select funds that do not invest into other funds.

Funds are also categorized whether it is focused on energy or not. More detailed analysis should find funds with focus on renewable energy or new energy including technology development. However, detailed categorization will not be used in this report as it is sometimes difficult to make a clear line between these two categories. From the perspective of utilization of the fund, it will be necessary to invest sizable amount against the fund size in order to have an influence on the fund concept. In this report, funds with following characteristics are in the scope: fund size is USD 500m or lower, finished fundraising in the year 2009, and some investment activities are already conducted. Existing funds are laid out below with categorizations by area of investment and geographical area.[37]

[37] In this report, existing fund data are taken from Tim Friedman, "The Preqin Infrastructure Review 2009", and additional fund information is complemented for case studies.

1) Asia Pacific (India, China)

Table 5-3 Asia Pacific Funds (India and China)

Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71) Koenig&Cie (M, 33)	HCP FF I (G, 43) HCP FF II (G, 48)
	No	Old Lane India (N, 475) IDFC Private Equity (N, 418) Macquarie Global II (G, 381) Macquarie Global III (G, 292) Asian Infrastructures (M, 234) India Development (N, 174) Pareto WW Offshore (G, 127) Israel Infrastructure I (G, 109) AIG Indian Sectoral (N, 105) AMPCI Infra (N, 97) IFC Infra (M, 95) Srei Venture (N, 9)	Reliance Energy India (N, 190) Mistral Energy II (G, 104)
		Not Focus on Energy	Focus on Energy
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

In this survey scope, there are some nation focused funds in India. Reliance Energy India is the only energy focused fund among them, established by the Indian infrastructure conglomerate Reliance Group. Its investment targets include companies and projects related to power generation, transmission, and distribution. The Reliance Group, which has a power company, established the fund taking 10% - 30% minority stakes in principle. The fund is invested by the Temasek Holdings, an investment company owned by the Government of Singapore.

2) Asia Pacific (Southeast Asia)

Table 5-4 Asia Pacific Funds (Southeast Asia)

Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71) Koenig&Cie (M, 33)	HCP FF I (G, 43) HCP FF II (G, 48)
	No	Saratoga Asia II (R, 429) Macquarie Global II (G, 381) Macquarie Global III (G, 292) Asian Infrastructures (M, 234) Saratoga Asia I (R, 144) Pareto WW Offshore (G, 127) Israel Infrastructure I (G, 109) IFC Infra (M, 95)	Southeast Asia Strategic Assets (R, 150) Mistral Energy II (G, 104) Asia Clean Energy Fund (R, 85) Mekong Brahmaputra Clean Development Fund (R, 45) JAIC-IDI Asian Energy Fund (R, 10)
		Not Focus on Energy	Focus on Energy
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

Compared to other areas, there are few funds with geographical focus in the Southeast Asia, indicating that the area is in the earliest days of the infrastructure fund. On the other hand, establishment of the Southeast Asia Strategic Assets Fund managed by the Malaysian CIMB Group should receive a particular attention as energy focused infrastructure fund in Southeast Asia with USD 150m size.

3) Asia Pacific (South Korea, Australia, Others)

Table 5-5 Asia Pacific Funds (South Korea, Australia, Others)

Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71) Koenig&Cie (M, 33)	HCP FF I (G, 43) HCP FF II (G, 48)
	No	Macquarie Korea Opportunities (N, 886) Korea Emerging Infrastructure (N, 423) Macquarie Global II (G, 381) Macquarie Global III (G, 292) Asian Infrastructures (M, 234) Macquarie Global (M, 230) Santander Infrastructure I (M, 185) Pareto WW Offshore (G, 127) Israel Infrastructure I (G, 109)	Mistral Energy II (G, 104)
		Not Focus on Energy	Focus on Energy
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

There was no energy focused fund limiting geographical area of investment to South Korea or Australia. Investments in energy assets in these countries are made as one of the investment areas of infrastructure funds with regional or nation focus.

4) North America

Table 5-6 North America Funds

<table>
<tr><td rowspan="2">Invest to other funds</td><td>Yes</td><td>SOPEP Infrastructures (G, 345)
Capital innovations FF (G, 143)
Syndicated Access FF (G, 71)
Koenig&Cie (M, 33)</td><td>Sterling Stamos II (R, 475)
UBS AFA Global (M, 345)
Sterling Stamos I (R, 190)
Tuckerbrook II (R, 143)
Tuckerbrook I (R, 52)
HCP FF I (G, 43)
HCP FF II (G, 48)</td></tr>
<tr><td>No</td><td>Innisfree PFI III (M, 540)
Macquarie Essentia Assets (M, 414)
Highstar Capital (R, 386)
Macquarie Global II (G, 381)
Macquarie Global III (G, 292)
Macquarie Global I (M, 230)
Santander Infrastructure I (M, 185)
Pareto WW Offshore (G, 127)
Israel Infrastructure I (G, 109)
Infrastructure & Environment (N, 95)</td><td>URSG Power & Biofuels II (N, 451)
Starwood Energy (G, 411)
Energy Spectrum IV (N, 335)
US Power (N, 238)
Energy Spectrum II/III (N, 178)
Energy Spectrum I (N, 133)
Mistral Energy II (G, 104)
DREAM Infrastructure (R, 95)</td></tr>
<tr><td></td><td></td><td>Not Focus on Energy</td><td>Focus on Energy</td></tr>
<tr><td></td><td></td><td colspan="2">Area of Investment</td></tr>
</table>

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

In the North America, there are many infrastructure funds including ones with energy focus. This can be because of its history of the utilization of infrastructure funds from early days. In the United States, system design of the industry contributes to high liquidity of power assets and in turn sets up the environment where energy focus funds have opportunities to grow. Lastly, energy focus funds in the U.S. are not concentrated on the new energy as it is the case in the Europe.

5) Central and South America

Table 5-7 Central and South America Funds

		Not Focus on Energy	Focus on Energy
Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71)	HCP FF I (G, 43) HCP FF II (G, 48)
	No	Macquarie Global II (G, 381) AG Angra (Brazil) (N, 349) Macquarie Global III (G, 292) Macquarie Global I (M, 230) Santander Infrastructure I (M, 185) Darby Brazil (N, 194) Darby Latin America (R, 186) Pareto WW Offshore (G, 127) Israel Infrastructure I (G, 109) IFC Infra (M, 95)	Latin Power III (R, 372) Latin Power II (R, 149) Mistral energy II (G, 104) Latin Power I (R, 95)
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

In the Central and South America, Conduit as general partner (GP) manages three Latin Power funds that focus on this area and energy. Conduit is the unique GP managing energy funds successfully.

Investment size the Conduit's funds target range from USD 60m to 1b in terms of the project total cost. Many projects are co-invested with the local and other sponsors, but targeting shares of 51% or more. For the development stage of the project, Conduit develops the green field projects or acquires operating assets. It focuses on projects in a region which have high economic growth expectation and high creditworthiness of off-takers.

6) Europe

Table 5-8 European Funds

Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71) Koenig&Cie (M, 33)	UBS AFA Global (M, 345) HCP FF I (G, 43) HCP FF II (G, 48)
	No	Innisfree PFI III (R, 540) Innisfree PFI Continuation II (R, 525) AIG Emerging Europe Infra (R, 499) NIBC European Infra (R, 399) Innisfree M&G PPP (R, 338) Innisfree PFI Continuation I (R, 338) AIG Brunwick Millenium (R, 334) Macquarie Global II (G, 381) Macquarie Global III (G, 292) Macquarie Global I (M, 230) Innisfree PFI II (N, 225) Santander Infrastructure I (M, 185) Great Circle Fund (M, 181) DG Infra + (N, 155) PPP Italia (N, 138) Innisfree PFI I (128) Pareto WW Offshore (127) Barclays UK (110) Israel Infrastructure I (109)	Fortis Clean Energy (M, 460) European Clean Energy (R, 407) Ampere Equity (R, 368) Hg Renewables Power (R, 345) Englefield Renewables (N, 230) DIF Renewables (R, 155) Impax New Energy Investors (N, 144) EnerCap Power (G, 113) Eolia Mistral (G, 109) Enfia Infrastructure I (N, 104) Mistral Energy II (G, 104) Taiga inversións (N, 85)
		Not Focus on Energy	Focus on Energy
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

Many infrastructure funds with energy focus have been established similar to North America. In this area, infrastructure investments by the fund started from early days, since 1990s, and M&A in the industry has been relatively active. One unique point of the energy funds in this area is that compared to the North America, many of energy funds limit investment concentration in new energy business.

7) Middle East

Table 5-9 Middle East Funds

Invest to other funds	Yes	SOPEP Infrastructures (G, 345) Capital innovations FF (G, 143) Syndicated Access FF (G, 71)	HCP FF I (G, 43) HCP FF II (G, 48)
	No	Macquarie Global II (G, 381) Macquarie Global III (G, 292) Alcazar Capital Partners (M, 285) Zanes Corp Infrastructures (N, 250) Macquarie Global (M, 230) Santander Infrastructure I (M, 185) Great Circle Fund (M, 181) Pareto WW Offshore (G, 127) Israel Infrastructure I (G, 109)	GCC Energy Fund (R, 345) Mistral Energy II (G, 104)
		Not Focus on Energy	Focus on Energy
		Area of Investment	

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

Infrastructure building has been accelerated during the past years in the Middle East, and infrastructure funds became one of the venues for infrastructure investments. However, there are few funds focused on the Middle East area, and the funds usually include Africa or Asia as their investment target. For example, Alcazar Capital Partners includes Sub-Sahara African and CIS countries in addition to the Middle East as its investment area.

8) Africa

Table 5-10 Africa Funds

<table>
<tr><td rowspan="2">Invest to other funds</td><td>Yes</td><td>SOPEP Infrastructures (G, 345)
Capital innovations FF (G, 143)
Syndicated Access FF (G, 71)</td><td>HCP FF I (G, 43)
HCP FF II (G, 48)</td></tr>
<tr><td>No</td><td>AIG African Infrastructures (N, 388)
Macquarie Global II (G, 381)
Macquarie Global III (G, 292)
Alcazar Capital Partners I (M, 285)
Macquarie Global I (M, 230)
Pareto WW Offshore (G, 127)
Israel Infrastructure I (G, 109)
Moroccan Infra (N, 100)
IFC Infra (M, 95)</td><td>GCC Energy Fund (M, 345)
Mistral Energy II (G, 104)</td></tr>
<tr><td></td><td></td><td>Not Focus on Energy</td><td>Focus on Energy</td></tr>
<tr><td></td><td></td><td colspan="2">Area of Investment</td></tr>
</table>

Legend: <Geographical Target> (G) Global, (M) Multiple Areas, (R) Single Geographical Area, (N) National Focus

Note: Figure in ( ) is fund size in million USD

There are some infrastructure funds with regional focus including Africa, though not many. However, most of the funds are not only Africa focus but also includes Middle East or other emerging countries as their investment focus. This may be because of the high country risk associated with the African countries giving difficult time to infrastructure funds that are characterized as relatively low risk assets. Yet, there are a few funds with focus on country with relatively low country risk such as South Africa. Infrastructure investments in Africa have started not long ago, and thus are still limited to particular country or region.

As explained above, small to medium size energy focused funds of USD 500m or lower are often found in the North America and Europe, On the other hand, in the emerging markets such as the Middle East, Africa, and Southeast Asia, regional focused small to medium size energy funds have just started to be established, possibly in response to investment opportunities arisen from the deregulation.

Characteristic of the investment area is that there are many funds focused on new energy in Europe, mostly promoting new energy installation. In the Southeast Asian funds, there is Vietnamese fund focusing on hydro development in the Mekong River area. Development policies of particular country or international society seem to have impacts on the type of energy fund that have been developed.

In the emerging countries, small to medium size energy funds with regional focus have just started to be established. Such funds source projects in independent networks based on many investment opportunities from deregulation. Such projects are mostly club deal type requiring local network and sponsor risk is usually high compared to the big projects. On the other hand, by handling the project "bilaterally", cutting off competitors, there are chances for a high expected return.

5-1-1-2. Europe/US/Southeast Asian Fund Case Study

(1) Taiga Mistral (Europe)

Taiga Mistral is the fund management company managing a fund focusing on developing countries' specific type of projects in energy in Europe. The company was established in 2007 as the wind farm fund management company establishing Polish wind farm focus fund (Taiga Poland I) and Spanish wind farm and solar focus fund (Taiga III) ever since. Currently, Taiga Mistral manages about EUR 200m assets including more than 190MW wind farm assets. The company's funds are unique in a sense that it is focused in particular country and utilizes management networks and knowhow.

Marta Fernández, former marketing manager at the major European wind farm developer Gamesa Energie in charge of Poland, Bulgaria, and Romania, and Mikel Garay, former Acciona Energia in charge of Poland were the core members providing Polish networks from its initiation.

Table 5-11 Major Members of Taiga Mistral

Name	Background
Antonio Tuñón	Director at power companies such as OMEL, chairman of CEO at CVC (Investment Fund) and established Taiga Mistral
Mikel Garay	Acciona Energia S.A (European major wind farm company) in charge of Poland, and joined Taiga Mistral
Cristina Tuñón	UBS Wealth Management (Asset management company), and joined Taiga Mistral

Source: Taiga Mistral Website

Taiga Mistral seems to utilize business experience of the management rather than financial background, and targets value addition to the project utilizing experience and knowhow on power project development.

> *"Once Taiga Mistral is in charge of the management and administration of a farm, the management team must carry out an initial study and analysis of the situation and its background. <u>Taiga Mistral will carry out a comprehensive analysis of the wind farm's operation contracts with the dual aim of optimising costs and controlling the scope of all the</u>*

services provided to the farm, and will make use of the economies of scale to join suppliers and lower costs wherever possible, thus improving the project's expected profitability."[38]

As its investment policy, green field projects before commercial operation date (COD) are targeted. 41.4MW Kobylnica project and 8MW Radostowo project have reached COD by now. European Bank for Reconstruction and Development (EBRD) has committed to invest 20% of total fund size of Taiga Poland II based on the track record of bringing wind farm green field projects to COD in Poland. EBRD plans to utilize the fund's sourcing ability in Poland to promote development of the wind farm projects in the country through investing into the fund. It also seems to intend to transfer technology to the invested projects.

Project Description

The EBRD is considering making an equity investment of up to €20 million in Taiga Poland II SICAR ("TP II" or the "Fund"), a private equity investment fund to be registered as a partnership limited by shares under the laws of Luxembourg.

The Fund will seek equity and equity-related investments in the development and construction of wind power projects in Poland, with the aim to bring such projects to successful commissioning of operation. TP II will have a similar investment focus to the precedent fund, Taiga Poland I, and will benefit from the already existing platform and pre-identified potential target projects.[39]

Transition Impact

The transition impact and demonstration effects of the proposed project are expected to be achieved by the:

(a) support of the development of the private equity for the energy sector, particularly for the renewable energy sector in Poland;

(b) expansion of the financial intermediation for the Polish energy and renewable energy sectors;

(c) transfer of the relevant technical and operational skills set to the investee projects;

(d) promotion and enhancement of high standards of corporate governance and integrity in the investee projects[40]

(2) Energy Spectrum (US)

There are some nation focused energy funds in the United States. Energy Spectrum Capital (ESC) receives particular attention as a unique fund management company utilizing its expertise. ESC was established in 1996 as a private equity management company targeting mid to upstream energy assets.

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38 Abstract from the website of Taiga Mistral
39 Abstract from the EBRD website
40 EBRD Website

Currently ESC manages USD 230m, targeting medium size oil and gas refineries, production, storage, and transporting facilities. Size of the investment projects range from USD 25m to 100m. Stages of the project targeted are greenfield with potential growth or expansion, pursuing capital gain as private equity.

ESC is unique in a way that it utilizes knowhow of the energy fund focusing on oil and gas. Founding members established Energy Trust Partners to invest into the upstream asset, and also established Energy Spectrum Advisors that is the advisory arm of the group. Therefore, Energy Spectrum Group consists of one advisory company and two private equity management companies.

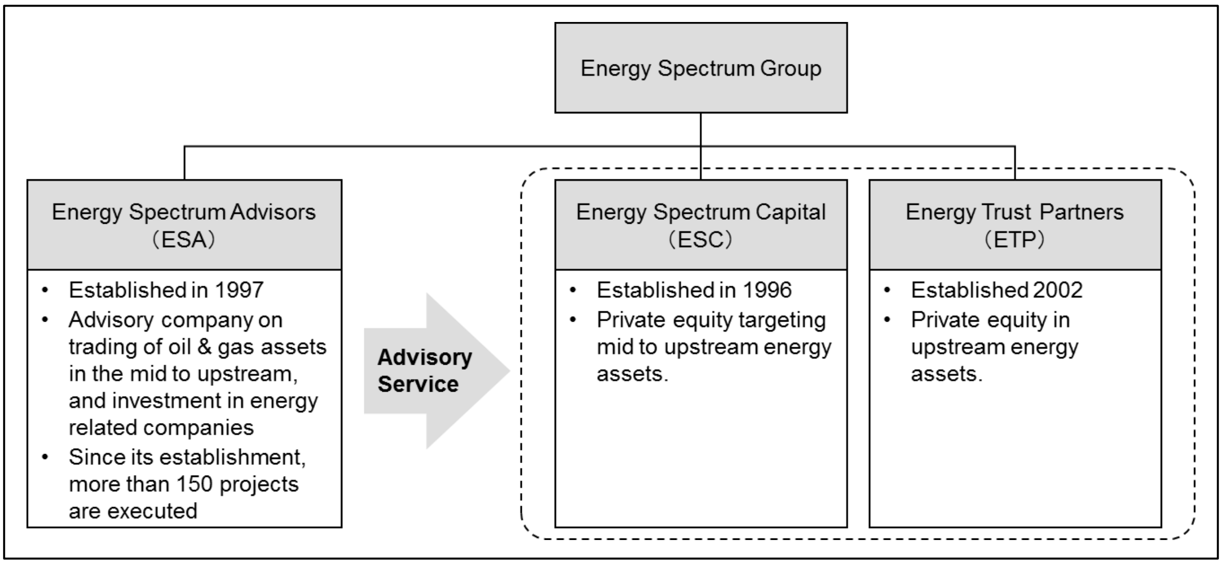


Figure 5-2 Vehicles of Energy Spectrum Group

There are some cases where management positions are concurrently served by the same person across the three companies, thus they seem to be co-managed as a group. Energy Spectrum Advisors may be involved in the investment, additional acquisition after the investment, or selling the assets by the Energy Spectrum Capital and Energy Trust Partners. Management of Energy Spectrum Capital has extensive network in oil and gas industry, but establishing advisory firm shall make it possible to capture more deal opportunities and accumulate experiences and knowhow.

Table 5-12 Management Members of Energy Spectrum Capital

Name	Background
Thomas O. Whitener, Jr.	After InterFirst Bank Dallas, Dean Witter Reynolds, R. and Reid Investments, established Energy Spectrum. Extensive experience on energy investments for long term.
James P. Benson	After InterFirst Bank Dallas and R. Reid Investments, established Energy Spectrum. Long term experience in

	investment and M&A in the energy sector.
James W. Spann	After CIGNA Private Securities, established Energy Spectrum. Extensive track record and knowhow in mainly oil and gas investments and M&A business.
Leland B. White	After R. Reid Investments and InterFirst Bank Dallas, established Energy Spectrum. Extensive track record and knowhow in mainly oil and gas investments and M&A business.
Peter W. Augustini	After Metropolitan Life Insurance, Atlantic Richfield, McKinsey & Company, joined Energy Spectrum Capital in 2004, giving strategic planning and monitoring business of the investees.
Benjamin H. Davis	After R. Reid Investments, joined Energy Spectrum Capital 2006, marketing oil and gas industry with his extensive industry network

Source: Energy Spectrum Capital Website

Co-management of the three entities under the group platform may be contributing to Energy Spectrum Capital's good judgment on investment project and value up capability after the investment.

(3) South East Asian Strategic Assets Fund（SEASAF） (Southeast Asia)

SEASAF is the energy fund in the Southeast Asia that also focuses on the region. Malaysian financial group, CIMB Group, and South African Standard Bank formed the South East Asian Strategic Assets as JV in 2006. In the next year, it created South East Asian Strategic Assets Fund (SEASAF) by co-investment with the Employees Provident Fund of Malaysia. In addition, Asian Development Bank (ADB) invested in 2009, and CIMB bought shares of Standard Bank in 2011. In 2012, CIMB sold its 60% shares to the new JV partner, Rohatyn group, changing JV name to CapAsia.

Investment areas of the fund are energy, infrastructure, and natural resources. Geographical focus is mainly Malaysia and Indonesia, followed by Singapore, Thailand, Brunei, Myanmar, Lao, Philippines, Cambodia, and Vietnam. It seems to balance countries that have established their positioning as emerging countries and countries that future growth is expected. Basically, the fund opts for operating assets producing stable and assured cash flow, limiting development risk and construction risk. However, in some countries the fund invests to the green field projects.

5-1-1-3. Purpose and Effects of the Fund Utilization

In the case studies of the fund, EBRD has made a commitment to Taiga Mistral which focused on Polish wind farm. As already mentioned above, EBRD seems to highly evaluate the fund as having capability to source wind farm projects, having experience and knowhow to support development and operation that will contribute to promoting domestic wind farm projects in Poland.

Many of the renewable projects are small to medium size. Targeting this kind of projects that the investment banks or the major funds do not or cannot approach, the fund may have more possibility to bring it to the bilateral negotiation without competitions. Although in many cases, the sponsor risk is relatively high, but less competition means less option for the counter-party. Therefore, by understanding the needs of the counter-party, it may be possible to keep the acquisition price low and make investment. The project of this size often come from club deal, thus the fund's sourcing ability will be the key. High sourcing ability stems from the network in the country, the region, and the particular industry or business area. In the case of Taiga Mistral, EBRD is supposed to have made a decision to support the fund based on the following facts: Taiga Mistral's first fund has track record of investing in multiple wind farm projects in Poland, it already has existing network in the market, and it already has project pipelines. By supporting the fund that is able to access small to medium size projects through club deal, it would be possible to make investments to good projects.

As the purpose and effect of the fund utilization, development and operation support by the fund with experience knowhow and experts may contribute to the higher probability of completion and safe operation of the project. Therefore, such fund that does not only provide finance and conducts financial monitoring but also supports project owners in its business, tends to be utilized. Especially for the project development in the developing countries, in addition to the finance, technologies are in need. Thus, it is expected that the fund utilization alleviates business risk by playing not only financing function but also transferring technology and business knowhow, or providing business support function.

5-2. Outlines of Investment Policies and Investment Area

5-2-1. Investment Policies and Investment Area

5-2-1-1. Type of Generation/Business Size

The Indonesian government installed FIT on renewable energy projects of 10MW or lower. The government designed FIT in a way that depending on the area and connected grid voltage, the price is different giving incentives for much needed area. It is also possible to sign long-term PPA without price negotiation with PLN.

Table 5-13 FIT Pricing Structure

System	Hydro Wind Solar Power etc. (<10MW)		Biomass (<10MW) (*)		Thermal
	Moderate Pressure (Rp/kWh)	Light Pressure (Rp/kWh)	Moderate Pressure (Rp/kWh)	Light Pressure (Rp/kWh)	High Pressure (USD/kWh)
Java, Madura, Bali	656	1,004	975	1,325	9.7cent ⇒11〜15cent
Sumatera, Sulawesi	787	1,205	1,170	1,590	
Kalimantan, Nusa Tenggara	853	1,305	1,268	1,723	
Maluku, Papua	984	1,506	1,463	1,988	

Source: The Regulation of Ministry of Energy and Mineral Resources No. 31 Year 2009

(*) The price varies if final disposal technology is used.

For geothermal that has underground resource risk, FIT price is USD base, and the price is higher preferentially than other generation types. Among small scale projects of hydro, solar, and biomass eligible for FIT, underdeveloped biomass though high potentiality receives higher price preferentially as below table shows.

For the small hydro, the FIT price is low compared to biomass and geothermal, but the development record of the hydro as a whole is relatively high. This can be explained by its lower generation cost due to no fuel cost comparing to biomass and relatively lower development cost comparing to geothermal.

Table 5-14 Development Potential of Renewable Energy in Indonesia (2011)

NO	NEW/RENEWABLE ENERGY	RESOURCES (RS)	INSTALLED CAPACITY (IC)	IC/RS RATIO
1	2	3	4	5 = 4/3
1	Hydro	75.670 MW	6.654,29 MW	8,79 %
2	Geothermal	29.038 MW	1.226 MW	4,22 %
3	Mini/Micro Hydro	769,69 MW	228,983 MW	29,75 %
4	Biomass	49.810 MW	1.618,40 MW	3,25 %
5	Solar	4,80 kWh/m²/day	22,45 MW	-
6	Wind	3 – 6 m/s	1,87 MW	-
7	Uranium	3.000 MW (e.g. 24,112 ton) for 11 years*)	30 MW	1,00 %

Source: Directorate General of New Renewable Energy and Energy Conservation

Hydro power can be used as base load, operating 24 hours a day, same as nuclear power, thus it is expected to provide power to the area where few large size thermal power plant is built because of its power demand size. Given the conditions above, small hydro projects that are in the scope of this survey meet the requirements of the investment target of energy fund because small hydro projects 1) are able to sign long-term PPA based on the FIT system, 2) have high development potential, and 3) have high social meaning thanks to stable power generation.

Size of the project targeted will be 10MW or lower as it meets the requirement of adopting FIT for long-term PPA with PLN. With the long-term fixed price power purchase agreement, unless the power plant is shut down for a long time due to the equipment failure, etc, stable cash flow can be expected. It is very meaningful to support small hydro growth financially for meeting power demand of surrounded areas, especially in Sumatra and Sulawesi where the electrification rates are low but have rivers with rich water flow. Therefore, as investment policy of energy fund in Indonesia, having high potential small hydro power projects of 10MW or lower as main target and consider larger size hydro, and other types of renewable energy such as geothermal and biomass as complementary investments.

5-2-1-2. Stage of Development

In the stage of development, as already noted, there are mainly three types: “Development Phase”, “Construction Phase”, and “Operation Phase”. Merits and demerits of each phase are outlined below table.

The risk is limited in the later stage projects, but the cost of acquisition is increased giving low return in general, which creates low risk low return investment. On the other hand, the risk of failing a project is increased in the earlier stage projects, but it may be possible to invest equity at par value in some cases, creating high risk high return investment.

Table 5-15 Merits and Demerits in Each Development Stage

Development Stage	Merits	Demerits
Development Phase	Many investment opportunities Relatively low acquisition cost Possible high return Wider scope of possible involvement in the development process	Relatively high possibility of failing projects on the way due to permit issues, etc
Construction Phase	Possible involvement in construction and engineering	Completion risk and risk of cost overrun
Operation Phase	Low risk of failing on the way as it is already completed and operating	High acquisition cost due to low risk of project failing

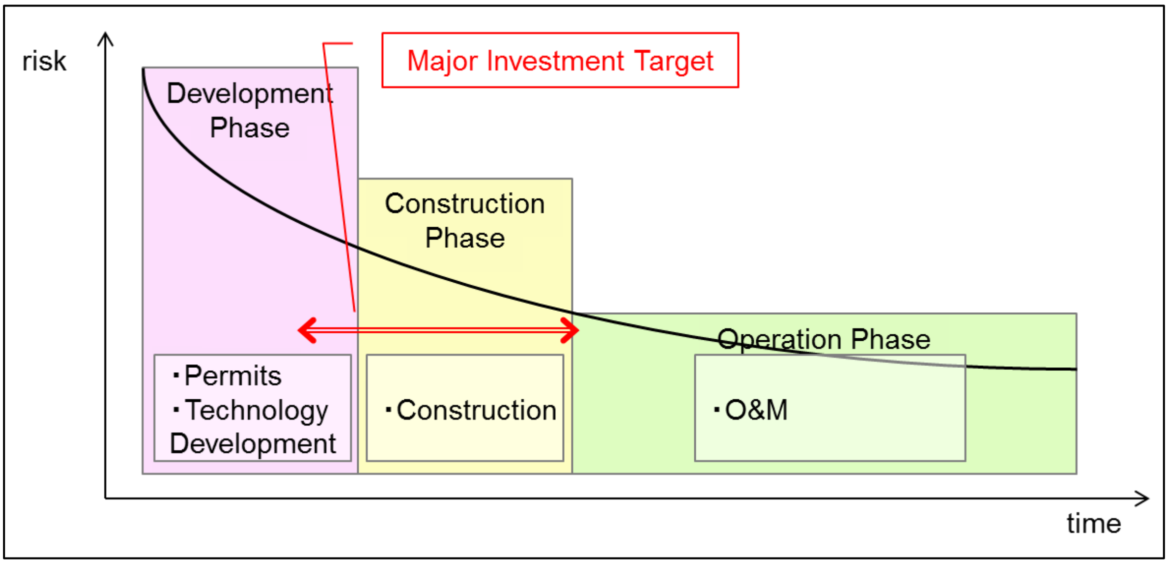


Figure 5-3 Development Stages and Investment Target

It is around 2012 when FIT system was in place and development of small renewable energy projects started to move forward, thus most of the projects are still in the development phase. One of the purposes of utilizing the energy fund is supposed to be to support the development of the projects in the country, thus projects in development phase are the primary target. If projects in the development phase have already obtained major primary permits: the Research Permit, Location Permit, and MOU with PLN on the power purchase, risk is somewhat mitigated for investment consideration. However, it will be a requisite condition to have signed PPA with PLN in order to consider financing terms.

In near future, there may be a project interrupted in the middle of construction with cost overrun especially with technical problems. It will be worth considering to support this kind of project in technical issues by the Japanese technical consulting company and in financial issues by the energy fund.

5-2-1-3. Development Area

In Indonesia small hydro potential is widely spread instead of disproportionately located in the particular island. Yet, it is necessary to consider the FIT price difference as discussed above. In the Java-Bali grid, purchase price is relatively low at Rp.656/kWh, giving difficult time to keep positive cash flow. On the other hand, in Sumatra and Sulawesi where many potential sites with rich water flow exist, the potential is high due to the purchase price that is 20% higher than Java-Bali. Kalimantan and Papua's hydro potential is also high, but there is not much track record of projects being developed. It seems to be realistic to focus on Sumatra and Sulawesi for the project development. However, if the project is considerable in both technical and financial perspectives, then anywhere in Indonesia shall be considered for investment.

5-2-1-4. Conditions on Project Developers

In considering making investment, it is preferable that the developer of the potential investee have small hydro development experience. However, there are not so many developers with small hydro business experience. In reality, it is recommended that the energy fund supports in this respect for developers who have some kind of knowhow or experience that are related to the small hydro business.

There are many local companies that have accumulated wealth from construction, mining, plantation or other businesses who try to enter into the small hydro business after FIT was installed. Some developers have advantage of being able to proceed with the land acquisition without problem based on the existing relationship with the locals through its main business.

Some construction companies that usually worked on the power projects as contractors sometimes develop their own project and conduct construction work as well. Since the completion risk in small hydro is sizable, even in the case construction companies do not provide the service for their project, it will alleviate some risk as they can be a backstop once risk becomes imminent.

On the other hand, developers with operational experience in power business will be able to utilize their knowhow in O&M after COD. There are some cases that coal fired power developers or plantation owners with biomass power project development experience come into the small hydro business. This kind of power business background will be evaluated positively in selecting project developers as the investee.

In sum, it is preferable for the developers to have some kind of knowhow related to the small hydro business in selecting the investees. For example, construction knowhow for hydro, experience in obtaining permits for mining or plantation, and power generation knowhow from coal fired power plant or biomass power plant can be utilized in small hydro business, mitigating some risks.

5-2-1-5. Summary

Based on the discussion above, the scope of small hydro investment can be summarized below.

Table 5-16 Scope of Small Hydro Investment

1. Scale of Project	✓ Up to 10MW, that is in the range of FIT is considerable.
2. Development Phase	✓ Research Permit, Location Permit, and MOU with PLN is considered as a pre-requisite condition. ✓ However, it is a precondition that PPA with PLN is already obtained at the timing of the full-scale financing consideration.
3. Development Area	✓ If the project is technically and financially feasible, projects in any part of Indonesia can be considerable. ✓ In the early phase, Sumatra and Sulawesi will be the primary target.
4. Conditions on the Developers	✓ It is required to have some kind of expertise related to small hydro projects. ✓ It is desirable to have the track record in hydro project business, contractor work experience, or power business expertise.

For the investment into other types of renewable energy, geothermal and biomass power projects can be in the scope of target. Project size of the geothermal power is often more than 50MW that is much bigger than the small hydro projects. Thus it is necessary to take cautious steps in order not to lose balance in the portfolio with heavy geothermal. Biomass is usually the same scale as small hydro as the Government of Indonesia gives incentives to the projects of 10MW or lower.

5-2-2. Portfolio Building

In building portfolio of the energy fund, perspectives in project scale, development stage, development area, developers are outlined below.

5-2-2-1. Project Scale

In the small hydro business, basically scale of economy works. There is no strong reason to diversify the project scale in the portfolio. Especially projects below 5MW are usually less competitive in the sourcing stage. If project cost is managed to be low, then this size can also become a target for the fund. However, projects close to 10MW are desirable based on the investment efficiency.

5-2-2-2. Development Stage

Among the three development stages: “Development Phase”, “Construction Phase”, and “Operation Phase”, main target will be the later stage of “Development Phase”. Depending on the situation, “Construction Phase” with financial needs may also become primary target. If 1) investors desire low risk low return stable income gain, and 2) liquidity of operating assets is increased, then acquiring projects in “Operation Phase” for the energy fund portfolio can be considered as this will mitigate development risk and completion risk.

5-2-2-3. Development Area

In Indonesia, as discussed earlier, the hydro potential is widely spread, making it possible to diversity development area. Merits and demerits of geographical diversification are laid out in the below table.

Table 5-17 Merits and Demerits of Development Area

	Merits	Demerits
Same Area	Mitigate monitoring cost Possible utilization of relationship with local government/governor	Limited sourcing opportunities
Multiple Area	Many sourcing opportunities	Increased monitoring cost Necessary to find new local partner in the new area

5-2-2-4. Project Developer

There are many new entrants in the Indonesian small hydro business. Effects of diversifying project developers in the portfolio are outlined in the below table. By diversifying project developer, DD cost and partner risk will be affected. By investing into multiple developers' projects and supporting their pipeline projects, potentially DD cost can be mitigated and good project pipelines can be secured.

Table 5-18 Merits and Demerits of Developers

	Merits	Demerits
Single Project Developer	DD cost of the partner reduced	Partner risk concentrated
Multiple Project Developer	Partner risk diversified	DD cost for the partner is increased

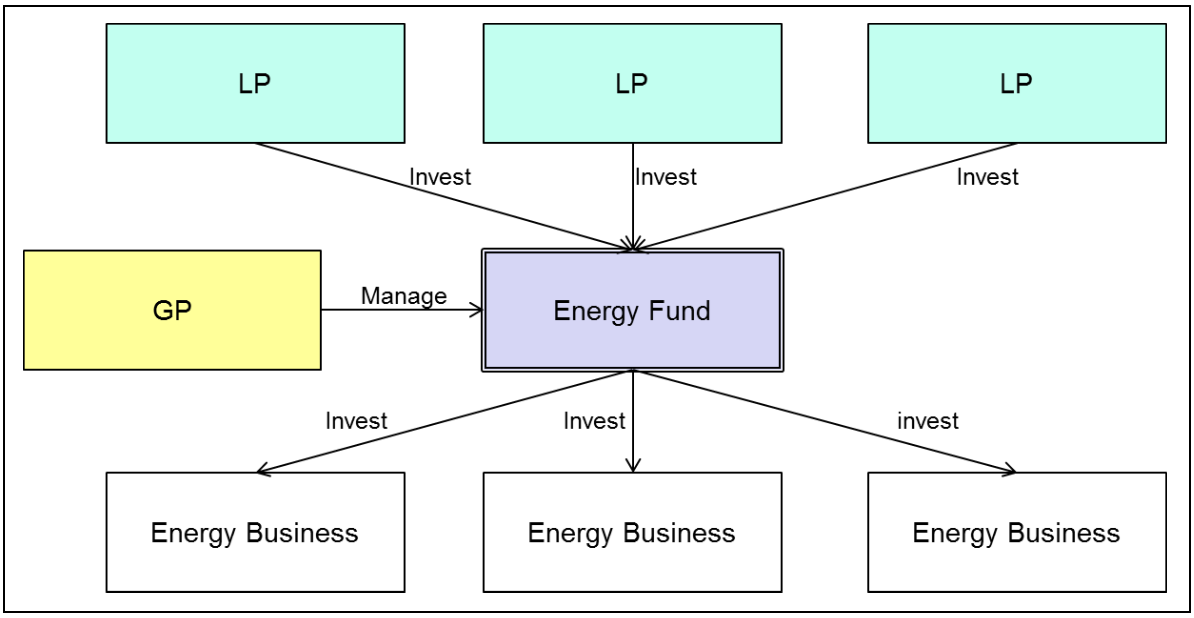
5-3. Considerations on Fund Operation System

5-3-1. Setting up GP and LP

In deciding the fund operation system, GP who creates the fund, sources potential investees, executes investments, conducts monitoring, makes exits, reports to investors, and manages the fund needs to be decided. GP, after deciding on the concept of the fund, has to submit required documents before inviting LP investors. When an investor utilizes fund to enhance its main business, it is called strategic investor. For energy fund potential strategic investors are energy companies, engineering companies, manufacturers, and financial institutions. In establishing a fund, the first investor who makes a commitment into the fund is called anchor investor. With anchor investor's investment into the fund, the fund is able to start its business officially. Therefore, the existence of an anchor investor is critical to the fund, and the fund may flexibly coordinate the concept of the fund with the anchor investor.

LP needs to make it clear the purpose of the fund investment, synergy with the main business, pure return, etc, as depending on the purpose, the fund to be invested may be different. It is necessary to make clear the acceptable risks and expected return, and then finds the fund that matches its needs or coordinates with the GP to establish a fund that meets its requirements. As noted above, if the fund is at the early stage of its establishment without the anchor investor, then the GP may have more flexibility to coordinate. Therefore, detailed discussion with GP is required for the process.

Figure 5-4 General Fund Structure



5-3-2. Setting up Investment Committee

GP, in making investment, has to hold an investment committee to discuss appropriateness of the investment. In general, investment committee is joined by the representative from GP, advisors, and outside experts depending on the situation.

Based on the decisions at the investment committee, cost reimbursement of the due diligence, investment decision making, executing exit will be carried out, thus the committee is the central part of the fund management. LP may join the investment committee as observer, but it is not common to join as investment committee member. Under the general scheme of the fund, LP invests into the fund and entrust GP to manage including the decision on investment.

Decision making process of the investment committee can take consensus by members, majority vote, and combination of the two. Decision making process is usually defined in the Limited Partnership Agreement (LPA) that is drafted at the time of fund establishment.

5-3-3. Setting up Advisory Committee

It is not a requirement for managing a fund to establish advisory committee, but commonly utilized for the reasons below. When there is an issue that requires deep expertise that is difficult for only investment committee to handle, experts may be gathered to discuss the matter. For consideration of the investment that requires high level expertise, advisory committee could be set up in advance so that LPs are more confident to consider investment to the fund.

5-3-4. Fund Management Policy and Size

Fund management policy is defined in the Private Placement Memorandum (PPM) that is made when GP conducts fund raise. Fund management policy may include investment term, investment target, size of one transaction, monitoring method, exit policy, expected return, decision making in the investment committee, and they may be different depending on the fund concept and fund size.

A fund under a particular fund concept may not adopt the same policy for the succeeding larger fund such as investment size per transaction and monitoring method since it may create inefficiencies. Without larger investment size per one investee, there will be so many investment projects in order to build portfolio of the fund size, leading to huge cost for due diligence and monitoring. Therefore, some of the mega funds become fund of funds for its efficient investment diversification, investing into other funds.

5-4. Review of the Funding Scheme Including JICA Private Sector Investment Finance Scheme

5-4-1. Review of the Investment into Small Hydro Project through the Energy Fund Backed by JICA Private Sector Investment Finance Scheme

Due to the restriction of FIT, the power generation capacity is currently at most 10 MW for small hydropower projects in Indonesia[41]. It is probable that an independent small hydropower project may be too small for JICA Private Sector Investment Finance Scheme. And it is expected that the communication with the project owners and the management procedures can be cumbersome when they make the investments directly to several projects. It is one idea to effectively invest in energy funds by using the Private Sector Investment Finance Scheme and entrusting the operational matters to GP who manages the funds.

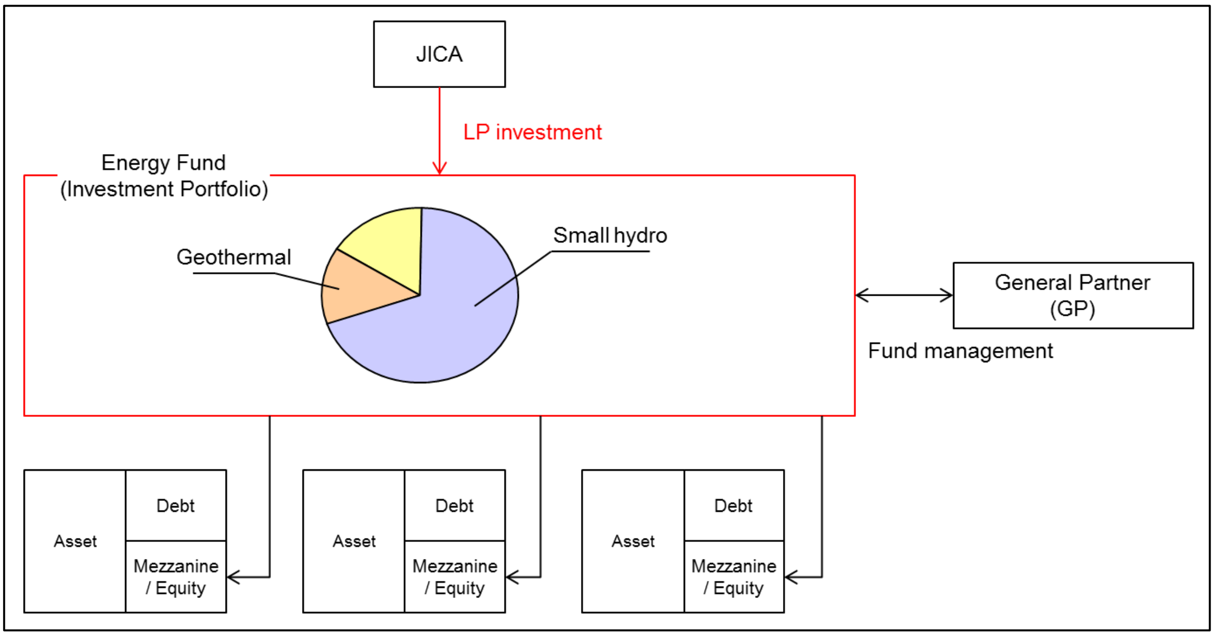


Figure 5-5 Finance Structure Example with Utilization of Energy Fund

Before investing in energy funds under JICA Private Sector Investment Finance Scheme, it is necessary to confirm and arrange the following matters in order not to have any misunderstanding with GP of the funds.

5-4-1-1. Check Points in Investing into the Funds

(1) Check Points for Coordination with Fund Management

1) GP Portfolio Strategy

(A) Targeted Investment Geographic Area

It is necessary to confirm three points for the investment area. Firstly, the area can be a) only

[41] Even if the project size is above 10MW, PLN is obligated to purchase up to 10MW. In some cases, PLN guarantees to purchase what is above 10MW when there is a need for PLN.

Indonesia, b) ASEAN nations including Thailand, Vietnam and the Philippines, or c) entire Asia including Japan and China. Secondly, allocation of investment in each country needs to be defined. Thirdly, if there is any upper and lower limitation of the investment amount for one country.

(B) Targeted Project Types

It is necessary to confirm three points for the project types of its target. Firstly, whether it is targeting only renewable energy or energy including other types such as coal and gas power needs to be clarified. Secondly, whether they invest only in projects or possibly projects and corporations needs to be looked at. Thirdly, whether they invest only in greenfield project or both greenfield and operating project shall be confirmed.

(C) Investment Forms

It is necessary to confirm the investment form that they invest only in equity by common stock or mezzanine financing such as subordinated loans and preferred stocks.

(D) Expected Returns

In the infrastructure funds, the fundamental targets are the revenue stream from the long term stable cash flow. Therefore, they are fundamentally considered as low-risk and low-return investments. Thus, the expected return ratio is generally somewhere around 10%. For example, in the case of investment in the power plants, they will repay the loan on long-term and stable bases from the sales of electric power, because the value of assets will not rise drastically after starting the commercial operation. The risk is limited, but the return will be reasonable and equivalent to the underlying risk.

(2) Check Points for Coordination with Other Investors

When considering investment in energy funds, it is necessary to confirm whether they have the preferential negotiation right for the investments among other LP investors and GP. In general, the general partners are entrusted for decision making because investment projects have high confidential matters and require swift decision making. But if there are some limited partners, having the preferential negotiation right, it is possible that their intentions are reflected into the investment decisions.

5-5. Plans for Investing to Exit by Funds

Because Indonesian small hydropower project owners are small to medium size organizations, there is a strong desire for the financial needs by equity and mezzanine loans. The followings are the examples of exit case when the investment is done by equity or subordinated loans.

5-5-1. IPO or Sales of Stocks to the Third Party such as M&A (Sales of Common Stock)

The project owners who are running several projects can sell common stocks that the funds invested by realizing IPO in the future. In this case, there is a high possibility of getting more returns than the original investments, depending on the market environment at the time of IPO. On another front, there is a risk that IPO cannot be done. Therefore, it is important for the project owners to have some future projects in hand and to be in the position to anticipate the timing of IPO. If they do not intend to conduct IPO, they can sell stocks to the third party through M&A, in that case, they can acquire the preferential sellout right by entering into buy-back conditions in advance. Although the sales of stocks to the third party can be a coincidental event, it is likely that the corporate value is higher from the time when the investment was first executed because of the commencement of next projects and decreasing debt amounts. Therefore, it is anticipated that the project owners are able to sell common stocks at more expensive prices than ones the funds originally purchased.

5-5-2. Return of Subordinated Loans (Repayment of Mezzanine Loans)

The project owners repay subordinated loans annually from the revenue arising from the projects on the same term as senior loans. The schedule of repayment is generally under the period of deferment for 2 years during the construction and it is assumed that they repay the loan between 5 and 7 years after the start of commercial operation. . Thus, the principal and the interest will be recouped within 7 to 9 years. The small hydropower plant project owners usually enter in PPAs with PLN for 20 years, therefore it is possible to get returns as scheduled if the power plants operate in a stable manner. However, it is unlikely to have better returns and the originally defined interest earning is the return on investment.

5-5-3. Exit Plan by Refinancing from the Local or Major Financial Institutions in ASEAN

After starting commercial operation, it is expected that they repay subordinated loans and refinance in the case that the local banks or large financial institutions in ASEAN countries provide senior loans with lower interest rates. They can repay the whole amount or a part of subordinated loans before maturity. In general, there is a clause for a penalty for repaying loans before their maturities, the infrastructure funds can acquire higher return than the scheduled interest amount. However, since the repayment is done earlier, depending on the amount of penalty, the total interest earning can be less than originally expected.

5-6. Consideration on Support Structure for Individual Project after the Execution of Investment by Funds

After the execution of investments, in order to improve the value of the project and to maximize the return, it is important that not only monitoring each project but also creating the support structure to secure the improvement of business of the sponsor companies in the medium to long-term business plans.

5-6-1. Monitoring the Projects

After execution of the loans, the project is divided into two phases, during the construction period and after completion of the construction. During the construction period, it is necessary to visit the construction site constantly to check the progress work in order not to have any delay, and also to check the issues which might lead to the trouble. If there is any delay, they will confer with EPC contractors according to the contract. It is often the case that the infra funds already have people acquainted with the operation of EPC contractors, in that case, it is possible for them to give advises to the project owners before execution of the contract.

After the construction is complete, its focus will shift to the operation of the power plants. As the infra funds appoint at least one board member from them to SPC, they are able to receive operational data from the power plant monthly such as the flow rate, output capacity of electricity, operating time in a timely manner and they can make necessary recommendation for more suitable operations to the project owners.

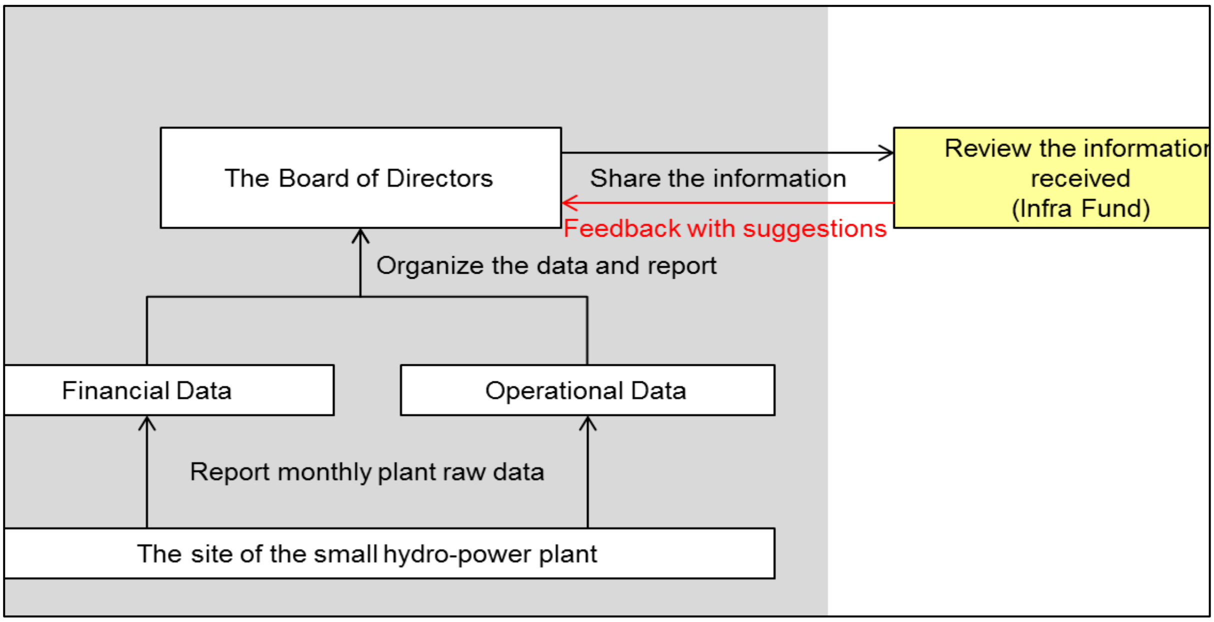


Figure 5-6 Flow of the Monitoring

5-6-2. Improving the Value of the Sponsor Companies

Because the sponsor companies have not only ongoing projects but also future projects in the pipeline, they need a support structure in line with the growth strategy, aiming for IPO in the future.

The important support structure for the sponsor companies is the ordinary support function by people within the funds who are knowledgeable with the power plants and their management, in addition to the above, it is important to have a financial advisory function for fund raising or consulting functions utilizing the network of the funds.

5-6-2-1. Support by the Advisory Functions

It requires a large amount of funds in order to develop a number of projects in parallel. . In order to fund the development costs at the initial stage of the projects, and to deal with the equity payment for each individual project, it is necessary to consider inviting strategic investors. It is also important to construct a structure to support various financing arrangements to satisfy needs from the sponsor companies.

5-6-2-2. Support by the Consulting Functions

For example, it is possible to help the small hydropower projects to apply for CDM business to the United Nations, and support in acquiring CDM credit. It may be difficult for the project owners to independently arrange some research by a third party and to make documentation for application, when it comes to apply. Since it is also important to make arrangement for the carbon credit buyers as well as supporting the application matters for CDM, a consulting function is considered to be important to deal with CDM related issues all together.

5-7. Outline of Conditions and Issues Required for Fund Establishment

5-7-1. Detailed Analysis for Comparisons with Similar Funds (investment target, investment policy, track record)

The following three funds are examples of energy funds that invest into the energy project including renewable energy in mostly Southeast Asia;

・Asia Clean Energy Fund（Armstrong Asset Management）
・Mekong Brahmaputra Clean Development Fund（Dragon Capital）
・JAIC-IDI Asian Energy Fund（Asian Energy Investments）

The overview of each fund, investment target, investment policy and track record are shown below.

5-7-1-1. Asia Clean Energy Fund（Armstrong Asset Management）

Asia Clean Energy Fund, which was established in Singapore by English fund manager as clean energy fund, seems to consider investment in small hydro projects including green field ones. The overview of the GP, Armstrong Asset Management, is shown below.

Table 5-19 Overview of Armstrong Asset Management

Overview	The fund management company which manages the private equity fund that invests in renewable energy projects in Southeast Asia. European Investment Bank (EIB), Deutsche Investitions- und Entwicklungsgesellschaft (DEG) and IFC invest in the fund as LP.
History	2011 Armstrong Asset Management was established Aug, 2012 Achieved first closing at US$66 million by the investment commitments from the fund of funds, Global Energy Efficiency and Renewable Energy Fund and DEG. May, 2013 It achieved second closing by US$20 million commitment from IFC
Management	Mr. Andrew Affleck, Managing Partner Former CEO of Low Carbon Investors Ltd. Prior to engaging in the current position, he had been active mainly in Asia as co-founder of Devonshire Capital, and established Armstrong Asset Management. Dr. Stephen Mahon, Partner He has a PhD in Geophysics and Planetary Physics. He joined Armstrong Asset Management, after efforts to improve business value for a lot of low carbon technology companies as director of Low Carbon Investors. Mr. Edward Douglas, Investment Director He has been engaging in investment business as Senior Investment Director

	of FE Clean Energy Group, which is private equity fund focusing on renewable energy after his tenure at Siemens, Cummins Power, SP International, and Temasek Holings.

The high specialized team consists of the management, based upon specific clean energy fund group, and investment managers who have background of engineering.

The investment targets of Asia Clean Energy Fund are outlined by sector, area and stage of investment below.

Table 5-20 Investment Scope

Category	Renewable Energy Generation Project – Wind, Solar, Hydro, Biomass, Waste to energy – Small scale of 10MW or lower Resource Efficiency – Clean water supply, Waste recycling, Energy efficiency
Area	Southeast Asia (with a focus on Indonesia, Philippines, Malaysia, Thailand, Vietnam)
Stage	Development phase (Pre-Permit), Green Field (After Permit), Operating phase

It aims to achieve IRR 20% returns in 10 years fund term, by 10-15 investment projects, USD 5-12 million per project as its investment policy. Specific policies are shown as following;

- ✓ An obvious market need supported by strong economic fundamentals
- ✓ A commitment to positive social and environmental impact
- ✓ Risk minimization through a portfolio of small-scale projects
- ✓ No technology risk
- ✓ The ability to generate early cash flows
- ✓ Excellent entry valuations due to lack of investor competition
- ✓ Competitive advantage as a result of the team's local operating experience
- ✓ A clear exit strategy.

Therefore, they aim to more than 20% IRR by the combination of the operating projects that can create cash flow early and projects in pre-permitting and development phase with desire to gain upside by the low price acquisition cost. In addition, the fund intends to limit the risk by not taking technology risk.

As investment track record, they made a strategic partnership with Symbior Solar Siam, which is energy developer and subsidiary of Symbior Energy (Hong Kong), and plan to acquire 60% share of Symbior Elements, a subsidiary of Symbior Solar Siam, which develop and operate the solar power project. They plan to invest in the development and construction of a 30 MW solar projects in Central and Northeast of Thailand. Although, they are planning to invest in 3-4 projects including small hydro power project, it is difficult to evaluate their performance at the moment.

5-7-1-2. Mekong Brahmaputra Clean Development Fund (Dragon Capital)

Specialized energy fund has been established by Dragon Capital, which is local institution in Vietnam, as GP, and their overview is shown below,

Table 5-21 Overview of Dragon Capital

Overview	Dragon Capital is local financial institution in Vietnam. A number of funds specializing Southeast Asia have been established by Dragon Capital, and they launched energy focused fund in July, 2010. FMO (Netherlands), BIO (Belgium), Finnfund (Finland) and ADB invest in its energy fund as LP.
History	1994 Dragon Capital was established 1995 Vietnam Enterprise Investments (listed on the Irish Stock Exchange) was established as first fund by Dragon Capital 2005 Vietnam Dragon Fund (listed on the Irish Stock Exchange) was established by investment from Japanese investors. 2010 Mekong Brahmaputra Clean Development Fund was established as energy specialized fund (July）
Management	Mr. Dominic Scriven, CEO He established Dragon Capital in 1994, after his experience at M&G (UK), Citicorp (HK), and Sun Hung Kai (HK). Mr. Alex Pasikowski, Deputy CEO He was in charge of proprietary trading of Australia, Pacific and Southeast Asia in Morgan Stanley. He has been stationed in London, New York, Tokyo, Hong Kong branch. He joined Dragon Capital in 2001, after Swiss Bank, Lehman Brothers, and Deutsche Securities.

Because Dragon Capital is originally local financial institution in Vietnam, their management is organized by members having financial sector background. The investment targets of Mekong Brahmaputra Clean Development Fund is outlined by sector and area below.

Table 5-22 Investment Scope (Mekong Brahmaputra Clean Development Fund)

Sector	Renewable Energy Generation Project, Resource Efficiency, Water treatment, Waste treatment
Area	Vietnam, Thailand, Laos, Cambodia, Nepal, Bhutan, Bangladesh, Sri Lanka

They cover the neighboring countries connected with Vietnam by land except Sri Lanka as investment area, and exclude the huge market such as India and China.

As investment policy, they are aiming that each investment projects have a positive impact on environment and contribute the sustainable growth of society by evaluating companies to be met the principle of economics, social, environmental aspects, which is called triple bottom lines. They set the specific policy of economic aspect that they are aiming more than IRR 15% return in 10 years period by USD 1-7 million scaled projects.

This Fund has three investment track records as below;

Table 5-23 Track Records of Mekong Brahmaputra Clean Development Fund

Project/Company	Country	Type	Scale	Note
Hoa Phu hydro power project	Vietnam	Hydro power generation	29MW	Debt financed from Vietcombank
Electricite du Laos Generation Plc.	Laos	Power company	―	Power generation subsidiary company of EdL
Phnom Penh Water Supply Authority (PPWSA)	Cambodia	Water supply	330,000m/day	

5-7-1-3. JAIC-IDI Asian Energy Fund（Asian Energy Investments）

Japan Asia Investment Co., Ltd. (JAIC), a Japanese venture capital, and Industrial Decisions Inc. (IDI), an advisory company that specializes in energy and the environment that is a subsidiary of Mizuho Financial Group, jointly set up the energy fund focusing Southeast Asia. Its business has been carried over by Asian Energy Investments (AEI) at present. The overview of the company is as follows.

Table 5-24 Overview of AEI

Overview	Asian Energy Investments is Japanese fund management company specializing energy sector. Based in Singapore, it held a fund that focus on Southeast Asia with gathering members having background of energy and finance sector. The company is engaging in fund raising for coal fund, renewable energy fund, and new energy fund at present.
History	2008 JAIC and IDI established JAIC-IDI Asian Energy Fund 2011 Invested in Biomass IPP in Thailand 2011 Invested in small hydro power project in Indonesia 2012 Transferred GP functions to Asian Energy Investments

Management	Mr. Ichiro Kawada, Managing Director He has experience of investment in local companies and set up the joint funds with local financial institutions, with residing one year in Thailand, four years in Indonesia, and seven years in Singapore while he was in Japan Asia Investment Co., Ltd. Mr. Takahiro Kasahara, Director He joined IDI, after his experience at Industrial Bank of Japan. He has more than 10 years experiences in the financial sector and fund investment. He has established three energy infrastructure funds so far.

AEI inherits business from JAIC-IDI Asian Energy Fund, the members who are originated in Southeast Asia, Finance and Energy, manage the fund.

The investment targets of JAIC-IDI Asian Energy Fund, as sector and area, are shown below,

Table 5-25 Investment Scope (JAIC-IDI Asian Energy Fund)

Sector	Energy projects with a focus on renewable energy power generation projects, or companies related energy industry.
Area	Asia excluding Japan

As investment policy, they formed a portfolio in environment and energy field based on economic growth of South-East Asian countries. They support the investee company by hands-on consulting, and aim for value-up. The Fund completed two investment, and is currently under the harvest period.

This Fund has two investment track records as below;

Table 5-26 Track Records of JAIC-IDI Asian Energy Fund

Project/Company	Country	Type	Scale	Note
Biomass power company	Thailand	Biomass power generation	6MW + 3.5MW	－
Small hydro power project	Indonesia	Small hydro power generation	7.5MW	Green field project

5-7-2. Issues and conditions regarding to related laws and regulations [42]

The procedures are required based on the Limited Partnership Act for Investment (LPAI) and Financial Instruments and Exchange Act (FIEA), if energy fund is established and operated on

[42] Ministry of Economy, Trade and Industry, ”MODEL AGREEMENT FOR INVESTMENT LIMITED PARTNERSHIP”, November 2010

Japanese law. Usually, establishments and operations of Investment LPS are conducted based on the Specially Permitted Businesses for Qualified Institutional Investor, etc. under the Article 63(2) of the FIEA. It is necessary that the fund establishment and operation satisfy the following points.

<In establishing the fund>[43]

① When the fund is established, the number of limited partners is less than 500[44].

② When the fund is established, there is not disqualified investor[45] as limited partners.

③ When the fund is established, there is one or more qualified institutional investors as limited partners.

④ When the fund is established, the number of limited partners who are not qualified institutional investor is 49 or less. [46]

⑤ The transfer of LP interest from an investor who is the institutional investor at the time of joining the fund is prohibited by the investment limited partnership agreement unless it is transferred to the qualified institutional investor[47]

⑥ The transfer of LP interest from an investor who is the institutional investor at the time of joining the fund is prohibited by the investment limited partnership agreement unless the investor transfers its interest in whole to a single person. [48]

<In operating the fund＞

① There will be continuously no disqualified investor becoming a limited partner during operating period

② There will be continuously one or more qualified institutional investor existing as a limited partner during operating period.

③ The number of limited partners except qualified institutional investor continues to be 49 or less during operating period. [49]

It is necessary to confirm to GP of the fund regarding above issues, and these should be guaranteed by investment limited partnership agreement made based on the Limited Partnership Act for Investment.

In the case of a Japanese investor investing to the offshore private placement fund, it is subject to the Japanese Financial Instruments and Exchange Act as well. In the case that a Japanese investor considering an off-shore fund is not an institutional investor and there is no other qualified investor, GP of the fund has to register as Financial Instruments Business Operator (Type II Financial

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[43] Financial Instruments and Exchange Ac, Article 63-1-1

[44] Financial Instruments and Exchange Ac, Article 2-3-3 and Enforcement Order of the Limited Partnership Act for Investment, Article1-7-2, provided that it comes under criteria 4

[45] Financial Instruments and Exchange Ac, Article 63-1-1, which fall under イ-ハ

[46] Financial Instruments and Exchange Ac, Article 17-12-1,2

[47] Financial Instruments and Exchange Ac, Article 12-3-1

[48] Financial Instruments and Exchange Ac, Article 12-3-2, イ

[49] Financial Instruments and Exchange Ac, Article 17-12-1,2

Instruments Business, investment Management Business). Therefore, usually qualified institutional investors are invited or existing investor applies for a qualified institutional investor for obtaining the status of the Specially Permitted Businesses for Qualified Institutional Investor. The above is the condition as formal requirements.

On the other hand, it is one of the important practical issues for an investor how to be involved in the investment decision making and utilize the fund. Basically, LP investors entrust GP to make a judgment for an investment, and do not participate in the investment committee as member. However, some investors who hope to have influence on decision making as much as possible or hope to receive information on the investment project for consideration of the co-investment sometimes require GP to establish an advisory body such as advisory committee. Such investors aim to assure a certain influence in a fund by stating their opinion via advisory committee. However, it must be noted that attendance of advisory body is generally limited to investors with certain size of LP interest.

It will be difficult to coordinate such arrangement with the stake-holder including other LP unless they do so in the early stages of establishment of the fund. Therefore, these conditions are normally built into investment limited partnership agreement at the timing of the fund establishment.

5-7-3. Summary of other issues

Energy funds focused on South-East Asia have just started to take off compared to European and American energy funds which have plenty of investment track records already. Typically, Energy infrastructures can be considered as potential investment by institutional investors such as pension fund, based on the fact that these provide stable cash flow in a long term. However, in the market where liquidity of energy assets are low, projects in the development phase will be primary investment target, having to bear the development and construction risk. It is a dilemma that taking such risks by energy funds has its own social meaning from view of promoting development, but at the same time it tends to prevent investments from institutional investor.

As the survey shows through some case studies, energy funds in Southeast Asia reaching the decent size receive support from development financial institutions. If the investment support from development financial institutions becomes seed money and it encourages other institutional investors, energy fund will be able to make multiple and sizable investment. This will create better environment for energy funds to build a stable portfolio, and contribute the activation of energy market.

Chapter.6 Summary

The Indonesian government has formulated the “Second Crash Program” with the intention to increase the volume of electricity supply due to the increase in electricity demand. Previously, in the “First Crash Program”, the Indonesian government focused on coal fired power plants. However, in the second one, they diversified their focus to include renewable energy sources such as small hydro power plants.

Compared to other renewable energy sources, hydro has huge development potential at about 75GW, and it has more development track record. In addition, development potential of small hydro power plants in Indonesia has two merits: small initial investment in the development phase and short-term development. Also, from the point of view of the spread of renewable energy sources and the development of power resources in Indonesia, this research has concluded that small hydro power plants are one of the most promising projects.

However, the development of small hydro power projects have seen difficulties with some issues: 1) creditworthiness of project owners, 2) capability of local financial institutions on risk assessment of the project, and 3) neglecting the importance of technical matters and engineering by project owners. Therefore, in consideration of investment of the small hydro project, it is necessary to look into not only financial aspect but also various aspects including technical, environmental and social aspects.

In the Survey, high potential projects are selected based on its status of obtaining permit, and conducted surveys on technical, environmental/social and financial issues. The following is a summary of the results and issues concerning the technical, environmental and social, and business scheme/financing method of the Nasal Small Hydro Project based on the Survey.

Firstly, the technical survey found that the effective head difference is not 80.8m as in the plan but is 69.0m resulting in the decreased generation capacity from 12MW to 10MW. On the basis of the hydrological calculation, the capacity of passing water through the waterway is fully sufficient. It was also confirmed that the scale of water tank capacity was sufficient. Based on the economic feasibility study, maximum output of 10MW and 8MW is compared. As a result, 8MW is economically better than the other due to reduced civil and mechanical/electrical cost. The discussion was held with the project owner based on the results of technical review and economic feasibility study. The project owner has a policy to expand its portfolio, generation capacity and revenue size, thus 8MW will be too small for them. As a result, the project owner has an intention to further develop the project with 10MW generation capacity.

On the other hand, the main issues for future investigation are as follows: 1) in order to assess accuracy and validity of the calculation model used for estimation of water flow from rainfall data, simple measurement of water flow at the planned site is preferable, 2) consideration of the design of the structure and construction schedule for more accuracy of estimation of the construction cost, 3) waterproofing measures should be taken into account on the tailrace side of the power plant to prevent water from entering both at the time of flooding and normal operation. These points need to be confirmed in the detailed design for consideration of further investment consideration.

Secondly, environmental and social impact assessment led to the conclusion that from pollution control perspective, there will be some impact to air quality, water quality, waste, soil pollution, noise and vibration during construction, but the impact is minor. Land on plant site is comprised of secondary forest and cultivated land. According to UKL/UPL, Government Regulation No.7 and the result of hearing from local resident during field survey (April,2013), rare species such as Sumatran Tigar, Siamang were confirmed. However, considering limited land use change, etc., impacts due to project implementation is expected as insignificant. As mitigation measures, i) to minimize to divide the continuity of large diameter trees, ii) to break the construction temporarily when the rare species are found and observe/wait till they leave, iii) to consult with the expert, if the number of the report of sighting is increased, iv) to install sign board for reminder of road-kill, v) to establish a mechanism (responsible person, place, etc.) for information gathering of sighting by residents, and vi) to prepare enlightenment document material for conservation of the species and conduct education program, targeting related people and residents, will be performed. There is no anadromous fish confirmed around the river area, and the impact should be minor given the speices of emergence is limited in numbers. From a social environment perspective, there has been one (1) public consultation meeting conducted. Although land acquisition is necessary, the compensation of the loss of the land will be performed based on the mutual agreement. And resettlement of the residents will not occur. The local community is welcoming the project based on the positive impact of the project. With proper implementation of the environmental management plan and monitoring plan, the negative impacts will be reduced/minimized, and the positive impact will be maximized.

Lastly, regarding the business scheme and fund raising, the evaluation of this project is conducted on basis of the 10MW generation capacity that is based on the results of the technical review, economic feasibility study, and discussion with the project owner. Accordingly, if this project were to be evaluated under some conditions including an increased FIT and increased equity portion, it is certain that the repayment of loans to senior and mezzanine-lender is possible by revenue from sales of electricity from PLN.

The coming issues are to confirm new FIT system (about 20% increase in tariff), though it depends on the regulatory change, inviting new investor who can share the risk, identifying final specifications of the equipments, and confirming the grounds of the cost.

As discussed above, issues and concerns for going forward with the project are evidenced through the Survey. In summary, for further consideration, issues below need to be addressed for proper structure of the project scheme.

<Technical Aspects>

- evaluation on the accuracy of the calculation model used for estimation of water flow from rainfall data
- consideration on changes in detailed design and implementation plan for detailed projection

<Environmental/Social Aspects>

- Proper implementation of the environmental management plan and monitoring plan

<Financial Aspects>

- Finalizing the cost for EPC, etc/confirmation of the grounds of the cost
- Ensuring the project owner provides required equity capital

By 1) conducting FS review by the Japanese technical consulting company with track records, and 2) considering utilization of funding from Japan including JICA Private Sector Investment Finance Scheme and Japanese energy fund, feasibility of the small hydro power projects will increase. Providing technical and financial supports for the Indonesian small hydro power project owners shall contribute to the promotion of further development.

Appendix N4-1
Calculation of Head Loss (Nasal Location)

Chapter 1 Calculation of Head Loss

Section 1 Head loss at intake

1. Head loss due to inflow

$$h_e = f_e \cdot \frac{V_2^2}{2g} + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$$

where,

h_1:	Head loss due to inflow		(m)
f_e:	Inflow loss coefficient	0.1	
V_1:	Velocity before inflow		(m/s)
V_2:	Velocity after inflow		(m/s)

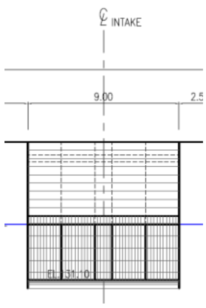
considering V_1=0, thus it could transform to following equation.

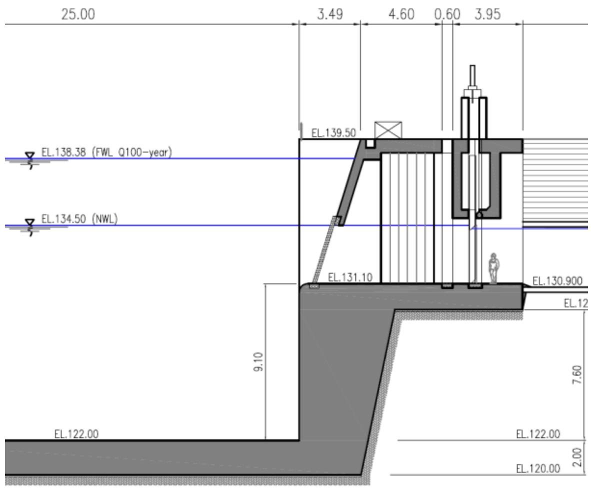
$$h_e = (1 + f_e) \cdot \frac{V_2^{\ 2}}{2g}$$

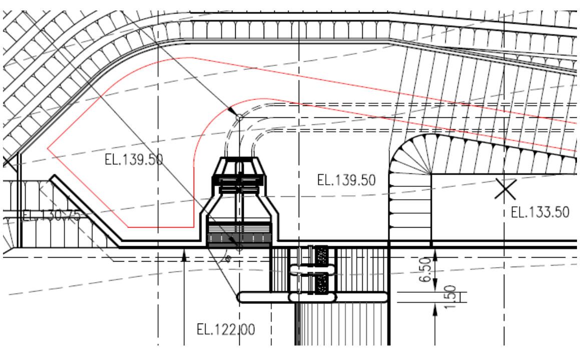
Head loss due to inflow is shown below.

Item	Upstream water level WL_1 (m)	Downstream water level WL_2 (m)	Intake sill Z_2 (m)					
MAX	134.500	134.480	131.100					
Regular	134.500	134.496	131.100					

Item	Flow Q (m^3/s)	Width of intake B (m)	Downstream depth H_2 (m)	Velocity after inflow V_2 (m/s)	Velocity head $V_2^{\ 2}/2g$	Loss coefficient $1+f_e$	Head loss h_1 (m)	
MAX	17.360	9.000	3.380	0.571	0.017	1.170	0.020	0.000
Regular	7.850	9.000	3.396	0.257	0.003	1.170	0.004	0.000







2.Head loss due to screen

$$h_2 = fr \cdot \frac{V_1^2}{2g} + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$$

where,

h_2:	Head loss due to screen		(m)
f_r:	Screen coefficient		
V_1:	Velocity before screen		(m/s)
β:	Screen barshape coefficient	2.34	
θ:	Screen angle of inclination	75.0	(°)
t:	thickness of screen	12	(mm)
b:	space between screen bars	88	(mm)

$$fr = \beta \cdot \sin\ \theta \cdot (t/b)^{4/3}$$

= 2.34 ×sin(75.00)× (12／88) $^{4/3}$
= 0.159

Head loss due to screen is shown below.

Item	Upstream level WL_1 (m)	Upstream sill Z_1 (m)	Upstream depth H_1 (m)	Upstream width B_1 (m)	Downstream level WL_2 (m)	Downstream sill Z_2 (m)	Downstream depth H_2 (m)	Downstream width B_2 (m)
MAX	134.480	131.100	3.380	9.000	134.477	131.100	3.377	9.000
Regular	134.496	131.100	3.396	9.000	134.496	131.100	3.396	9.000

Item	Flow Q (m^3/s)	Cross-sectional area of upstream A_1 (m^2)	Upstream Velocity V_1 (m/s)	Velocity head $V_1^2/2g$	Cross-sectional area of downstream A_2 (m^2)	Downstream Velocity V_2 (m/s)	Velocity head $V_2^2/2g$	
MAX	17.360	30.420	0.571	0.017	30.393	0.571	0.017	
Regular	7.850	30.564	0.257	0.003	30.564	0.257	0.003	

Item	Loss coefficient f_r	Head loss h_2 (m)						
MAX	0.159	0.003	0.000					
Regular	0.159	－	-0.000					

3.Head loss due to pier

$$h_3 = \frac{Q^2}{2g}\left[\frac{1}{C^2 B_2^2 (H_1 - h_3)^2} - \frac{1}{B_1^2 H_1^2}\right]$$

where,

h_3:	Head loss due to pier		(m)
Q:	Flow		(m^3/s)
C:	Pier shape coefficient	0.92	(m/s)
B_1:	Channel width before pier	9.00	(m)
B_2:	Channel width deducted pier width		
t:	Width of 1 unit of pier	1.00	(m)
H_1:	Water depth of upstream side		

assuming $h3/H1=0$, $h3$ is calculated by following equation.

$$h_3 = \left\{\frac{1}{C^2}\left(\frac{B_1}{B_2}\right)^2 - 1\right\}\frac{V_1^2}{2g}, \quad V_1 = \frac{Q}{B_1 H_1}$$

Considered this as the first approximate value,
calculate the values of two equations to be matched.
Head loss due to pier at Max and regular is shown below.

Item	Upstream level WL_1 (m)	Intake sill Z_1 (m)	Upstream depth H_1 (m)	Channel width before pier B_1	Deducted channel width B_2	Pier coefficient C	$C^2B_2^2$	$B_1^2H_1^2$
MAX	134.477	131.100	3.377	9.000	8.000	0.920	54.170	923.733
Regular	134.496	131.100	3.396	9.000	8.000	0.920	54.170	934.158

Item	Flow Q (m^3/s)	$Q^2/2g$	Head loss h_3	Downstream depth H_2	Downstream level WL_2 (m)	h_3'		h_3-h_3'
MAX	17.360	15.376	0.008	3.369	134.469	0.008		0.000
Regular	7.850	3.144	0.002	3.394	134.494	0.002		0.000

4.Head loss due to intake gate

$$h_4 = WL_1 - h_1 - h_2 - h_3 - WL_2$$

where,

h_4:	Head loss due to intake gate	(m)
h_1:	Head loss due to inflow	(m)
h_2:	Head loss due to screen	(m)
h_3:	Head loss due to intake pier	(m)
WL_1:	Intake water level	(m)
WL_2:	Upstream level	(m)

Item	Intake water level WL_1	Intake h_1	Screen h_2	Intake pier h_3	Upstream level WL_2	Head loss h_4		
MAX	134.500	0.020	0.003	0.008	133.828	0.641		
Regular	134.500	0.004	-	0.002	132.575	1.919		

5. total of head loss at intake

$$h_I = h_1 + h_2 + h_3 + h_4 + h_5$$

where,

h_1: Head loss due to inflow (m)
h_2: Head loss due to screen (m)
h_3: Head loss due to intake pier (m)
h_4: Head loss due to intake gate (m)
h_5: Surplus (m)

Head loss at intake is shown below.

Part/type of loss	記号	Head loss	
		MAX	Regular
Inflow	h_1	0.020	0.004
Screen	h_2	0.003	0.000
Intake pier	h_3	0.008	0.002
Intake gate	h_4	0.641	1.919
Surplus	h_5	0.000	0.000
Total	h_I	0.672	1.925

Water level at start of intake is shown below.

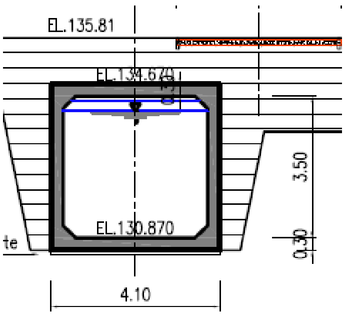
Plant discharge	MAX	Regular
Water level at start of intake	134.500	134.500
Head loss at intake	0.672	1.925
Water level at start of intake cannel	133.828	132.575

Section 2 Head loss at intake channel

1. Loss head due to slope

Head loss at intake channel means difference between water level at start of intake channel and water level at end of settling basin.
Water level at starting point of intake channel is estimated by backwater calculation from settling basin.

Name	Station point SP.m	Length of interval m	Slope of intake channel		Starting point sill height EL.m	End point sill height EL.m
Iintake channel start	0.00	1060.00	1/1666.67	0.0600%	130.900	130.264
Settling basin start	1060.00				130.264	
Total		1060.00				



channel width	*B:*	3.500 m
channel height	*H:*	3.500
Roughness coefficient	*n:*	0.015

2. Head loss at intake channel

$$h_{IV} = WL_1 - WL_2$$

WL_1: water level of start of intake channel (m)

WL_2: water level of end of intake channel (m)

Head loss at intake channel is shown below.

Part/type of loss		Head loss MAX	Head loss Regular
Water level at start of intake channel	WL_1	133.828	132.575
Water level at end of intake channel	WL_2	133.237	132.129
Total	h_{IV}	0.591	0.446

Calculation of non-uniform flow

$$\left(\frac{\alpha_2 Q^2}{2gA_2^2}+h_2+z_2\right)-\left(\frac{\alpha_1 Q^2}{2gA_1^2}+h_1+z_1\right)=-\frac{1}{2}\left(\frac{Q^2}{K_1^2}+\frac{Q^2}{K_2^2}\right)(L_2-L_1)$$

channel width	B:	3.500	m
channel height	H:	3.500	m
Roughness coefficient	n:	0.015	
Headrace gradient	i:	0.0006	
Correction coefficient	α:	1.000	

MAX flow Q: 17.360 (m^3/s)

No	channel length L (m)	Additional length dL (m)	Water depth h (m)	Cross-sectional area A (m^2)	Hydraulic radius R (m)	Flow velocity V (m/s)	Water level H (m)	Channel sill height Z (m)	Specific energy E	Conveyance K	Friction loss h_f (m)	
1	0.00		2.9733	10.4064	1.1016	1.6682	133.237	130.264	133.3792	739.993		
2	50.00	50.0	2.9705	10.3969	1.1012	1.6697	133.265	130.294	133.40678	739.148	0.0275	0.000
3	100.00	50.0	2.9679	10.3875	1.1009	1.6712	133.292	130.324	133.4344	738.321	0.0276	0.000
4	150.00	50.0	2.9653	10.3784	1.1005	1.6727	133.319	130.354	133.4620	737.511	0.0277	0.000
5	200.00	50.0	2.9627	10.3694	1.1002	1.6742	133.347	130.384	133.4897	736.718	0.0277	0.000
6	250.00	50.0	2.9602	10.3607	1.0998	1.6756	133.374	130.414	133.5174	735.941	0.0278	0.000
7	300.00	50.0	2.9577	10.3521	1.0995	1.6770	133.402	130.444	133.5452	735.181	0.0279	0.000
8	350.00	50.0	2.9553	10.3437	1.0991	1.6783	133.429	130.474	133.5731	734.436	0.0279	0.000
9	400.00	50.0	2.9530	10.3355	1.0988	1.6797	133.457	130.504	133.6009	733.708	0.0280	0.000
10	450.00	50.0	2.9507	10.3274	1.0985	1.6810	133.485	130.534	133.6289	732.994	0.0280	0.000
11	500.00	50.0	2.9486	10.3199	1.0982	1.6822	133.513	130.564	133.6569	732.331	0.0281	0.000
12	550.00	50.0	2.9465	10.3126	1.0979	1.6834	133.540	130.594	133.6850	731.686	0.0281	0.000
13	600.00	50.0	2.9444	10.3055	1.0976	1.6845	133.568	130.624	133.7132	731.057	0.0282	0.000
14	700.00	100.0	2.9405	10.2919	1.0971	1.6868	133.625	130.684	133.7697	729.847	0.0565	0.000
15	800.00	100.0	2.9366	10.2780	1.0965	1.6890	133.681	130.744	133.8261	728.619	0.0567	0.000
16	900.00	100.0	2.9331	10.2658	1.0961	1.6911	133.737	130.804	133.8830	727.536	0.0569	0.000
17	1,000.00	100.0	2.9298	10.2542	1.0956	1.6930	133.794	130.864	133.9400	726.510	0.0570	0.000
18	1,060.00	60.0	2.9279	10.2475	1.0953	1.6941	133.828	130.900	133.9743	725.920	0.0343	0.000
19												
20												
Total	1,060.00						133.828				0.5958	

Regular flow Q: 7.850 (m^3/s)

No	channel length L (m)	Additional length dL (m)	Water depth h (m)	Cross-sectional area A (m^2)	Hydraulic radius R (m)	Flow velocity V (m/s)	Water level H (m)	Channel sill height Z (m)	Specific energy E	Conveyance K	Friction loss h_f (m)	
1	0.00		1.8651	6.5278	0.9029	1.2026	132.129	130.264	132.2029	406.523		
2	50.00	50.0	1.8529	6.4852	0.9000	1.2105	132.147	130.294	132.22166	403.016	0.0188	0.000
3	100.00	50.0	1.8411	6.4437	0.8972	1.2182	132.165	130.324	132.2408	399.606	0.0191	0.000
4	150.00	50.0	1.8295	6.4034	0.8944	1.2259	132.184	130.354	132.2602	396.295	0.0195	0.000
5	200.00	50.0	1.8183	6.3642	0.8918	1.2335	132.202	130.384	132.2800	393.080	0.0198	0.000
6	250.00	50.0	1.8075	6.3261	0.8891	1.2409	132.221	130.414	132.3000	389.962	0.0201	0.000
7	300.00	50.0	1.7969	6.2891	0.8866	1.2482	132.241	130.444	132.3204	386.939	0.0204	0.000
8	350.00	50.0	1.7867	6.2533	0.8841	1.2553	132.261	130.474	132.3411	384.010	0.0207	0.000
9	400.00	50.0	1.7767	6.2186	0.8816	1.2623	132.281	130.504	132.3620	381.175	0.0211	0.000
10	450.00	50.0	1.7671	6.1849	0.8793	1.2692	132.301	130.534	132.3833	378.433	0.0214	0.000
11	500.00	50.0	1.7578	6.1524	0.8770	1.2759	132.322	130.564	132.4049	375.781	0.0217	0.000
12	550.00	50.0	1.7489	6.1213	0.8747	1.2824	132.343	130.594	132.4268	373.253	0.0220	0.000
13	600.00	50.0	1.7404	6.0913	0.8726	1.2887	132.364	130.624	132.4491	370.817	0.0223	0.000
14	700.00	100.0	1.7241	6.0342	0.8685	1.3009	132.408	130.684	132.4944	366.184	0.0454	0.000
15	800.00	100.0	1.7090	5.9816	0.8646	1.3123	132.453	130.744	132.5409	361.925	0.0465	0.000
16	900.00	100.0	1.6952	5.9330	0.8611	1.3231	132.499	130.804	132.5885	357.997	0.0476	0.000
17	1,000.00	100.0	1.6824	5.8883	0.8578	1.3332	132.546	130.864	132.6370	354.385	0.0486	0.000
18	1,060.00	60.0	1.6752	5.8632	0.8559	1.3389	132.575	130.900	132.6667	352.362	0.0296	0.000
19												
20												
Total	1,060.00						132.575				0.4644	

Flow depth is calculated by Manning's equation

$$AR^{2/3} = \frac{Qn}{\sqrt{I}} \quad \cdots\cdots ①$$

Uniform flow depth	$:h_o$		(m)
Plant discharge	$:Q$		(m^3/s)
Slope of headrace	$:I=$	0.0006	
Manning roughness coefficient	$:n=$	0.0150	
waterway width	$:B$	3.500	(m)
Slope of side walls	$:H$	3.500	(m)
Cross-sectional area of flow	$:A$		(m^2)
Wetted perimeter	$:S$		(m)
Hydraulic radius	$:R=A/S$		(m)

Item	Flow $Q\ (m^3/s)$	Right side $Q \cdot n/I^{0.5}$	Uniform flow depth $h_0\ (m)$	Cross-sectional area of flow $A\ (m^2)$	Wetted perimeter $S\ (m)$	Hydraulic radius $R\ (m)$	Left side $AR^{2/3}$	(Left side)-(Right side)
MAX	17.360	10.631	2.872	10.053	9.245	1.087	10.631	0.000
Regular	7.850	4.807	1.561	5.464	6.622	0.825	4.807	0.000

Calculation of critical water depth

$$\frac{\alpha Q^2}{g} = \frac{A^3}{T} \quad \cdots\cdots ②$$

Critical water depth	$:hc$		(m)
Plant discharge	$:Q$		(m^3/s)
Correction coefficient of velocity distribution	$:\alpha =$	1.0	
Gravitational acceleration	$:g=$	9.8	(m^2/s)
Width of headrace	$:B=$	3.5	(m)
Slope of side walls	$:m=$	0.0	(矩形)
Cross-sectional area of flow	$:A=(B+m \cdot hc)hc$		(m^2)
Width of water surface	$:T=B+2m \cdot hc$		(m)

substituting *mean velocity* : $V=Q/A$ and *hydraulic radius* : $D=A/T$ for equation ②:

$$\alpha \frac{V^2}{2g} = \frac{D}{2} \quad \cdots\cdots ③$$

$$V = \frac{Q}{A} \quad \cdots\cdots ④$$

$$D = \frac{A}{T} \quad \cdots\cdots ⑤$$

substituting ④ and ⑤ for ③:

$$\alpha \frac{Q^2}{g} = \frac{A^3}{T} \quad \cdots\cdots ⑥$$

thus, h satisfied ⑥ can be hc.

Item	Flow $Q\ (m^3/s)$	Critical water depth $h_c\ (m)$	Width of water surface $T\ (m)$	Calibration coefficient α	Cross-sectional area of flow $A\ (m^2)$	Left side $\alpha Q^2/g$	Right side A^3/T	(Left side)-(Light side)
MAX	17.360	1.359	3.500	1.000	4.757	30.752	30.752	0.000
Regular	7.850	0.801	3.500	1.000	2.802	6.288	6.288	0.000

Section 3 Head loss at settling basin

1. Head loss due to cross section changes

In inlet area of settling basin,

- flow velocity after inflow V_2 < flow velocity before inflow V_1

Thus, difference of velocity heads is negative.
Also flow velocity is slow, and loss head of cross section change due to sudden
Thus, head loss≒0

2. Head loss due to inflow

- Calculation of head loss in inflow area from settling basin to headrace

$$h_e = f_e \cdot \frac{V_2^2}{2g} + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$$

where,
- h_1: Head loss due to inflow (m)
- f_e: Inflow loss coefficient 0.2
- V_1: Velocity befor inflow (m/s)
- V_2: Velocity after inflow (m/s)

considering V_1=0, thus it could transform to following equation.

$$h_e = (1 + f_e) \cdot \frac{V_2^2}{2g}$$

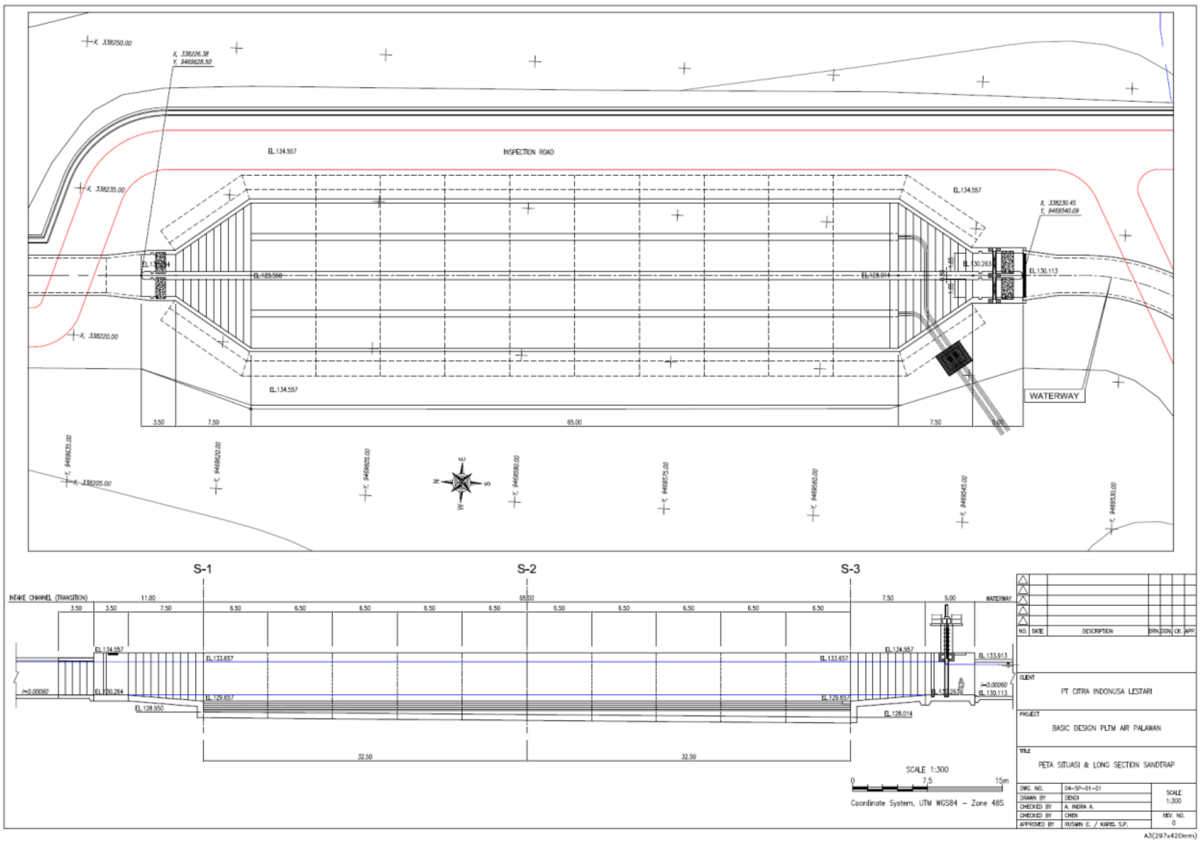
Head loss due to inflow is shown below.

Item	Upstream level WL_1 (m)	Downstream level WL_2 (m)	Channel sill Z_2 (m)					
MAX	133.237	133.064	130.113					
Regular	132.129	132.046	130.113					

Item	Flow Q (m^3/s)	Width of headrace B (m)	Downstream depth H_2 (m)	Velocity after inflow V_2 (m/s)	Velocity head $V_2^2/2g$	Loss coefficient $1+f_e$	Head loss h_1 (m)	
MAX	17.360	3.500	2.951	1.681	0.144	1.200	0.173	
Regular	7.850	3.500	1.933	1.160	0.069	1.200	0.083	

Head loss at settling basin is shown below.

Part/type of loss		Head loss MAX	Head loss Regular
Cross-section change	h_1	0.000	0.000
Inflow	h_2	0.173	0.083
Surplus	h_3	0.000	0.000
Total	h_I	0.173	0.083

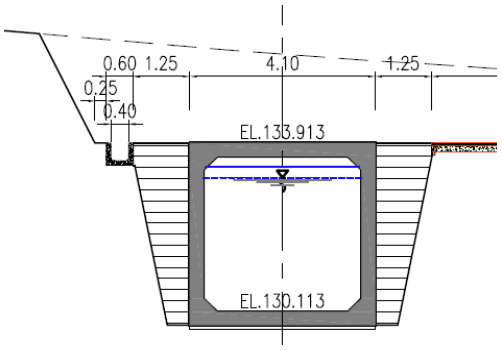

INSPECTION ROAD
EL.134.557
WATERWAY
S-1
S-2
S-3
INTAKE CHANNEL (TRANSITION)
EL.133.657
EL.129.657
EL.128.014
EL.133.913
EL.130.113
SCALE 1:300
Coordinate System, UTM WGS84 – Zone 48S
NO.
DATE
DESCRIPTION
DRN.
DGN.
CK.
APP.
CLIENT
PT CITRA INDONUSA LESTARI
PROJECT
BASIC DESIGN PLTM AIR PALAWAN
TITLE
PETA SITUASI & LONG SECTION SANDTRAP
DWG. NO. 04-SP-01-01
DRAWN BY DENDI
CHECKED BY A. INDRA A.
CHECKED BY CHEN
APPROVED BY RUSMIN C. / KAREL S.P.
SCALE 1:300
REV. NO. 0
A3(297x420mm)

Section 4 Head loss at Headrace

1. Loss head due to slope

Head loss at headrace means difference between water level at start of headrace and water level at end of head tank.
Water level at starting point of headrace is estimated by backwater calculation from head tank.

Name	tation poir SP. m	Length of interval m	Slope of headrace		Starting point sill height EL. m	End point sill height EL. m
Headrace start	0.00	3108.33	1/1666.67	0.0600%	130.113	128.248
Headrace end	3108.33				128.248	
Total		3108.33				



headrace width	B:	3.500	m
headrace height	H:	3.500	
Roughness coefficient	n:	0.015	

2. Head loss at headrace

$$h_{IV} = WL_1 - WL_2$$

WL_1: water level of start of headrace (m)
WL_2: water level of end of headrace (m)

Head loss at headrace is shown below.

Part/type of loss		Head loss	
		MAX	Regular
Water level at start of headrace	WL_1	133.064	132.046
Water level at end of headrace	WL_2	131.508	131.508
Total	h_{IV}	1.556	0.538

Calculation of non-uniform flow

$$\left(\frac{\alpha_2 Q^2}{2gA_2^2}+h_2+z_2\right)-\left(\frac{\alpha_1 Q^2}{2gA_1^2}+h_1+z_1\right)=-\frac{1}{2}\left(\frac{Q^2}{K_1^2}+\frac{Q^2}{K_2^2}\right)(L_2-L_1)$$

channel width	B:	3.500	m
channel height	H:	3.500	m

Roughness coefficient	n:	0.015
Headrace gradient	i:	0.0006
Correction coefficient	α:	1.000

MAX flow Q: 17.360 (m^3/s)

No	channel length L (m)	Additional length dL (m)	Water depth h (m)	Cross-sectional area A (m^2)	Hydraulic radius R (m)	Flow velocity V (m/s)	Water level H (m)	Channel sill height Z (m)	Specific energy E	Conveyance K	Friction loss h_f (m)	
1	0.00		3.2600	11.4100	1.1387	1.5215	131.508	128.248	131.6261	829.481		
2	100.00	100.0	3.2428	11.3498	1.1366	1.5295	131.551	128.308	131.67017	824.090	0.0441	0.000
3	200.00	100.0	3.2262	11.2917	1.1346	1.5374	131.594	128.368	131.7148	818.882	0.0447	0.000
4	300.00	100.0	3.2101	11.2355	1.1326	1.5451	131.638	128.428	131.7599	813.854	0.0452	0.000
5	400.00	100.0	3.1946	11.1813	1.1306	1.5526	131.683	128.488	131.8056	809.003	0.0458	0.000
6	500.00	100.0	3.1798	11.1293	1.1288	1.5598	131.728	128.548	131.8519	804.361	0.0463	0.000
7	600.00	100.0	3.1655	11.0794	1.1270	1.5669	131.774	128.608	131.8988	799.894	0.0468	0.000
8	800.00	200.0	3.1385	10.9848	1.1235	1.5804	131.867	128.728	131.9939	791.451	0.0952	0.000
9	1,000.00	200.0	3.1136	10.8975	1.1203	1.5930	131.962	128.848	132.0910	783.665	0.0972	0.000
10	1,200.00	200.0	3.0906	10.8172	1.1173	1.6049	132.059	128.968	132.1900	776.503	0.0991	0.000
11	1,400.00	200.0	3.0695	10.7434	1.1146	1.6159	132.158	129.088	132.2908	769.935	0.1008	0.000
12	1,600.00	200.0	3.0503	10.6759	1.1120	1.6261	132.258	129.208	132.3932	763.927	0.1025	0.000
13	1,800.00	200.0	3.0326	10.6142	1.1097	1.6355	132.361	129.328	132.4971	758.447	0.1040	0.000
14	2,000.00	200.0	3.0166	10.5581	1.1075	1.6442	132.465	129.448	132.6025	753.461	0.1055	0.000
15	2,200.00	200.0	3.0020	10.5070	1.1055	1.6522	132.570	129.568	132.7093	748.916	0.1068	0.000
16	2,400.00	200.0	2.9887	10.4605	1.1037	1.6596	132.677	129.688	132.8172	744.795	0.1081	0.000
17	2,600.00	200.0	2.9767	10.4185	1.1021	1.6663	132.785	129.808	132.9264	741.064	0.1092	0.000
18	2,800.00	200.0	2.9658	10.3804	1.1006	1.6724	132.894	129.928	133.0365	737.693	0.1103	0.000
19	3,000.00	200.0	2.9561	10.3464	1.0993	1.6779	133.004	130.048	133.1478	734.676	0.1112	0.000
20	3,108.33	108.3	2.9513	10.3294	1.0986	1.6806	133.064	130.113	133.2084	733.169	0.0606	0.000
Total	3,108.33						133.064				1.5833	

Regular flow Q: 7.850 (m^3/s)

No	channel length L (m)	Additional length dL (m)	Water depth h (m)	Cross-sectional area A (m^2)	Hydraulic radius R (m)	Flow velocity V (m/s)	Water level H (m)	Channel sill height Z (m)	Specific energy E	Conveyance K	Friction loss h_f (m)	
1	0.00		3.2600	11.4100	1.1387	0.6880	131.508	128.248	131.5321	829.481		
2	100.00	100.0	3.2083	11.2290	1.1323	0.6991	131.516	128.308	131.54121	813.270	0.0091	0.000
3	200.00	100.0	3.1570	11.0494	1.1259	0.7104	131.525	128.368	131.5507	797.217	0.0095	0.000
4	300.00	100.0	3.1060	10.8710	1.1193	0.7221	131.534	128.428	131.5606	781.305	0.0099	0.000
5	400.00	100.0	3.0554	10.6940	1.1127	0.7341	131.543	128.488	131.5709	765.538	0.0103	0.000
6	500.00	100.0	3.0052	10.5183	1.1060	0.7463	131.553	128.548	131.5817	749.925	0.0107	0.000
7	600.00	100.0	2.9555	10.3441	1.0992	0.7589	131.563	128.608	131.5928	734.472	0.0112	0.000
8	800.00	200.0	2.8573	10.0004	1.0853	0.7850	131.585	128.728	131.6167	704.080	0.0239	0.000
9	1,000.00	200.0	2.7610	9.6635	1.0711	0.8123	131.609	128.848	131.6427	674.421	0.0260	0.000
10	1,200.00	200.0	2.6669	9.3342	1.0566	0.8410	131.635	128.968	131.6710	645.562	0.0283	0.000
11	1,400.00	200.0	2.5752	9.0133	1.0419	0.8709	131.663	129.088	131.7019	617.577	0.0309	0.000
12	1,600.00	200.0	2.4862	8.7018	1.0271	0.9021	131.694	129.208	131.7358	590.545	0.0338	0.000
13	1,800.00	200.0	2.4002	8.4007	1.0121	0.9344	131.728	129.328	131.7728	564.551	0.0370	0.000
14	2,000.00	200.0	2.3174	8.1111	0.9971	0.9678	131.765	129.448	131.8132	539.681	0.0405	0.000
15	2,200.00	200.0	2.2383	7.8340	0.9821	1.0020	131.806	129.568	131.8575	516.029	0.0443	0.000
16	2,400.00	200.0	2.1631	7.5708	0.9674	1.0369	131.851	129.688	131.9059	493.682	0.0484	0.000
17	2,600.00	200.0	2.0922	7.3226	0.9529	1.0720	131.900	129.808	131.9588	472.727	0.0529	0.000
18	2,800.00	200.0	2.0258	7.0904	0.9389	1.1071	131.954	129.928	132.0164	453.241	0.0576	0.000
19	3,000.00	200.0	1.9643	6.8752	0.9255	1.1418	132.012	130.048	132.0789	435.289	0.0625	0.000
20	3,108.33	108.3	1.9331	6.7658	0.9185	1.1603	132.046	130.113	132.1148	426.197	0.0360	0.000
Total	3,108.33						132.046				0.5829	

Flow depth is calculated by Manning's equation

$$AR^{2/3} = \frac{Qn}{\sqrt{I}} \quad \cdots\cdots ①$$

Uniform flow depth	$:h_o$		(m)
Plant discharge	:Q		(m^3/s)
Slope of headrace	:I=	0.00060	
Manning roughness coefficient	:n=	0.015	
waterway width	:B	3.500	(m)
Slope of side walls	:H	3.500	(m)
Cross-sectional area of flow	:A		(m^2)
Wetted perimeter	:S		(m)
Hydraulic radius	:R=A/S		(m)

Item	Flow Q (m^3/s)	Right side $Q \cdot n/I^{0.5}$	Uniform flow depth h_0 (m)	Cross-sectional area of flow A (m^2)	Wetted perimeter S (m)	Hydraulic radius R (m)	Left side $AR^{2/3}$	(Left side)-(Right side)
MAX	17.360	10.631	2.872	10.053	9.245	1.087	10.631	0.000
Regular	7.850	4.807	1.561	5.464	6.622	0.825	4.807	0.000

Calculation of critical water depth

$$\frac{\alpha Q^2}{g} = \frac{A^3}{T} \quad \cdots\cdots ②$$

Critical water depth	:hc	(m)	
Plant discharge	:Q	(m^3/s)	
Correction coefficient of velocity distribution	: α =	1.0	
	:g=	9.8	(m^2/s)
Gravitational acceleration	:B=	3.500	(m)
Width of headrace	:m=	0.000	(矩形)
Slope of side walls	:A=(B+m・hc)hc		(m^2)
Cross-sectional area of flow	:T=B+2m・hc		(m)
Width of water surface			

substituting *mean velocity* : V=Q/A and *hydraulic radius* :D=A/T for equation ②:

$$\alpha \frac{V^2}{2g} = \frac{D}{2} \quad \cdots\cdots ③$$

$$V = \frac{Q}{A} \quad \cdots\cdots ④$$

$$D = \frac{A}{T} \quad \cdots\cdots ⑤$$

substituting ④ and ⑤ for ③:

$$\alpha \frac{Q^2}{g} = \frac{A^3}{T} \quad \cdots\cdots ⑥$$

thus, *h* satisfied ⑥ can be *hc*.

Item	Flow Q (m^3/s)	Critical water depth h_c (m)	Width of water surface T (m)	Calibration coefficient α	Cross-sectional area of flow A (m^2)	Left side $\alpha Q^2/g$	Right side A^3/T	(Left side)-(Light side)
MAX	17.360	1.359	3.500	1.000	4.757	30.752	30.752	0.000
Regular	7.850	0.801	3.500	1.000	2.802	6.288	6.288	0.000

Section 5 Head loss at Head tank

1. Head loss due to sudden enlargement

$$h_{se} = f_{se} \cdot \frac{V_2^2}{2g} + \left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$$

$$f_{se} = \left\{ 1 - \left(\frac{A_1}{A_2} \right) \right\}^2$$

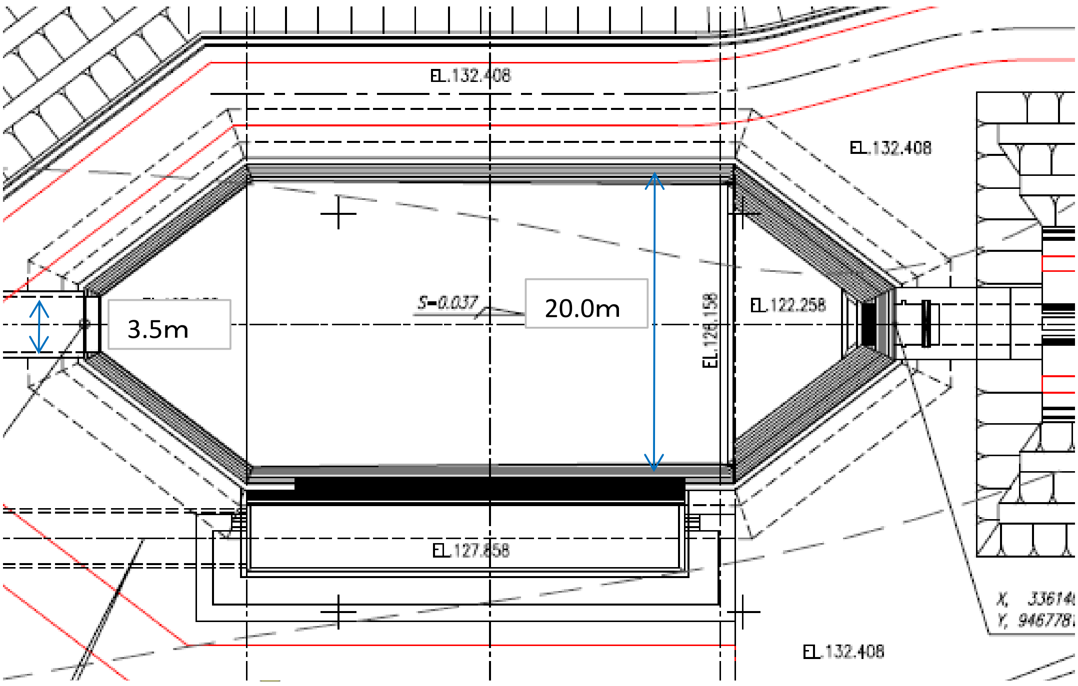
where,

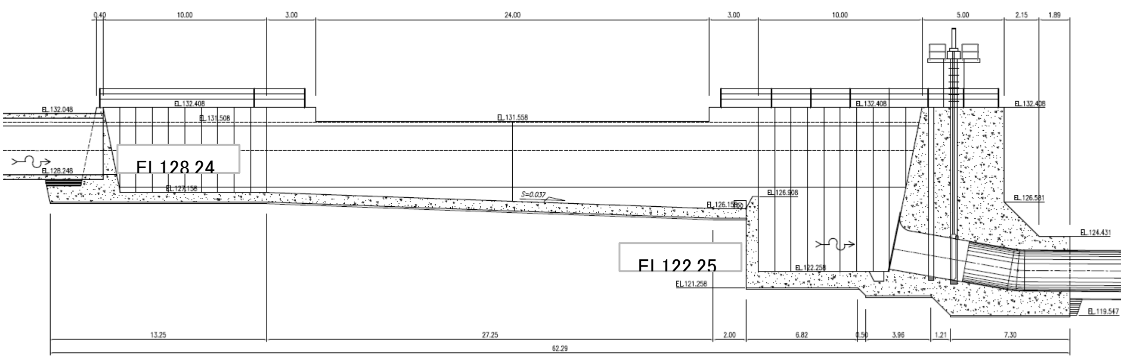
h_{se} : Head loss due to enlargement of cross section (m)
f_{se} : Loss coefficient of sudden enlargement
V_1 : Flow velocity before enlargement (m/s)
V_2 : Flow velocity after enlargement (m/s)

$V_2 < V_1$, Thus, head loss is not calculated because diffrence of velocity head is positive.

Item	Upstream water level WL_1 (m)	Upstream sill Z_1 (m)	Upstream depth H_1 (m)	Upstream effective width B_1 (m)	Downstream water level WL_2 (m)	Downstream sill Z_2 (m)	Downstream depth H_2 (m)	Downstream effective width B_2 (m)
MAX	131. 508	128. 248	3. 260	3. 500	131. 508	122. 258	9. 250	20. 000
Regular	131. 508	128. 248	3. 260	3. 500	131. 508	122. 258	9. 250	20. 000

Item	Flow Q (m^3/s)	Flow velocity V_1 (m/s)	Velocity head $V_1^2/2g$	Flow velocity V_2 (m/s)	Velocity head $V_2^2/2g$	Loss coefficien f_{se}	Loss head h_{se} (m)	WL_1-WL_2-h_2
MAX	17. 360	1. 521	0. 118	0. 094	0. 000	0. 880	−0. 118	0. 118
Regular	7. 850	0. 688	0. 024	0. 042	0. 000	0. 880	−0. 024	0. 024





2. Total of head loss at head tank

$$hv = h_1 + h_2$$

where, h_1: Head loss due to enlargement of cross sectio (m)

h_2: Surpus (m)

Total of head loss at head tank is shown below.

Part/type of loss		Head loss	
		MAX	Regular
Enlargement of the cross section	h_1	0.000	0.000
Surplus	h_2	0.000	0.000
Total		0.000	0.000

Section 6 Head loss at Penstock

1. Head loss due to inflow

$$h_1 = f_e \cdot \frac{V_2^2}{2g}$$

where,

h_1:	Head loss due to inflow		(m)
f_e:	Inflow loss coefficient	0.050	Bellmouth
V_2:	Velocity after inflow		(m/s)
D:	Pipe diameter		(m)
A:	Sectional area of pipe		(m^2)

Head loss due to inflow in case of Max and regular plant discharge are shown below.

Item	Flow $Q/(m^3/s)$	Pipe diameter D (m)	Sectional area $A(m^2)$	Velocity after inflow V_2 (m/s)	Velocity head $V_2^2/2g$	Loss coefficient f_e	Head loss h_e (m)	
MAX	17.360	2.550	5.107	3.399	0.589	0.050	0.029	
Regular	7.850	2.550	5.107	1.537	0.121	0.050	0.006	

2. Head loss due to friction

$$h_2 = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

where,

h_2:	Head loss due to friction	(m)
f:	Friction loss coefficient	
V:	Velocity in pipe	(m/s)
D:	Pipe diameter	(m)
L:	Pipe length	(m)

Friction loss coefficient of circular cross section channel is calculated by following equation.

$$f = 124.5 \cdot n^2 / D^{1/3}$$

where, n: Manning's roughness coefficient 0.012

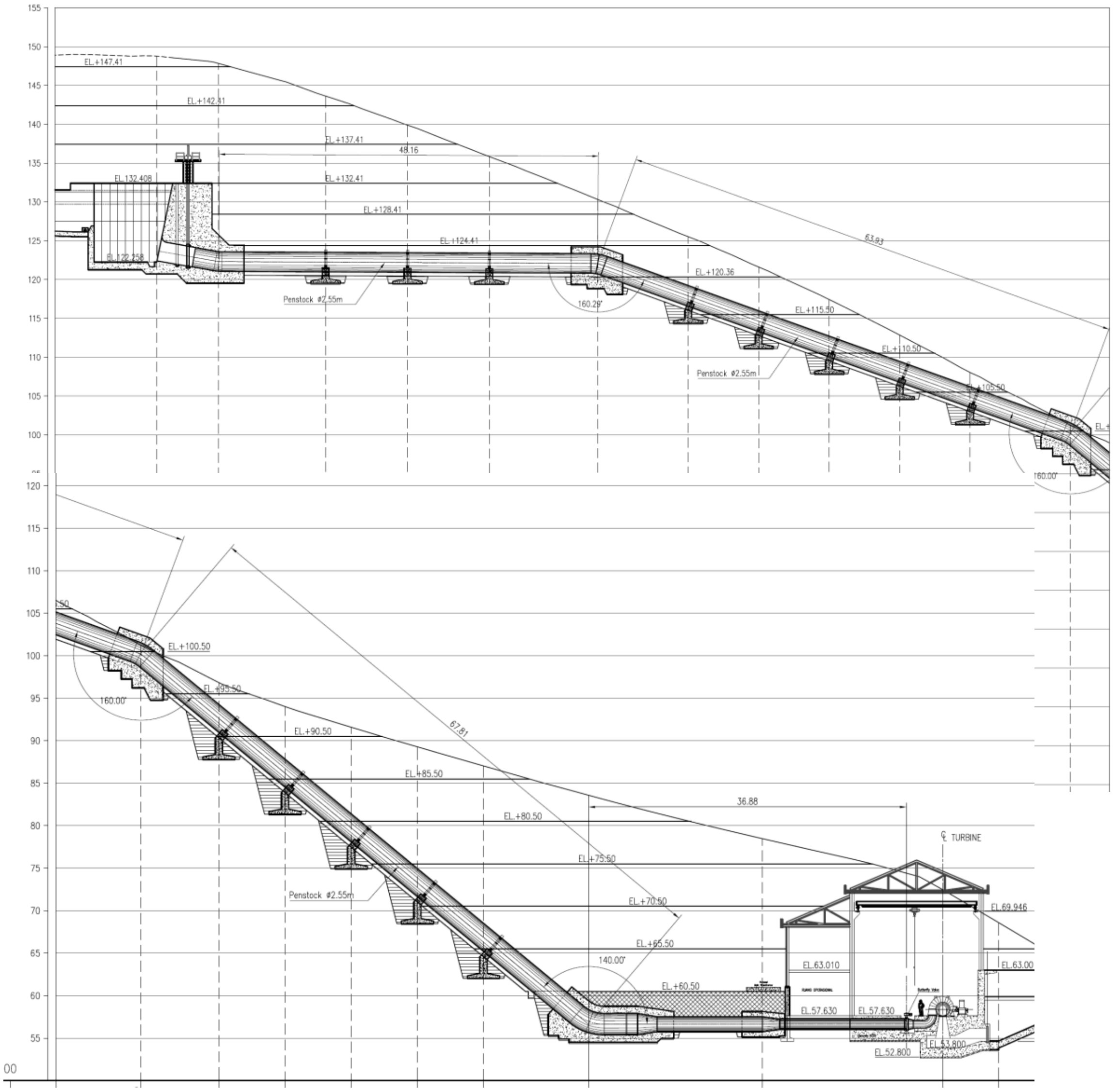
Friction loss coefficients of each diameter of pipe are shown below.

section	Pipe diameter D (m)	Pipe length L (m)	Sectional area $A(m^2)$	Roughness coeffient n	Loss coefficien f	$f \cdot L/D$
P1-branch	2.550	194.37	5.107	0.012	0.0131	0.999
branch-AB4	1.800	15.64	2.545	0.012	0.0147	0.128
AB4-cross section contractic	1.800～1.20	2.00	3.132	0.012	0.0142	0.014
cross section contractic -main	1.200	14.71	1.131	0.012	0.0169	0.207

Head loss due to friction at Max and regular plant discharge are shown below.

section	MAX $Q=$ 17.360			Regular $Q=$ 7.850		
	Velocity in pipe V (m/s)	Velocity head $V^2/2g$	Head loss h_2 (m)	Velocity in pipe V (m/s)	Velocity head $V^2/2g$	Head loss h_2 (m)
P1-branch	3.399	0.589	0.588	1.537	0.121	0.121
branch-AB4	3.411	0.594	0.076	3.084	0.485	0.062
AB4-cross section contractic	5.543	1.568	0.022	2.506	0.320	0.004
cross section contractic -main	7.675	3.005	0.622	6.941	2.458	0.509
計		h_2 =	1.308		h_2 =	0.696

※最大使用水量時は、２台運転であり、分岐下流は1/2流量で流速を算定



3.Head loss due to Y branch

$$h_3 = f_B \cdot \frac{v^2}{2g}$$

where,

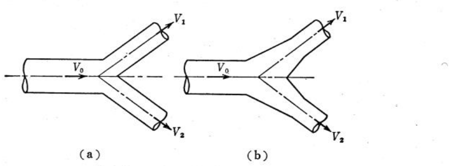
h_3:	Head loss due to Y Branch		(m)
D:	diameter	2.550	(m)
f_B:	loss coefficient	0.5	

Head loss due to Y branch at Max and regular plant discharge are shown below.

Item	Flow	sectional area	Velocity in pipe	Velocity head	loss coefficien	Head loss		
	$Q(m^3/s)$	$A_0(m^2)$	$V_0(m/s)$	$V_0{}^2/2g$	f_B	h_5 (m)		
MAX	17.360	5.107	3.399	0.589	0.500	0.295		
Regular	7.850	5.107	1.537	0.121	0.500	0.061		

普通の対称 Y 分岐 {第3•33図 (a)} $f_B=0.75$

分岐管の始部を円錐状に漸縮した対称 Y 分岐 {第3•33図 (b)} $f_B=0.50$



第 3•33 図 水圧管 Y 分岐

4.Head loss due to bend

$$h_4 = f_{b1} \cdot f_{b2} \cdot \frac{v^2}{2g}$$

where, h_4 : Head loss due to bend (m)

f_{b1} : Loss coefficient decided by radius of curvature of bend ρ and pipe diameter D.

f_{b2} : Loss ratio between central angle θ of arbitrary bend and 90° bend

V: Velocity in pipe (m/s)

Loss coefficient f_{b1}、f_{b2} is calculated by following equation;

$$f_{b1} = 0.131 + 0.1632\left(\frac{D}{\rho}\right)^{7/2} \qquad f_{b2} = \left(\frac{\theta}{90}\right)^{1/2}$$

Loss coefficient of bend on each part is shown below.

Point	Diameter of D (m)	Radius of curvature ρ	D/ρ	Loss coefficien f_{b1}	Angle θ	Loss ratio f_{b2}	$f_{b1} \cdot f_{b2}$
P2	2.550	10.000	0.255	0.132	0.13°	0.0385	0.0051
AB1	2.550	10.000	0.255	0.132	19.52°	0.4657	0.0615
AB2	2.550	10.000	0.255	0.132	20.00°	0.4714	0.0622
AB3	2.550	10.000	0.255	0.132	40.00°	0.6666	0.0880

Head loss due to bend at Max and regular plant discharge is shown below.

Diameter of D (m)	sectional area $A(m^2)$	MAX Q= 17.360			Regular Q= 7.850		
		Velocity in pipe V (m/s)	Velocity head $v^2/2g$	Head loss h_3 (m)	Velocity in pipe V (m/s)	Velocity head $v^2/2g$	Head loss h_3 (m)
2.550	5.107	3.399	0.589	0.003	1.537	0.121	0.001
2.550	5.107	3.399	0.589	0.036	1.537	0.121	0.007
2.550	5.107	3.399	0.589	0.037	1.537	0.121	0.008
2.550	5.107	3.399	0.589	0.052	1.537	0.121	0.011
計			h_4 =	0.128		h_4 =	0.027

5. Head loss due to sudden contraction of cross section

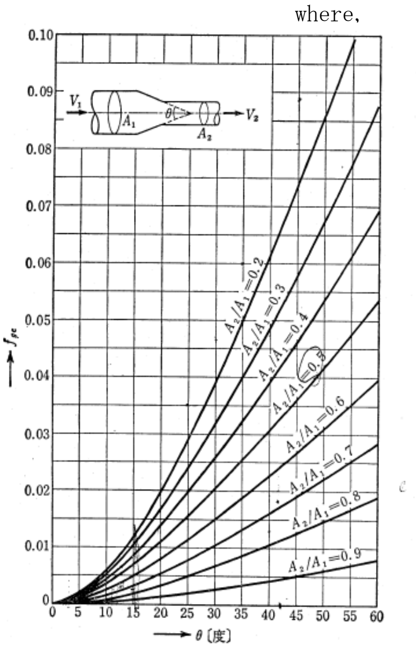
$$h_5 = f_{gc} \cdot \frac{V_2^{\ 2}}{2g}$$

where,

h_5:	Head loss due to sudden contraction of cross section	*(m)*
f_{gc}:	Contraction loss coefficient	
V_2:	Flow velocity after contraction	*(m/s)*

Head loss due to contraction at Max and regular plant discharge is shown below.

Pipe diameter *D (m)*	Area before $A_{1(m2)}$	Area after contractio $A_{2\ (m2)}$	Length *L*	A_2/A_1	Angle of contractio θ	Loss coefficint f_{gc}	
1.80～1.20	2.545	1.131	2.000	0.444	17.100	0.01	



where,

D:	Pipe diameter	*(m)*
A_1:	Area before contraction	(m^2)
A_2:	Area after contraction	(m^2)
θ:	Angle of contraction	*(°)*

$= \tan^{-1}(((A_1/\pi)^{0.5}-(A_2/\pi)^{0.5})/L)\times 2$

Head loss due to contraction at Max and regular plant discharge is shown below.

No.	MAX Q=		17.360	Regular Q=		7.850
	Velocity in pipe $V_{(m/s)}$	Velocity head $V^2/2g$	Head loss $h_{4(m)}$	Velocity in pipe $V_{(m/s)}$	Velocity head $V^2/2g$	Head loss $h_{4(m)}$
1	15.349	12.020	0.120	6.941	2.458	0.025
計		h_5 =	0.120		h_5 =	0.025

6. Total of head loss in penstock

$$h_{IV} = h_1 + h_2 + h_3 + h_4 + h_5 + h_6$$

where,

h_1: Head loss due to flow (m)
h_2: Head loss due to Friction (m)
h_3: Head loss due to Y Branch (m)
h_4: Head loss due to Bend (m)
h_5: Head loss due to Cross section contraction (m)
h_6: Surplus (m)

Total of head loss in penstock is shown below.

Part/type of loss		Head loss	
		MAX	Regular
Flow	h_1	0.029	0.006
Friction	h_2	1.308	0.696
Y Branch	h_3	0.295	0.061
Bend	h_4	0.128	0.027
Cross section contraction	h_5	0.120	0.025
Surplus	h_6	0.000	0.000
計	h_{VI}	1.880	0.815

Section 7 Head loss at Tailrace

1. Head loss due to submerged weir

・・・・・overflow formula of trapezoid shaped weir by HONMA

$$Q = C' \cdot B \cdot H_2 \cdot (H_1 - H_2)^{1/2}$$ ・・・・・・at submerged overflow

where,

Q:	flow	(m^3/s)
C:	coefficient of perfect overflow	
C':	coefficient of submerged overflow	
H_1:	upstream depth	(m)
H_2:	downstream depth	(m)
B:	weir width	(m)
W:	weir height	(m)

Coefficient of overflow is calculated shown below as over 5/3 of upstream slope and 0～4/3 of downstream slope

Overflow condition in case of Max and regular plant discharge are submerged overflow.

$$C = 1.37 + 1.02 \frac{H_1}{W}$$

$$C' = C \times 2.6$$

where,

B:	weir width	12.000	(m)
W:	weir height	0.500	(m)
	elevation of weir	59.000	(m)

Head loss due to submerged weir in case of Max and regular plant discharge are shown below.

Item	Flow Q (m^3/s)	Upstream level WL_1	Upstream depth H_1	Downstream level WL_2	Downstream depth H_2	H_2/H_1	Result	
MAX	17.360	59.666	0.666	59.500	0.500	0.750	>0.7	submerged
Regular	7.850	59.541	0.541	59.500	0.500	0.924	>0.7	submerged

Item	coefficient of perfect overflow C	coefficient of submerged overflow C'	$C' \cdot B \cdot H_2 \cdot (H_1 - H_2)^{1/2}$	$h_1 = H_1 - H_2$			
MAX	2.729	7.096	17.360	0.166			
Regular	2.474	6.433	7.850	0.041			

2. Head loss due to cross section changes

$$h_2 = \frac{V_2^2 - V_1^2}{2g}$$

where, h_2: Head loss due to cross section changes (m)
V_1: Velocity of upstream (m)
V_2: Velocity of downstream (m)

Item	Upstream level WL_1	Upstream sill Z_1	Upstream depth H_1	Upstream width B_1	downstream level WL_2	downstream sill Z_2	downstream depth H_2	downstream width B_2
MAX	59.905	54.646	5.259	20.000	59.666	59.000	0.666	12.000
Regular	59.616	54.646	4.970	20.000	59.541	59.000	0.541	12.000

Item	Flow $Q\ (m^3/s)$	Cross-sectional area of upstream A_1	Cross-sectional area of downstream A_2	Velocity of upstream V_1	Velocity of downstream V_2	Head loss h_2	WL_1-WL_2-h_2
MAX	17.360	105.188	7.995	0.165	2.171	0.239	0.000
Regular	7.850	99.391	6.496	0.079	1.208	0.074	0.000

3. Head loss due to sudden enlargement

$$h_3 = f_o \cdot \frac{V_1^2}{2g}$$

where, h_3: Head loss due to sudden enlargement (m)
f_o: loss coefficient of exit 1.0
V_1: Velocity before sudden enlargement (m/s)

$$f_o = \left\{1 - \left(\frac{A_1}{A_2}\right)\right\}^2$$

fo is calculated as A2=∞ in the formula for coefficient of sudden enlargement
Q is flow of each turbine.

Shape square
B: Tailrace depth 3.000 (m)
H: Tailrace width 1.000 (m)

Item	Flow $Q\ (m^3/s)$	Cross-sectional area before sudden enlargement $A_1\ (m^2)$	Cross-sectional area after sudden enlargement $A_2\ (m^2)$	Velocity before sudden enlargement $V_1\ (m/s)$	Velocity head $V_1^2/2g$	Loss coefficient f_o	Head loss $h_3\ (m)$
MAX	8.680	3.000	105.188	2.893	0.427	0.944	0.403
Regular	3.925	3.000	99.391	1.308	0.087	0.941	0.082

4. Total of head loss in tailrace

$$h_{VII} = h_1 + h_2 + h_3 + h_4$$

where,
h_1: Head loss due to submerged weir (m)
h_2: Head loss due to cross section changes (m)
h_3: Head loss due to sudden enlargement (m)
h_4: Surplus (m)

Total of head loss in tailrace is shown below.

		Head loss	
		MAX	Regular
Submerged weir	h_1	0.166	0.041
Cross section change	h_2	0.239	0.074
sudden enlargement	h_3	0.403	0.082
Surplus	h_4	0.000	0.000
Total	h_{VII}	0.808	0.198

Section 8　Total of Head losses

Total of head loss from intake through tailrace channel is shown below.

Item	MAX	Regular
Intake	0.672	1.925
Intake Channel	0.591	0.446
Desilting basin	0.173	0.083
Headrace	1.556	0.538
Head tank	0.000	0.000
Penstock	1.880	0.815
Tailrace	0.808	0.198
Others	0.320	0.095
合　　計	6.000	4.100

Section 9　Calculation of Effective head

Item	Unit	MAX	Regular
Plant discharge	m^3/s	17.360	7.850
Intake level	m	134.500	134.500
Tailrace level	m	59.500	59.500
Gross head	m	75.000	75.000
Head loss	m	6.000	4.100
Effective head	m	69.000	70.900

Chapter 2 Calculation of theoretical water-power and generating power

Section 1 Calculation of theoretical water-power

$$P_e = 9.8 \cdot H_m \cdot Q_m$$

where,

Pe:	Theoretical water-power	*(kW)*
Hm:	Effective head	*(m)*
Qm:	Plant discharge	*(m3/s)*

Per Unit

	Unit	MAX	Regular
Plant discharge: Q_m	m^3/s	8.680	7.850
Effective head: H_m	m	69.000	70.900
Theoretical water-power: P_e	kW	5,869	5,454

Section 2 Calculation of generating power

$$E = P_e \cdot \eta_1 \cdot \eta_2$$

where,

E:	Theoretical water power	*(kW)*
Pe:	Effective head	*(kW)*
$\eta 1$:	Plant discharge	
$\eta 2$:	Efficiency of generator	

	Unit	MAX	Regular
Theoretical water-power : P_e	kW	5,869	5,454
Combined coefficiency : η_2		0.853	0.870
Generating power : E	kW	5,000	4,745

×2		10,000

Appendix N4-2
Stability calculation of intake weir
(Nasal Location)

(1)Design condition

1) Reference

①	Ministry of construction River errosion control technical standard	1997	Japan rivers association
②	The structural mechanics handbook	1997	Japan society of civil engineer
③	Feasibility Study Basic Engineering Design	2011	

2) 材料条件

Concrete					
Unit weight	γ_c	kN/m^3	24.0		Reference③
Masonry block					
Unit weight	γ_s	kN/m^3	22.0		Reference③
Design strength	σ_{ck}	N/mm^2	－		
Allowable bending compressive stress intensity	σ_{ca}	N/mm^2	－		
Allowable shearing stress intensity	τ_a	N/mm^2	－		

3) Natural condition

(a)Soil condition (sedimentation)					
Unit weight (wet)	γ_t	kN/m^3	17.65		Reference①
Unit weight (Underwater)	γ_s	kN/m^3	9.81		Reference①
(b)Foundation ground					
Compressive strength	q_u	kN/m^2	9810		Reference①
Allowable bearing capacity (At normal)	σ	kN/m^2	588		Reference①
Allowable bearing capacity (During earthquake)		kN/m^2	883		Reference①
Internal friction angle	φ	°	35.0		Reference①
Cohesion	C	kN/m^2	0.0		Reference①
(C)Design horizontal seismic coefficient					
Standard seismic coefficient	κ_o		0.20		Reference①
Zoning factor	γ_1		1.00		Reference①
Ground condition factor	γ_2		1.20		Reference①
Design horizontal seismic coefficient	κ_h		0.24		Reference①
Overdesign factor (Normal)	α		1.00		Reference①
Overdesign factor (Short time)	α		1.50		Reference①
(d)Design water level					
Dam top height	EL	m	134.50		Reference③
At design flood level	WL	m	139.83		Reference③
At normal water level	WL	m	134.50		Reference③
Design sedimentation level(No sediment)	EL	m	122.00		Reference③
Design sedimentation level(Full sediment)	EL	m	134.50		Reference③
Elevation of dam foundation rock	EL	m	122.00		Reference③
			At top watrer level (During earthquake)	At design flood level(Normal)	
Wave caused by wind	h_w	m	－	－	Reference①
Wave caused by earthquake	h_e	m	0.63	－	Reference①
Design seismic coefficient	κ_h		0.24	－	Reference①
Earthquake frequency	τ		1.00	1.00	Reference①
Reservoir water depth	H_o		6.90	11.10	
Design water level (Upstream)	WL	m	135.35	139.83	Reference①
Design water level (Downstream)	WL	m	122.00	122.00	Reference③

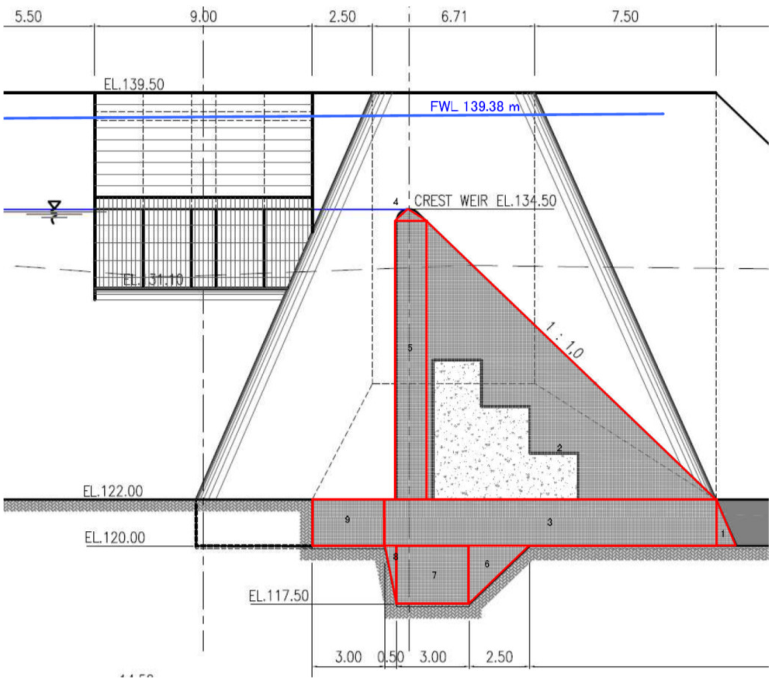
4) Loading condition

			At top watrer level (During earthquake)	At design flood level(Normal)	
(a)Dead load	W	kN/m^2	3179.83	3179.83	
(b)Soil and water weight					
(c) Seismic inertia force					
Inertia force by dam dead load	P_f	kN/m^2	763.16	-	Reference①
(d)Static water pressure (Upstream)					
Static water pressure from water surface to depth h	$P_{w'}$	kN/m^2	130.96	174.91	Reference①
Total of static water pressure from water surface to depth h	P_w	kN/m^2	874.18	1,559.34	Reference①
Unit weight of water	γ_w	kN/m^3	9.81	9.81	
Depth from surface	h_1	m	13.35	17.83	
Static water pressure (Downstream)					
Static water pressure from water surface to depth h	$P_{w'}$	kN/m^2	-	52.29	Reference①
Total of static water pressure from water surface to depth h	P_w	kN/m^2	-	139.35	Reference①
Unit weight of water	γ_w	kN/m^3	9.81	9.81	Reference①
Depth from surface	h_2	m	-	5.33	
(e)Uplift pressure (Buoyancy)					
Uplift pressure on upstream end	P_u	kN/m^2	4.45	9.50	Reference①
Uplift pressure on downstream end	$P_{u'}$	kN/m^2	-	1.78	Reference①
Uplift coefficient	μ		0.3333	0.3333	Reference①
(f)Mud pressure					
Horizontal direction mud earth pressure from sediment surface to depth d	$P_{e'}$	kN/m^2	-	-	Reference①
Total of horizontal direction mud earth pressure from seddiment surface to depth d	P_e	kN/m^2	-	-	Reference①
Mud pressure coefficient	C_e		0.5	0.5	Reference①
Unit weight of sedimentation (underwater)	W_1	kN/m^3	9.81	9.81	Reference①
Depth from sediment surface (No sediment)	d		-	-	
Depth from sediment surface (Full sediment)	d		12.50	12.50	
(g)Dynamic water pressure during earthquake					
Dynamic water pressure from water surface to depth h	$P_{d'}$	kN/m^2	27.50	-	Reference①
Total dynamic water pressure from water surface to depth h	P_d	kN/m^2	244.77	-	Reference①
Unit weight of water	γ_w	kN/m^3	9.81	9.81	Reference①
Design horizontal seismic coefficient	κ_h		0.24	-	Reference①
Depth from water surfece to foundation ground	H	m	13.35	17.83	
Depth from surface	h	m	13.35	17.83	

5) Stability condition

			At top watrer level (During earthquake)	At design flood level(Normal)	
(a)Stability against sliding					
Vertical load on dam base bottom	ΣV				
Horizontal load on dam base bottom	ΣH				
Friction factor between dam bottom and bearing ground	f		0.70	0.70	Reference①
Shear strength of rock mass	τ_B		618	411	Reference①
Friction angle between dam base bottom and bearing ground	φ_B	°	35.0	35.0	Reference③
Cohesion between dam base bottom and bearing ground	C		0.0	0.0	Reference③
Allowble bearing capacity	σ		883	588	Reference③
Bottom width of Dam(Overflow section)	L		16.71	16.71	Reference③
Bottom width of Dam (Dam pillar section)					
(b)Stability against overturning					
Distance from point of application of resultant force R to around toe of dam bottom	d				
Resisting moment around toe of dam base	ΣM_r				
Overturning moment around toe of dam base	ΣM_o				
Vertical component of load acting to dam	V_i				
Horizontal distance from toe of dam bottom to point of application of V_i	a_i				
horizontal component of load acting to	H_j				
Height of point application of H_j from dam bottom	b_j				
Bottom width of Dam(Overflow section)	L		16.71	16.71	Reference③
(c) Stability against bearing capacity of bearing ground					
Allowble bearing capacity of ground	q_a				
Modulus of subgrade reaction	q_1				
Modulus of subgrade reaction	q_2				

6) Model of loading calculation



(2)Stability calculation (No sediment-top water level-during earthquake)

1) Loading calculation

(a) Dead load

Loading item	Cross section shape		Vertical force		Arm	Resisting moment
			Calculation	V (kN)	x (m)	V・x (kN・m)
1	Triangle	W1	24 ×1.000	24.000	-0.333	-8.000
2	Triangle	W2	24 ×72.000	1,728.000	8.000	13,823.862
3	Rectangle	W3	24 ×27.420	658.080	6.855	4,511.138
4	Triangle	W4	24 ×0.303	7.272	12.605	91.664
5	Rectangle	W5	24 ×14.520	348.480	12.605	4,392.590
6	Triangle	W6	24 ×3.125	75.000	9.877	740.749
7	Rectangle	W7	24 ×7.500	180.000	11.710	2,107.800
8	Triangle	W8	24 ×0.625	15.000	13.377	200.650
9	Rectangle	W9	24 ×6.000	144.000	15.210	2,190.240
Total				3,179.832		28,050.693

(b) Water weight or Mud weight

Loading item	Cross section shape		Vertical force		Arm	Resisting moment
			Calculation	V (kN)	x (m)	V・x (kN・m)
A	Rectangle	WA	9.81 × ×43.750	429.188	14.960	6,420.652
Total				429.188		6,420.652

(c) Horizontal force due to static water pressure

Loading item	Pressure distribution	Horizontal force		Arm	Overturning moment
		Calculation	H (kN)	y (m)	H・y (kN・m)
Upstream	Triangle(H1)	9.81 × 13.350 ^{2} × 0.5	874.181	4.450	3,890.105
Downstream		9.81 × 0.000 ^{2} × 0.5	0.000	0.000	
Total			874.181		3,890.105

(d) Uplift pressure

Loading item		Vertical force				Arm	Resising moment
		Upstream end(kN/m^2)	Downstream end(kN/m^2)		V (kN)	x (m)	V・x (kN・m)
Bottom	Triangle(U1)	-4.450	0.000	→	-37.180	5.570	-207.093
	Rectangle	0.000	0.000	→	0.000	8.355	
Total					-37.180		-207.093

(e) Horizontal force due to mud pressure

Loading item	Pressure distribution	Horizontal force		Arm	Overturning moment
		Calculation	H (kN)	y (m)	H・y (kN・m)
Upstream	Triangle(D1)	0.5×9.81× 0.0 ^{2} × 0.5	0.000	0.000	
Downstream	None				
Total			0.000		0.000

(f) Dam dead load, Inertia force (kh= 0.24)

Loading item	Cross section shape		Vertical force V (kN)	Horizontal force H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
1	Triangle	W1	24.000	5.760	-1.333	-7.680
2	Triangle	W2	1,728.000	414.720	4.000	1,658.714
3	Rectangle	W3	658.080	157.939	-1.000	-157.939
4	Triangle	W4	7.272	1.745	12.167	21.231
5	Rectangle	W5	348.480	83.635	6.000	501.810
6	Triangle	W6	75.000	18.000	-2.833	-51.000
7	Rectangle	W7	180.000	43.200	-3.250	-140.400
8	Triangle	W8	15.000	3.600	-2.833	-10.200
9	Rectangle	W9	144.000	34.560	-1.000	-34.560
Total				763.159		1,779.976

(g) Horizontal force due to dynamic water pressure

Loading item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Westergaard	(7／12)×9.81×0.112× 13.350 2	244.771	5.340	1,307.077
Downstream		(7／12)×9.81×0.112× 0.000 2	0.000	0.000	0.000
Total			244.771		1,307.077

(h) Total of applied loading

Loading item	Verical force V (kN)	Resisting moment Mr (kN・m)	Horizontal force H (kN)	Overturning moment Mo (kN・m)
Dead load	3,179.832	28,050.693	—	—
Water and mud weight	429.188	6,420.652	—	—
Static water pressure (Horizontal force)	—	—	874.181	3,890.105
Uplift pressure	-37.180	-207.093	—	—
Mud pressure	—	—	0.000	0.000
Inertia force	—	—	763.159	1,779.976
Dynamic water pressure	—	—	244.771	1,307.077
Total	3,571.840	34,264.252	1,882.111	6,977.158

2) Stability analysis

(a) Stability analysis against sliding

Safety factor against sliding Fs is calculated by Henny's equation.

$$y\ \frac{f\cdot\Sigma V+\tau\cdot L}{\Sigma H} = \frac{0.7 \times 3571.840 + 617 \times 16.710}{1882.111} = 6.81$$

where,
- ΣV : Vertical load on dam base bottom (= 3571.840 kN/m)
- ΣH : Horizontal load on dam base bottom (= 1882.111 kN/m)
- f : Friction factor between dam bottom and bearing ground
  $f=\mu=\tan\phi_B=$ 0.7
- τ : Shearing strength of rock mass (kN/m^2)
  use coulomb's equation provided this, 「C_B=0、σ =allowable bearing capacity」
  $\tau=(C_B+\sigma\cdot\tan\phi_B)\times 1.5=$ 617
- B : Bottom width for sliding analysis (= 16.710 m)

Thus, stability analysis against sliding is following, which is stable.

Fs= 6.81 ≧ 1.2 (Safety factor)

(b) Stability analysis against overturning

Distance d from point of application of resultant force R to around toe of dam bottom:

$$d = \frac{\Sigma Mr-\Sigma Mo}{\Sigma V} = \frac{34,264.252 - 6,977.158}{3,571.840} = 7.640 \quad (m)$$

where,
- ΣMr : Resisting moment around toe of dam bottom (= 34,264.252 kN·m)
- ΣMo : Overturning moment around toe of dam botto (= 6,977.158 kN·m)

Distance|e| from point of application of resultant force R to center of bottom:

$$|e| = |(B/2)-d| = |(16.710 / 2)- 7.640 | = | 0.715 | = 0.715 \quad (m)$$

where, B : Bottom width for overturning analysis (= 16.710 m)

Thus, results of stability analysis against overturning shows below.

Case : during earthquake

|e|= 0.715 ≦ B/6 = 2.785 (m)····Equation of analysis at regular q_1
(reference value)

|e|= 0.715 ≦ B/3 = 5.570 (m)····Equation of analysis under seismic motion
(result : OK)

(c) Stability analysis against bearing capacity of foundation ground

Point of application of resultant force R is in 1/3 of bottom width.

Thus, modulus of subgrade reaction shows trapezoidal distribution that express following equation.

$$q1, q2 = \frac{\Sigma V}{B}\left(1 \pm \frac{6\cdot e}{B}\right)$$

Thus, allowable bearing stress of ground at normal in this design: 588 (kN/m^2)

Stability anaylysis against bearing capacity of foundation ground is following which is stable.

q1 = 268.632 ≦ 882 (kN/m^2)
q2 = 158.877 ≦ 882 (kN/m^2)

(3)Stability calculation (No sediment-Design flood level-Normal)

1) Loading calculation

(a) Dead load

Loading item	Cross section shape	Vertical force Calculation	V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
1	Triangle W1	24 ×1.000	24.000	-0.333	-8.000
2	Triangle W2	24 ×72.000	1,728.000	8.000	13,823.862
3	Rectangle W3	24 ×27.420	658.080	6.855	4,511.138
4	Triangle W4	24 ×0.303	7.272	12.605	91.664
5	Rectangle W5	24 ×14.520	348.480	12.605	4,392.590
6	Triangle W6	24 ×3.125	75.000	9.877	740.749
7	Rectangle W7	24 ×7.500	180.000	11.710	2,107.800
8	Triangle W8	24 ×0.625	15.000	13.377	200.650
9	Rectangle W9	24 ×6.000	144.000	15.210	2,190.240
Total			3,179.832		28,050.693

(b) Water weight or Mud weight

Loading item	Cross section shape	Vertical force Calucution	V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
A	Rectangle WA	9.81 × ×43.750	429.188	14.960	6,420.652
Total			429.188		6,420.652

(c) Horizontal force due to static water pressure

Loading item	Pressure	Horizontal force Calcuration	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Triangle(H1)	9.81 × 17.830 ^{2} × 0.5	1,559.343	5.943	9,267.175
Upstream	Triangle(deducted)	9.81 × -4.200 ^{2} × 0.5	-86.524	11.700	-1,012.331
Downstream		9.81 × 0.000 ^{2} × 0.5	0.000	0.000	
Total			1,472.819		8,254.844

(d) Uplift pressure

Loading item		Vertical force upstream (kN/m^2)	Downstream (kN/m^2)		V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
Bottom	Triangle(U1)	-5.943	0.000	→	-49.654	5.570	-276.573
	Rectangle	0.000	0.000	→	0.000	8.355	
total					-49.654		-276.573

(e) Horizontal force due to Mud pressure

Load item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Triangle(D1)	0.5×9.81× 0.0 ^{2} × 0.5	0.000	0.000	
Downs	None				
Total			0.000		0.000

(f) Total of applied loading

Load item	Vertical force V (kN)	Resisting moment Mr (kN・m)	Horizontal force H (kN)	Overturning moment Mo (kN・m)
Dead load	3,179.832	28,050.693	—	—
Water or Mud weight	429.188	6,420.652	—	—
Static pressure	—	—	1,472.819	8,254.844
Uplift	-49.654	-276.573	—	—
Mud pressure	—	—	0.000	0.000
Total	3,559.366	34,194.772	1,472.819	8,254.844

2） Stability analysis

(a) Stability analysis against sliding

Safety factor against sliding Fs is calculated by Henny's equation.

$$y\ \frac{f\cdot\Sigma V+\tau\cdot L}{\Sigma H}=\frac{0.7\times 3559.366+411\times 16.710}{1472.819}=6.35$$

where, ΣV : Vertical load on dam base bottom (= 3559.366 kN/m)

ΣH : Horizontal load on dam base bottom (= 1472.819 kN/m)

f : Friction factor between dam bottom and bearing ground

$f=\mu=\tan\phi_B=$ 0.7

τ : Shearing strength of rock mass (kN/m^2)

use coulomb's equation provided this, 「C_B=0、σ=allowable bearing capacity」

$\tau=C_B+\sigma\cdot\tan\phi_B=$ 411

B : Bottom width for sliding analysis (= 16.710 m)

Thus, stability analysis against sliding is following, which is stable.

Fs= 6.35 ≧ 1.5 (safety factor)

(b) Stability analysis against overturning

Distance d from point of application of resultant force R to around toe of dam bottom:

$$d=\frac{\Sigma Mr-\Sigma Mo}{\Sigma V}=\frac{34,194.772-8,254.844}{3,559.366}=7.288\ (m)$$

where, ΣMr : Resisting moment around toe of dam bottom (= 34,194.772 kN·m)

ΣMo : Overturning moment around toe of dam bottom 8,254.844 kN·m)

Distance |e| from point of application of resultant force R to center of dam bottom:

$|e|=|(B/2)-d|=|(16.710/2)-7.288|=|1.067|=1.067$ (m)

where, B : Bottom width for overturning analysis (= 16.710 m)

Thus, result of stability analysis against overturning shows below.

Case : Normal

$|e|=1.067\leqq B/6=2.785$ (m)····Equation of analysis at regular (result : OK)

$|e|=1.067\leqq B/3=5.570$ (m)····Equation of analysis during earthquake (reference value)

(c) Stability analysis against bearing capacity of foundation ground

Point of application of resultant force R is in 1/3 of bottom width.

Thus, modulus of subgrade reaction shows trapezoidal distribution that express following equation.

$$q1,q2=\frac{\Sigma V}{B}\left(1\pm\frac{6\cdot e}{B}\right)$$

Thus, allowable bearing stress of ground at normal in this design 588 (kN/m^2)

Stability analysis against bearing capacity of foundation ground is following, which is stable

$q1=294.617\leqq 588$ (kN/m^2)

$q2=131.400\leqq 588$ (kN/m^2)

(4) Stability calculation (Full sediment-Top water level- during earthquake)

1) Loading calculation

(a) Dead load

Loading item	Cross section shape	Vertical force Calculation	V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
1	Triangle W1	24 ×1.000	24.000	-0.333	-8.000
2	Triangle W2	24 ×72.000	1,728.000	8.000	13,823.862
3	Rectangle W3	24 ×27.420	658.080	6.855	4,511.138
4	Triangle W4	24 ×0.303	7.272	12.605	91.664
5	Rectangle W5	24 ×14.520	348.480	12.605	4,392.590
6	Triangle W6	24 ×3.125	75.000	9.877	740.749
7	Rectangle W7	24 ×7.500	180.000	11.710	2,107.800
8	Triangle W8	24 ×0.625	15.000	13.377	200.650
9	Rectangle W9	24 ×6.000	144.000	15.210	2,190.240
Total			3,179.832		28,050.693

(b) Water weight or Mud weight

Loading item	Cross section shape	Vertical force Calculation	V (kN)	Arm x (m)	Resiting moment V・x (kN・m)
A	Rectangle WA	9.81 × ×43.750	429.188	14.960	6,420.652
Total			429.188		6,420.652

(c) Horizontal force due to static water pressure

Loading item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Triangle (H1)	$9.81 \times 13.350^2 \times 0.5$	874.181	4.450	3,890.105
Downstream		$9.81 \times 0.000^2 \times 0.5$	0.000	0.000	
Total			874.181		3,890.105

(d) Uplift pressure

Loading item		Upstream end (kN/m²)	Downstream end (kN/m²)		V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
Bottom	Triangle (U1)	-4.450	0.000	→	-37.180	5.570	-207.093
	Rectangle	0.000	0.000	→	0.000	8.355	
Total					-37.180		-207.093

(e) Horizontal force due to mud pressure

Loading item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Triangle (D1)	$0.5 \times 9.81 \times 12.5^2 \times 0.5$	383.203	4.167	1,596.807
Downstream	None				
Total			383.203		1,596.807

(f) Dead load/innertia force (kh= 0.24)

Loading item	Cross section shape	Vertical force	Horizontal force	Arm	Overturning moment
		V (kN)	H (kN)	y (m)	H・y (kN・m)
1	Triangle W1	24.000	5.760	-1.333	-7.680
2	Triangle W2	1,728.000	414.720	4.000	1,658.714
3	Rectangle W3	658.080	157.939	-1.000	-157.939
4	Triangle W4	7.272	1.745	12.167	21.231
5	Rectangle W5	348.480	83.635	6.000	501.810
6	Triangle W6	75.000	18.000	-2.833	-51.000
7	Rectangle W7	180.000	43.200	-3.250	-140.400
8	Triangle W8	15.000	3.600	-2.833	-10.200
9	Rectangle W9	144.000	34.560	-1.000	-34.560
Total			763.159		1,779.976

(g) Horizontal force due to dynamic water pressure

Loading item	Pressure distribution	Horizontal force		Arm	Overturning moment
		Calculation	H (kN)	y (m)	H・y (kN・m)
Upstream	Westergaard	(7／12)×9.81×0.112× 13.350 2	244.771	5.340	1,307.077
Downstream		(7／12)×9.81×0.112× 0.000 2	0.000	0.000	0.000
Total			244.771		1,307.077

(h) Total of applied loading

Loading item	Vertical force	Resisting moment	Horizontal force	Overturning moment
	V (kN)	Mr (kN・m)	H (kN)	Mo (kN・m)
Dead load	3,179.832	28,050.693	—	—
water of mud weight	429.188	6,420.652	—	—
Static water pressure (Horizontal force)	—	—	874.181	3,890.105
Uplift pressure	-37.180	-207.093	—	—
Mud pressure	—	—	383.203	1,596.807
Inneria force of dead load	—	—	763.159	1,779.976
Dynamic water pressure	—	—	244.771	1,307.077
Total	3,571.840	34,264.252	2,265.314	8,573.965

2） Stability analysis

(a) Stability analysis against sliding

Safety factor against sliding Fs is calculated by Henny's equation.

$$y \quad \frac{f\cdot \Sigma V + \tau \cdot L}{\Sigma H} = \frac{0.7 \times 3571.840 + 617 \times 16.710}{2265.314} = 5.66$$

where, ΣV : Vertical load on dam base bottom (= 3571.840 kN/m)

ΣH : Horizontal load on dam base bottom (2265.314 kN/m)

f : Friction factor between dam bottom and bearing ground

$f = \mu = \tan\phi_B =$ 0.7

τ : Shearing strength of rock mass (kN/m^2)

use coulomb's equation provided this, 「C_B=0、σ =allowable bearing capacity」

$\tau = (C_B + \sigma \cdot \tan\phi_B) \times 1.5 =$ 617

B : Bottom width for sliding analysis (= 16.710 m)

Thus, stability analysis against sliding is following, which is stable.

Fs= 5.66 ≧ 1.2 (Safety factor)

(b) Stability analysis against overturning

Distance d from point of application of resultant force R to around toe of dam bottom:

$$d = \frac{\Sigma Mr - \Sigma Mo}{\Sigma V} = \frac{34,264.252 - 8,573.965}{3,571.840} = 7.192 \quad (m)$$

where, ΣMr : Resisting moment around toe of dam bottom (= 34,264.252 kN・m)

ΣMo : Overturning moment around toe of dam bottom (= 8,573.965 kN・m)

Distance |e| from point of application of resultant force R to center of dam bottom:

$|e| = |(B/2) - d| = |(16.710 / 2) - 7.192 | = | 1.163 | = 1.163$ (m)

where, B : Bottom width for overturning analysis (= 16.710 m)

Thus, result of stability analysis against overturning shows below.

Case : during earthquake

|e|= 1.163 ≦ B／6 = 2.785 (m)・・・・Equation of analysis at regular (reference value)

|e|= 1.163 ≦ B／3 = 5.570 (m)・・・・Equation of analysis during earthquake (result : ＯＫ)

(c) Stability analysis against bearing capacity of foundation ground

Point of application of resultant force R is in 1/3 of bottom width.

Thus, modulus of subgrade reaction shows trapezoidal distribution that express following equation.

$$q1, q2 = \frac{\Sigma V}{B} \left(1 \pm \frac{6\cdot e}{B} \right)$$

Thus, allowable bearing stress of ground at normal in this design 588 (kN/m^2)

Stability analysis against bearing capacity of foundation ground is following, which is stable

q1 = 303.017 ≦ 882 (kN/m^2)

q2 = 124.492 ≦ 882 (kN/m^2)

(5) Stability calculation (Full sediment-Design flood level-Normal)

1) Loading calculation

(a) Dead load

Loading item	Cross section shape	Vertical force Calculation	V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
1	Triangle W1	24 ×1.000	24.000	-0.333	-8.000
2	Triangle W2	24 ×72.000	1,728.000	8.000	13,823.862
3	Rectangle W3	24 ×27.420	658.080	6.855	4,511.138
4	Triangle W4	24 ×0.303	7.272	12.605	91.664
5	Rectangle W5	24 ×14.520	348.480	12.605	4,392.590
6	Triangle W6	24 ×3.125	75.000	9.877	740.749
7	Rectangle W7	24 ×7.500	180.000	11.710	2,107.800
8	Triangle W8	24 ×0.625	15.000	13.377	200.650
9	Rectangle W9	24 ×6.000	144.000	15.210	2,190.240
Total			3,179.832		28,050.693

(b) Water weight or Mud weight

Loading item	Cross section shape	Vertical force Calculation	V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
A	Rectangle WA	9.81 × ×43.750	429.188	14.960	6,420.652
Total			429.188		6,420.652

(c) Horizontal force due to static water pressure

Loading item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning momnst H・y (kN・m)
Upstream	Triangle (H1)	$9.81 \times 17.830^2 \times 0.5$	1,559.343	5.943	9,267.175
Upstream	Triangle (deducted)	$9.81 \times -4.200^2 \times 0.5$	-86.524	11.700	-1,012.331
Downstream		$9.81 \times 0.000^2 \times 0.5$	0.000	0.000	
Total			1,472.819		8,254.844

(d) Uplift pressure

Loading item		Upstream (kN/m^2)	Downstream (kN/m^2)		V (kN)	Arm x (m)	Resisting moment V・x (kN・m)
Bottom	Triangle (U1)	-5.943	0.000	→	-49.654	5.570	-276.573
	Rectangle	0.000	0.000	→	0.000	8.355	
Total					-49.654		-276.573

(e) Horizontal force due to Mud pressure

Loading item	Pressure distribution	Horizontal force Calculation	H (kN)	Arm y (m)	Overturning moment H・y (kN・m)
Upstream	Triangle (D1)	$0.5 \times 9.81 \times 12.5^2 \times 0.5$	488.281	4.167	2,034.667
Downstream	None				
Total			488.281		2,034.667

(f) Total of applied loading

Loading item	Vertical force V (kN)	Resisting moment Mr (kN・m)	Horizontal force H (kN)	Overturning moment Mo (kN・m)
Dead load	3,179.832	28,050.693	—	—
Water of Mud weight	429.188	6,420.652	—	—
Static pressure	—	—	1,472.819	8,254.844
Uplift	-49.654	-276.573	—	—
Mud pressure	—	—	488.281	2,034.667
Total	3,559.366	34,194.772	1,961.100	10,289.511

2) Stability analysis

(a) Stability analysis against sliding

Safety factor against sliding Fs is calculated by Henny's equation.

$$y \frac{f \cdot \Sigma V + \tau \cdot L}{\Sigma H} = \frac{0.7 \times 3559.366 + 411 \times 16.710}{1961.100} = 4.77$$

where, ΣV : Vertical load on dam base bottom (= 3559.366 kN/m)

ΣH : Horizontal load on dam base bottom 1961.100 kN/m)

f : Friction factor between dam bottom and bearing ground

$f = \mu = \tan\phi_B =$ 0.7

τ : Shearing strength of rock mass (kN/m^2)

use coulomb's equation provided this, 「C_B=0、 σ =allowable bearing capacity」

$\tau = C_B + \sigma \cdot \tan\phi_B =$ 411

B : Bottom width for sliding analysis (16.710 m)

Thus, stability analysis against sliding is following, which is stable.

Fs= 4.77 ≧ 1.5 (Safety factor)

(b) Stability analysis against overturning

Distance d from point of application of resultant force R to around toe of dam bottom:

$$d = \frac{\Sigma Mr - \Sigma Mo}{\Sigma V} = \frac{34,194.772 - 10,289.511}{3,559.366} = 6.716 \quad (m)$$

where, ΣMr : Resisting moment around toe of dam bottom (= 34,194.772 kN·m)

ΣMo : Overturning moment around toe of dam bottom (= 10,289.511 kN·m)

Distance |e| from point of application of resultant force R to center of bottom:

$|e| = |(B/2) - d| = |(16.710 / 2) - 6.716 | = | 1.639 | = 1.639$ (m)

where, B : Bottom width for overturning analysis (= 16.710 m)

Thus, results of stability analysis against overturning shows below.

case: Normal

$|e|$= 1.639 ≦ B/6 = 2.785 (m)····Equation of analysis at regular (result : OK)

$|e|$= 1.639 ≦ B/3 = 5.570 (m)····Equation of analysis under seismic motion (reference value)

(c) Stability analysis against bearing capacity of foundation ground

Point of application of resultant force R is in 1/3 of bottom width.

Thus, modulus of subgrade reaction shows trapezoidal distribution that express following equation.

$$q1, q2 = \frac{\Sigma V}{B} \left(1 \pm \frac{6 \cdot e}{B} \right)$$

Thus, allowable bearing stress of ground at normal in this design : 588 (kN/m^2)

Stability analysis against bearing capacity of foundation ground is following, which is stable.

q1 = 338.366 ≦ 588 (kN/m^2)

q2 = 87.651 ≦ 588 (kN/m^2)

(6) Result of stability calculation

1) No sediment

cross section				At top water level	At design flood level
				During earthquake	Normal
Overflow section	Active force	Vertical force	(kN)	3,571.840	3,559.366
		Horizontal force	(kN)	1,882.111	1,472.819
		Resisting moment	(kN·m)	34,264.252	34,194.772
		Overturning moment	(kN·m)	6,977.158	8,254.844
	sliding	Safety factor		6.810	6.350
		Required safety factor		1.200	1.500
		Result		OK	OK
	Overturning	Eccentric throw	(m)	0.715	1.067
		Standard value		5.570	2.785
		Result		OK	OK
	Bearing capacity	Applied stress coefficient	(kN/m^2)	268.632	294.617
		Allowable bearing capacity	(kN/m^2)	882.000	588.000
		Result		OK	OK

2) sediment

Cross section				At top water level	At design flood level
				During earthquake	Normal
Overflow section	Active force	Vertical force	(kN)	3,571.840	3,559.366
		Horizontal force	(kN)	2,265.314	1,961.100
		Resisting moment	(kN·m)	34,264.252	34,194.772
		Overturning moment	(kN·m)	8,573.965	10,289.511
	Sliding	Safety factor		5.660	4.770
		Required safety factor		1.200	1.500
		Result		OK	OK
	Overturning	Eccentric throw	(m)	1.163	1.639
		Standard value	(m)	5.570	2.785
		Result		OK	OK
	Bearing capacity	Applied stress coefficient	(kN/m^2)	303.017	87.651
		Allowable bearing capacity	(kN/m^2)	882.000	588.000
		Result		OK	OK

Appendix N4-3

Calculation of pressure of penstock and the steel pipe (Nasal location)

(1)Design detail

Calculations are based on Technical standards of hydropower generation facilities and Japan’ s domestic technical standards.

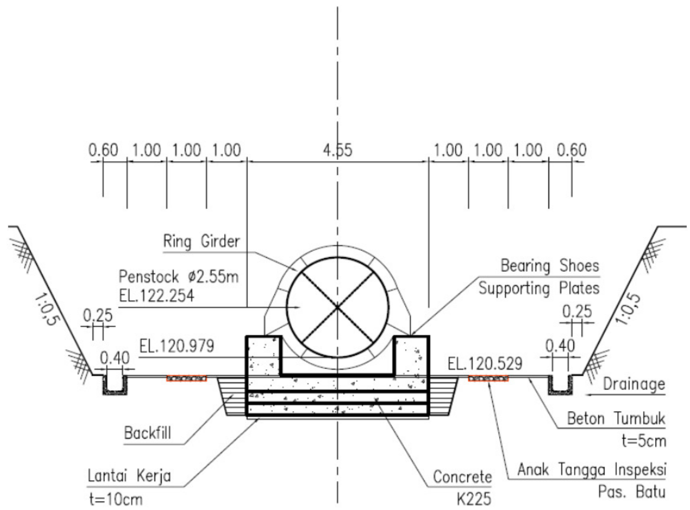
Type	:	Exposed penstock and concrete revetteed embedded penstock	
Number of pipe	:	1 waterway	
Inner diameter	:	2.550	m
Pipe thickness	:	14～16	mm
Pipe length	:	226.720	m (Curve length from start of penstock to inlet valve)
Maximum static head	:	74.984	m (Head from tank water level WL 131,508m to center of inlet valve EL 56.524 m)
Maximum water hammer pressure	:	18.000	m (Center of inlet valve)
Attacck wave head	:	0.000	m
Maximum design head	:	92.984	m (Center of inlet valve)
Maximum discharge	:	17.360	m^3/s
Turbine closing tim	:	4	sec
Corrosion allowance	:	1.5	mm
Safety factor against external pressure	:	1.5	Over
Temperature change	:	20	℃

Type of material :

Allowable stress

Material	Thickness (mm)	Tensile stress (N/mm^2)	Compressive stress (N/mm^2)	Shearing stress (N/mm^2)	Bearing stress (N/mm^2)
ISO E275 A-D	t ≦16	150	150	85	255
	16＜ t ≦40	145	145	80	245
	40＜ t ≦63	140	140	80	235

Elastic modules of steel	:	206	kN/mm^2
Linear expansion coefficient of steel	:	1.2×10^{-5}	/℃
Poisson's ratio of steel	:	0.3	
Weld efficiency	:	Plant 0.85 Site 0.80	



(2) Calculation of design head

(a) Symbols definition

T : Closing time of valve = 4.0 sec (Reference value)

L : Pipe length = 226.720 m

(Curve length from start of tank to center of inlet valve)

Q : Maximum discharge = 17.36 m^3/s

α : Propagation velocity of pressure wave = 868 m/s

H_0 : Hydrostatic head after closed valve in turbin ϵ = 74.984 m

(water tank level 131.508 m — Center of inlet valve 56.524 m)

V_0 : Mean velocity in pipe (m/s)

h_0 : Rising head by water hammering at closed valve (m)

T_1 : Turnaround time of pressure wave in pipe

$= 2L/\alpha = 0.52 < 4.0$ sec : slow closure

(b) Calculation of mean velocity in pipe

V_0 : Effective mean velocity (m/s)

Q : Flow (m^3/s)

A_0 : Effective mean sectional area (m^2)

Dn : Effective mean velocity (m)

Ln : Pipe length for each pipe (m)

An : Sectional area = Q/Vn (m^2)

{ for reducer pipe $Vn = \dfrac{V_{n+1} + V_{n-1}}{2}$ }

n	Dn	An	Qn	Vn	Ln	Vn・Ln
1	2.550	5.107	17.360	3.399	7.970	27.090
2	2.550	5.107	17.360	3.399	48.160	163.696
3	2.550	5.107	17.360	3.399	63.930	217.298
4	2.550	5.107	17.360	3.399	67.810	230.486
5	2.550	5.107	17.360	3.399	6.500	22.094
6	1.800	2.545	8.680	3.411	15.640	53.348
7	1.200	1.131	8.680	7.675	16.710	128.249
Σ					226.720	842.261

$$V_0 = \frac{\Sigma\ (Vn \cdot Ln)}{\Sigma\ Ln} = \frac{842.261}{226.720} = 3.715\ \text{m/s}$$

(c) Calculation of propagation velocity of pressure wave

$$\alpha = \frac{1}{\sqrt{\frac{W}{g}\left(\frac{1}{K}+\frac{1}{E}\cdot\frac{D}{t}\right)}}$$

where,

α : Propagation velocity of pressure wave (m/s)
D : Inner pipe diameter (ı
t : Pipe thickness (m)
W : Unit weight of water = 1 t/m^3
g : Gravitational accelerati = 9.8 m/s^2
K : Bulk modulus of water ≒ 200,000 t/m^2
E : Elastic modulus of steel = 21,000,000 t/m^2

n	Dn	t (mm)	α	Ln	α・Ln
1	2.550	14	847	7.970	6,751
2	2.550	14	847	48.160	40,792
3	2.550	14	847	63.930	54,149
4	2.550	14	847	67.810	57,435
5	2.550	14	847	6.500	5,506
6	1.800	14	939	15.640	14,686
7	1.200	14	1,039	16.710	17,362
Σ				226.720	196,681

$$\alpha = \frac{\Sigma(\alpha \cdot Ln)}{\Sigma Ln} = \frac{196,681}{226.720} = 868 \quad m/s$$

(d) Calculation of Water hammer pressure

Rising pressure(rising head) by water hammering at closed valve is calculated.
Assuming there is not sluice valve, Allievi's calculation is used here.

① Pipeline constant of Allievi

$$\rho = \frac{\alpha V_0}{2 g H_0} = \frac{868 \times 3.715}{2 \times 9.8 \times 74.98} = 2.194$$

② Closing time constant of valve

$$\theta = \frac{\alpha T}{2 L_0} = \frac{868 \times 4.0}{2 \times 226.720} = 7.657$$

③ Ratio of pipeline constant to closing time constant

$$n = \frac{\rho}{\theta} = \frac{2.194}{7.657} = 0.287$$

④ Calculation of water hammer pressure

Pipeline constant of Allievi : ρ = 1.180 ＞ 1

Thus, water hammer pressure is calculated using following eqation from "Japan hydraulic gate and penstock association".

$$\frac{h_0}{H_0} = \frac{2n}{1 + n(\theta - 1)} = \frac{2 \times 0.287}{1 + 0.287 (7.657 - 1)}$$

$$= 0.197$$

$$\therefore h_0 = 0.1970 \times 74.98 = 14.77 \fallingdotseq 15.00 \text{ m}$$

⑤ Overdesign of water hammer pressure

Measured value and calculated value of risieng pressure often don't match due to turbin's affection. Thus, water hammer pressure head could have 20% of allowance.

$$\therefore h_0 = 14.77 \times 1.2 = 18.00 \text{ m}$$

(e) Design head

Design head is calculated by following equation.

Design head ＝ hydrostatic head ＋ attack wave head ＋ water hammer pressure head

Hydrostatic head is from tank water level (∇ 131.508 m) to pipe center height.

Depth of overflow spillway is not considered here, thus wave head is 0.

Water hammer pressure head is maximum at center of turbin, 0 at head tank, and vary in linear fashion in propotion to pipe length at middle part. Water hammer pressure head is calculated by following equation below.

$$H_3 = h_0 \times \frac{L_i}{L_0}$$

where, h_0 : Maximum watter hammer pressure head ＝ 18.00 m

L_i : Pipe length from tank to each cases location (m)

L_0 : Pipe length from tank to center of inlet val ＝ 226.720 m

Design head of cross section for each cases

No.	Cross section of cases	Length L_i (m)	Static water head H_1 (m)	Attack wave head H_2 (m)	Watter hammer pressure head H_3 (m)	Design head H (m)
1	D＝2.55 t＝14	7.970	9.254 (EL122.254)	0.000	0.633	9.89
2	D＝2.55 t＝14	47.160	9.531 (EL121.977)	0.000	4.377	13.91
3	D＝2.55 t＝14	63.930	31.681 (EL99.827)	0.000	9.453	41.13
4	D＝2.55 t＝14	67.810	74.609 (EL56.899)	0.000	14.837	89.45
5	D＝2.55 t＝14	6.500	74.984 (EL56.524)	0.000	15.353	90.34
6	D＝1.8 t＝14	15.640	74.984 (EL56.524)	0.000	16.595	91.58
7	D＝1.2 t＝14	15.640	74.984 (EL56.524)	0.000	17.837	92.82

( ) Pipe center height

(3) Calculation of pipe thickness

(a) Calculation of minimum pipe thinckness

Minimum pipe thickness is calculated by following equation.

$$t_0 = \frac{D_0 + 800}{400} \quad \text{(only more than 6mm)}$$

where, t_0 : Minimum thickness including corrosion allowa (mm)

D_0 : Inner diameter (mm)

Inner diameter D_0 (mm)	Minimum thickness t_0 (mm)	Thickness t (mm)	Result
1800	6.50	14	≧6mm OK

(b) Allowable head

Allowable head for each material and thickness bearing all the internal pressure

on pipe itself is calculated by equation below.

$$H_a = \frac{2000 \cdot \sigma a \cdot \eta \ (t_0 - \varepsilon)}{g \cdot (D_0 + \varepsilon)}$$

where, Ha : Allowble head (m)

σa : Allowble stress (steel material : ISO E275)

= 150 N/mm^2 (t ≦16mm)

= 145 N/mm^2 (16mm< t ≦40mm)

η : Weld efficiency = 0.80 (Field weld)

ε : Corrosion allowance = 1.5 mm

t_0 : Thickness (mm)

D_0 : Inner diameter (mm)

No.	Inner diameter D_0 (mm)	Thickness t_0 (mm)	Corrosion allowance ε (mm)	Material	Allowble stress σa (N/mm^2)	Weld efficiency η	Allowble head Ha (m)
1	2550	14	1.5	ISO E275	150	0.80	119.98
2	2550	14	1.5	ISO E275	150	0.80	119.98
3	2550	14	1.5	ISO E275	150	0.80	119.98
4	2550	14	1.5	ISO E276	150	0.80	119.98
5	2550	14	1.5	ISO E277	150	0.80	119.98
6	1800	14	1.5	ISO E276	150	0.80	169.93
7	1200	14	1.5	ISO E277	150	0.80	254.78

(c) Pipe thickness

Table below shows comparison between Design head and allowble head.

No.	Inner diameter D_0 (mm)	Thickness t_0 (mm)	Design head H (m)	Material	Allowable stress σa (N/mm^2)	Allowble head Ha (m)	Result
1	2550	14	9.89	ISO E275	150	119.98	OK
2	2550	14	13.91	ISO E275	150	119.98	OK
3	2550	14	41.13	ISO E275	150	119.98	OK
4	2550	14	89.45	ISO E275	150	119.98	OK
5	2550	14	90.34	ISO E275	150	119.98	OK
6	1800	14	90.34	ISO E275	150	169.93	OK
7	1200	14	91.58	ISO E275	150	254.78	OK

(d) Consideration for inner pressure

① Circumferential stress

$$\sigma_1 = \frac{P \cdot D}{2(t_0 - \varepsilon)}$$

ここに、 σ_1 : Circumferential stress (N/mm^2)
P : Design inner pressure (MPa)
D : Inner diameter exempt corrosion allowai $= D_0 + \varepsilon$ (mm)
t_0 : Thickness (mm)
ε : Corrosion allowance $=$ 1.5 mm

No.	Design inner pressure P (MPa)	Inner diameter D (mm)	material t 0 (mm)	Circumferential stress σ 1 (N/mm 2)	Weld efficiency η	Allowable stress η ・ σ a (N/mm 2)	Result
1	0.097	2550	14	9.9	0.80	120.0	OK
2	0.136	2550	14	13.9	0.80	120.0	OK
3	0.403	2550	14	41.1	0.80	120.0	OK
4	0.877	2550	14	89.5	0.80	120.0	OK
5	0.886	2550	14	90.4	0.80	120.0	OK
6	0.886	1800	14	63.8	0.80	120.0	OK
7	0.898	1200	14	43.1	0.80	120.0	OK

(4) Calculation of pipe axis direction stress

(a) Temperature stress

$$\sigma_{21} = \pm \alpha \cdot E \cdot \Delta T$$

where, σ_{21} : Temperature stress (N/mm^2)

α : Linear expansion coefficient of steel = 1.2 × 10^{-5} /℃

E : Elastic modulus of steel = 206000 N/mm^2

ΔT : Temperature change = 20 ℃

No.	Linear expansion coefficien α (/℃)	Elastic modules E (N/mm2)	Temperature change ΔT (℃)	Temperature stress σ21 (N/mm2)
1	0.000012	206000	20	49.4
2	0.000012	206000	20	49.4
3	0.000012	206000	20	49.4
4	0.000012	206000	20	49.4
5	0.000012	206000	20	49.4

(b) Stress due to Poisson effect

$$\sigma_{22} = \nu \cdot \sigma r$$

where, σ_{22} : Stress due to Poisson effect (N/mm^2)

ν : Poisson's ratio of steel = 0.3

σr : Circumferential stress = σ_1 (N/mm^2)

No.	Poisson's ratio ν	Circumferential stress σr (N/mm2)	Poisson stress σ22 (N/mm2)
1	0.3	9.9	3.0
2	0.3	13.9	4.2
3	0.3	41.1	12.3
4	0.3	89.5	26.9
5	0.3	90.4	27.1

(c) Stress due to inclined pipe

In this case, axial load due to all the pipe weight above the part of this case is considered.

$$\sigma_{24} = \frac{\Sigma (\pi \cdot Dmn \cdot tn \cdot Ln}{As} \gamma s \cdot \sin\theta$$

where, σ_{24} : Stress by inclined pip (N/mm^2)

tn : Pipe wall thickness of particular pa (mm)

Dmn : Wall thickness central diameter of t (mm)

Ln : Length of pipe of thickness tn (mm)

γs : Load due to unit mass of pipe

$\gamma s = \gamma p \cdot g$

γp : Unit weight of pipe

$\gamma p = 7.850 \quad t/m^3$

g : Gravitational acceleration

$g = 9.8 \quad t/m^2$

θ : Angle of pipe axis and water surface (°)

Mean angle of each part in this case.

As : Cross section for pipe of particular part considered stress

$As = \pi \cdot Dm \cdot t_0$

Dm : Wall thickness for part considered stress (mm)

t_0 : Wall radius for part considered stress (mm)

No.	Inner diameter D_0 (mm)	Thickness t_0 (mm)	Diameter Dm (mm)	Length Ln (m)	Weight of section (t)	Slope angle θ (°)	Pipe slope load (pipe axis direction) (KN/m)	Inclined stress σ_{24} (N/mm^2)
1	2550	14	2564	7.970	503.960	9.2	789.622	0.1
2	2550	14	2564	48.160	3,045.258	27.3	14,477.343	1.3
3	2550	14	2564	63.930	4,042.428	22.6	29,701.507	2.6
4	2550	14	2564	67.810	4,287.768	23.6	46,524.224	4.1
5	2550	14	2564	6.500	411.009	24.6	48,200.956	4.3

(d) Bending stress assuming pipe as beam

$\sigma_{25} = M / Z$

where, σ_{25} : Bending stress assuming pipe as b (N/mm²)

Z : Section modulu (mm³)

$Z = (\pi / 32) \cdot \{(D_0 + t_0 - \varepsilon)^4 - (D_0 + \varepsilon)^4\} / (D_0 + t_0 - \varepsilon)$

M : Bending moment where requesting stress (N·mm)

In this case, interval of bearing support is considered as span length to simplify the case. Then use it as simple beam, and bending moment of center of span is used.

$M = P \cdot L^2 / 8$

L : Span length (m)

L = 10.000 m

P : Load in direction to perpendicular to pipe axis

$P = (Wp + Ww) \cdot \cos\theta$

θ : Angle of pipe axis and horizontal plane (°)

Mean angle of each area in this case.

Wp : Pipe self weight/1m (kN)

$Wp = \gamma p \cdot (\pi / 4) \cdot \{(D_0 + t_0)^2 - D_0^2\}$

γp : Unit weight of pipe

γp = 7.850 t/m^3

Ww : Water weight in pipe/1m

$Ww = \gamma w \cdot (\pi / 4) \cdot D_0^2$

γw : Unit weight of water

γp = 1.000 t/m^3

g : Gravitational acceleration

g = 9.8 t/m^2

D_0 : Inner diameter

t_0 : Wall thickness

ε : Corrosion allowance

ε = 1.5 mm

No.	Inner diameter D_0 (m)	Thickness t_0 (mm)	Slope angle θ (°)	Span length L (m)	Axial load P (kN/m)	Bending moment M (kN·m)	Section modulus Z (mm³)	Bending stress σ_{25} (N/mm²)
1	2550	14	9.2	10.000	57.969	724.613	64,229,439	11.3
2	2550	14	27.3	10.000	52.183	652.288	64,229,439	10.2
3	2550	14	22.6	10.000	54.215	677.688	64,229,439	10.6
4	2550	14	23.6	10.000	53.812	672.650	64,229,439	10.5
5	2550	14	24.6	10.000	53.394	667.425	64,229,439	10.4
6	1800	14	0.0	10.000	31.076	388.450	32,085,786	12.1
7	1200	14	0.0	10.000	15.192	189.900	14,323,015	13.3

(e) Shearing stress of vertical direction to pipe axis

$$\tau = \frac{2 \cdot S \cdot \cos\theta}{As}$$

where, τ : Shearing stress of vertical direction to pipe axi (N/mm^2)

S : Shearing stress where requiring stress (N)
In this case, interval of bearing support is considered as span length to simplify the case. Then use it as simple beam, and shearing force at end of span is used.

$S \cdot \cos\theta = P \cdot L / 2$

L : Span length (m)

$L = 10.000$ m

P : Load in direction to perpendicular to pipe axis

$P = (Wp + Ww) \cdot \cos\theta$

θ : Angle of pipe axis and horizontal plane (°)

Mean gngle of each area in this case.

Wp : Pipe self weight /1m (kN)

$Wp = \gamma p \cdot (\pi / 4) \cdot \{(D_0 + t_0)^2 - D_0^2\}$

γp : Unit weight of pipe

$\gamma p = 7.850$ t/m^3

Ww : Water weight in pipe/1m

$Ww = \gamma w \cdot (\pi / 4) \cdot D_0^2$

γw : Unit weight of water

$\gamma p = 1.000$ t/m^3

g : Gravitational acceleration

$g = 9.8$ t/m^2

As : Cross section for pipe of particular part considered stress

$As = \pi \cdot Dm \cdot t_0$

Dm : Pipe wall thickness center diameter for part considered stress (mm)

t_0 : Wall thickness for part considered stress (mm)

No.	Inner diameter D_0 (m)	Thickness t_0 (mm)	Diameter Dm (mm)	Slope angle θ (°)	Span length L (m)	Axial load P (kN/m)	Shearing force $S \cdot \cos\theta$ (kN)	Shearing stress τ (N/mm^2)
1	2550	14	2564	9.2	10.000	57.969	289.845	2.6
2	2550	14	2564	27.3	10.000	52.183	260.915	2.3
3	2550	14	2564	22.6	10.000	54.215	271.075	2.4
4	2550	14	2564	23.6	10.000	53.812	269.060	2.4
5	2550	14	2564	24.6	10.000	53.394	266.970	2.4
6	1800	14	1814	0.0	10.000	31.076	155.380	1.9
7	1200	14	1214	0.0	10.000	15.192	75.960	1.4

(f) Total of axial stress

when temperature rise $\sigma_2 = -\sigma_{21} + \sigma_{22} + \sigma_{23} - \sigma_{24} + \sigma_{25}$

when temperature drop $\sigma_2' = +\sigma_{21} + \sigma_{22} + \sigma_{23} - \sigma_{24} + \sigma_{25}$

No.	Temperature stress σ_{21} (N/mm^2)	Poisson's stress σ_{22} (N/mm^2)	Local stress σ_{23} (N/mm^2)	Inclined stress σ_{24} (N/mm^2)	Bending stress σ_{25} (N/mm^2)	Total of axial stress σ_2 (N/mm^2)	Total of axial stress σ_2' (N/mm^2)
1	49.4	3.0	—	0.1	11.3	-35.3	63.6
2	49.4	4.2	—	1.3	10.2	-36.4	62.5
3	49.4	12.3	—	2.6	10.6	-29.1	69.8
4	49.4	26.9	—	4.1	10.5	-16.2	82.7
5	49.4	27.1	—	4.3	10.4	-16.2	82.7
6	0.0	0.0	—	0.0	12.1	12.1	12.1
7	0.0	0.0	—	0.0	13.3	13.3	13.3

(Axial stress:tensile direction is plus.)

(5)Analysis by equivalent stress

$$\sigma eq = \sqrt{(\sigma_1{}^2 + \sigma_2{}^2 - \sigma_1 \cdot \sigma_2 + 3\tau^2)}$$

where, σeq : Equivalent stres (N/mm^2)

$\sigma 1$: Circumferential direction stres (N/mm^2)

$\sigma 2$: Axial stress (N/mm^2)

τ : Shearing stress of vertical to pipe axi (kgf/cm^2)

No.	Circumferential stress σ_1 (N/mm^2)	Total of axial stress σ_2 (N/mm^2)	Total of axial stress σ_2' (N/mm^2)	Shearing stress τ (N/mm^2)	Equivalent stress σeq (N/mm^2)	Equivalent stress $\sigma eq'$ (N/mm^2)	Allowble stress σa (N/mm^2)	Result
1	9.9	-35.3	63.6	2.6	41.4	59.5	120	OK
2	13.9	-36.4	62.5	2.3	45.1	57.0	120	OK
3	41.1	-29.1	69.8	2.4	61.2	60.9	120	OK
4	89.5	-16.2	82.7	2.4	98.7	86.4	120	OK
5	90.4	-16.2	82.7	2.4	99.6	86.9	120	OK
6	0.0	12.1	12.1	1.9	12.5	12.5	120	OK
7	0.0	13.3	13.3	1.4	13.5	13.5	120	OK

(6) Result of hydraulic head and stress analysis

No.	Inner diameter	Thickness to use	Pipe length	Pipe thickness			Inner pressure		
				Design head	Alllowable head	Result	Circumferential stress	Allowable stress	Result
	D_0	t_0	Ln	H	Ha		σ 1	η ・ σ a	
	(mm)	(mm)	(m)	(m)	(m)		(N/mm^2)	(N/mm^2)	
1	2550	14	7.970	9.89	119.98	OK	9.90	120.00	OK
2	2550	14	48.160	13.91	119.98	OK	13.90	120.00	OK
3	2550	14	63.930	41.13	119.98	OK	41.10	120.00	OK
4	2550	14	67.810	89.45	119.98	OK	89.50	120.00	OK
5	2550	14	6.500	90.34	119.98	OK	90.40	120.00	OK
6	1800	14	15.640	90.34	169.93	OK	63.80	120.00	OK
7	1200	14	16.710	91.58	254.78	OK	43.10	120.00	OK

No.	Inner diameter	Thickness to use	Pipe length	Axial stress			
				Equivalent stress		Allowable stress	Result
	D_0	t_0	Ln	σ eq	σ eq'	σ a	
	(mm)	(mm)	(m)	(N/mm^2)	(N/mm^2)	(N/mm^2)	
1	2550	14	7.970	41.40	59.45	120	OK
2	2550	14	48.160	45.10	56.99	120	OK
3	2550	14	63.930	61.20	60.88	120	OK
4	2550	14	67.810	98.70	86.40	120	OK
5	2550	14	6.500	99.60	86.89	120	OK
6	1800	14	15.640	12.50	12.54	120	OK
7	1200	14	16.710	13.50	13.52	120	OK

As a result of this analysis conducted by Japanese method, it is proved its stability. In addition, it is expected economical improvement by installing pipe with different thickness.

Appendix N4-4
Construction Cost
(Nasal Location)

No.	Work Item	Unit	Volume	Plan 1 Output 8MW (2 x 4MW)		Plan 2 Output 10MW (2 x 5MW)	
				Unit Price (Rp)	Amount (Rp)	Unit Price (Rp)	Amount (Rp)
1	**Prepatory Works**						
1.1	Mobilization - Demobilization of Equipments	Ls	1.00		800,000,000		800,000,000
1.2	Access Road to Weir site	km	0.95	2,000,000,000	1,900,000,000	2,000,000,000	1,900,000,000
1.3	Access Road to Headpond site	km	1.27	2,000,000,000	2,530,000,000	2,000,000,000	2,530,000,000
1.4	Access Road to Powerhouse site	km	0.83	2,000,000,000	1,650,000,000	2,000,000,000	1,650,000,000
1.5	Access Road to Disposal Area	km	1.50	800,000,000	1,200,000,000	800,000,000	1,200,000,000
1.6	Building Facilities & other facilities (600 m^2)	Ls	1.00		2,500,000,000		2,500,000,000
1.7	Land Acquisition	Ha	40.00	150,000,000	6,000,000,000	150,000,000	6,000,000,000
	Sub Total 1				**16,580,000,000**		**16,580,000,000**
2	**Main Works (Civil)**						
2.1	Coffering - Dewatering, River Diversion	Ls	1.00		524,194,000		650,000,000
2.2	Weir, Intake & Intake (Transition) Channel Works	Ls	1.00		36,262,693,000		44,965,739,000
2.3	Sandtrap	Ls	1.00		5,344,498,000		6,627,177,000
2.4	Waterway	Ls	1.00		65,993,048,000		81,831,379,000
2.5	Headpond & Emergency Spillway	Ls	1.00		9,860,580,000		12,227,119,000
2.6	Inspection Road & side ditch, L = 2000 m	Ls	1.00		1,272,327,000		1,577,685,000
2.7	Civil Work for Saddle Support, Anchor Block for Penstock	Ls	1.00		4,082,680,000		5,062,523,000
2.8	Powerhouse & Tailrace	Ls	1.00		4,530,627,000		5,617,977,000
2.9	Metal Work Gates	Ls	1.00		3,701,815,000		4,590,250,000
2.10	Metal Work (Penstock Mechanical works) Furnishing & installation	Ls	1.00		11,014,554,000		13,658,047,000
	Sub Total 2				**142,587,016,000**		**176,807,896,000**
3	**Main Works (Electric)**						
3.1	Generating Equipments	MW		4,694,920,000	37,559,360,000	4,694,920,000	46,949,200,000
3.2	Transmission Line 20 kV - 35 km	km	35.00	400,000,000	14,000,000,000	400,000,000	14,000,000,000
	Sub Total 3				**51,559,360,000**		**60,949,200,000**
A=1+2+3	**Amount of Cost**				**210,726,376,000**		**254,337,096,000**
B	**Engineering Service Fee**				**2,000,000,000**		**2,000,000,000**
A+B	**Amount of Construction Cost**				**212,726,376,000**		**256,337,096,000**

Appendix N4-5
Consultation Result
(Nasal Location)

The record of agreement of the public consultation

BERITA ACARA RAPAT

HASIL RAPAT SOSIALISASI OLEH PT. CITRA INDONUSA LESTARI, PEMDA KAUR DAN MASYARAKAT AIR PALAWAN DI KABUPATEN KAUR

Pada hari ini Kamis, Tanggal Dua Februari Dua Ribu Dua Belas, bertempat di Kantor Camat Nasal, Kabupaten Kaur, Propinsi Bengkulu yang dihadiri oleh Kepala Desa, Perangkat Desa, Pemda Kaur, Masyarakat Desa Air Palawan dan Perwakilan PT. Citra Indonusa Lestari telah mengadakan acara sosialisasi secara langsung kepada masyarakat Desa Air Palawan dalam rencana pembangunan PLTM Sungai Nasal.

Demikian Berita Acara ini dibuat dengan sebenarnya dan daftar hadir musyawarah terlampir.

Desa Air Palawan, 02 Februari 2012

Pimpinan Rapat

PEMERINTAH KABUPATEN KAUR KECAMATAN NASAL

Mengetahui

Kepala Desa Air Palawan

PEMERINTAH KABUPATEN KAUR KEPALA DESA AIR PALAWAN

SUKMAH

Kepala Desa Muara Dua

PEMERINTAH KABUPATEN KAUR KEPALA DESA MUARA DUA KECAMATAN NASAL

SOBRI

Yg menerima
Bag. umum Setda
02-02-2012

HEPPI

PEMERINTAH KABUPATEN KAUR SETDA

DAFTAR HADIR RAPAT SOSIALISASI
PEMBANGUNAN PLTM SUNGAI NASAL

No	Nama	Alamat / Jabatan	Tanda Tangan
1	SUKMAH	AIR PALAWAN KADES.	
2	SARPIDI		
3	NETEN MURTIANA	AIR PALAWAN BPD	
4	ROSMALAINI		
5	SAHIDIN		
6	NUDIMAN		
7	A. KADIR		
8	SEDIANTO		
9	SADARMAN		
10	YENGKI		
11	SABRI		
12	Sukarmin		
13	fauzi		
14	ANDI		

Appendix N4-5

DAFTAR HADIR RAPAT SOSIALISASI
PEMBANGUNAN PLTM SUNGAI NASAL

No	Nama	Alamat / Jabatan	Tanda Tangan
15	Yurdi	M. Dua	[signature]
16	ARDAN	M. Dua	[signature]
17	Jamudin	—"	[signature]
18	Abu bakar	[illegible]	[signature]
19	HERLIZAN	—" —	[signature]
20	Sadarman —	—" —	[signature]
21			
22			
23			
24			
25			
26			
27			
28			

Appendix N4-6
Monitoring Form
(Nasal Location)

MONITORING FORM
for Nasal Mini Hydro Power Plant Project

-If environmental reviews indicate the need of monitoring by JICA, JICA undertakes monitoring for necessary items that are decided by environmental reviews. JICA undertakes monitoring based on regular reports, including measured data submitted by the project proponent. When necessary, the project proponent should refer to the following monitoring form for submitting reports.

-When monitoring plans, including monitoring items, frequencies and methods are decided, project phase or project life cycle (such as construction phase and operation phase) should be considered.

1. Pre-Construction Phase

1.1. Social Environment

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Status of Land Ownership		The project site	1 time / 6 months
Livelihoods / Incomes		The project site	1 time
Complaints of the Population		The project site	1 time during the land acquisition process

1.2. Water Quality

Monitoring Items	Comparison with standard	Locations	Frequency of monitoring
pH, SS, COD, DO, Total Nitrogen, Total Phosphorus, Heavy metals, Oil		Nasal river in the project site: 2points	1time before construction

2. Construction Phase

2.1. Water quality

Item	Measured value (Max, Min, Average）	Method	Comparison with standard	Location	Frequency
Water temperature				Upper stream of the Project site: 1 point Project site: 2points Downstream of the Project site: 1point	1time/ 1month
Turbidity					
pH					1time/6 months
SS					
COD					
DO					
Total Nitrogen					
Total Phosphorus					
Heavy metals					
Oil					

2.2. Air quality

Monitoring Items	Comparison with standard	Locations	Frequency of monitoring
Dust, NOx, SOx		Residential rea: 2 points	1time/6 month

2.3. Waste

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Type of waste, volume, disposal way		The project site	1 time/ 1month

2.4. Ecosystem

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Flora	Fill in the table below.	The project site	1 time/3 months
Water Biota	Fill in the table below.	The project site and the nearest residential areas	1 time/3 months
Wildlife	Fill in the table below.	The project site and the nearest residential areas	1 time/3 months

If any endangered species are recorded, please fill in the table below.

(Date:)

Scientific name	Local name	English name	Total No.of individual	Conservation Status		Remarks
				IUCN	Local	

2.5. Noise

Item (Unit)	Measured Value (Average)	Measured Value (Maximum)	Country's Standard	Guidelines for Community Noise, World Health Organization (WHO), 1999	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level			55dB (Residence)	Daytime 07:00 - 22:00 55dBA Nighttime 22:00 - 07:00 45dBA	1 time / every change of construction kind

2.6. Topography and Geology

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Physiography		The project site	1 time/6 months

2.7. Social Environment

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Safety and Security		The project site	1 time/6 months
Demography / Social Interaction		The project site and the nearest residential areas	1 time/6 months
Incomes of the Population		The nearest residential areas	1 time/6 months
Livelihood / Incomes		The project site	1 time/6 months
Public Facilities		Along the planned access road	1 time/6 months
Community Complaints		Close by settlements along the river, especially downstream of the project location	1 time/6 months
Aesthetics		The project site	1 time/3 months

3. Operation phase

3.1. Water quality

Item	Measured value (Max, Min, Average)	Method	Comparison with standard	Location	Frequency
Water temperature				Settlement along the river, especially downstream of the Project site	1time/6 months
Turbidity					
pH					
SS					
COD					
DO					
Total Nitrogen					
Total Phosphorus					
Heavy metals					
Oil					

3.2. Ecosystem

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Flora	Fill in the table below.	The project site	1 time/6 months
Water Biota	Fill in the table below.	The project site and the nearest residential areas	1 time/6 months
Disturbance of Wildlife	Fill in the table below.	The project site and the nearest residential areas	1 time/6 months

If any endangered species are recorded, please fill in the table below.

(Date:)

Scientific name	Local name	English name	Total No.of individual	Conservation Status		Remarks
				IUCN	Local	

3.3. Noise

Item (Unit)	Measured Value (Average)	Measured Value (Maximum)	Country's Standard	Guidelines for Community Noise, World Health Organization (WHO), 1999	Remarks (Measurement Point, Frequency, Method, etc.)
Noise Level			55dB (Residence)	Daytime 07:00 - 22:00 55dBA Nighttime 22:00 - 07:00 45dBA	1 time/6 months

3.4. Social Environment

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Safety and Security		The project site	1 time/6 months
Land Use		The project site	1 time
Livelihoods		The project site	1 time

3.5. Others

Monitoring items	Monitoring Results during Report Period	Locations	Frequency of monitoring
Electrical Energy			1 time

Appendix N4-7
Environment Check-list
(Nasal Location)

Nasal

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) N (c) N (d) N	(a) AMDAl is nor required, however, UKL/UPL is required in accordance with the Indonesian law. (b)UKL/UPL for the Project was submitted and the approval is supposed to be in 2014. (c)If there will be conditions, the project proponent will comply with the conditions on approval of UKL/UPL. (d)Subsequently to the approval of UKL/UPL, the project proponent is going to apply for the Principle Permit, Building Permit and Disturbance Permit.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(a)Public consultations were held one time (2 February 2012). Implementation of the project and acquisition of necessary land for it was basically agreed. (b)The local people basically welcome the project. Improvement of existing road and supply of electric power by the project are expected.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a)Y	(a) In Indonesian Laws there is no obligation to consider alternative plan in the UKL/UPL procedure. But the candidate site was selected based on the geographical conditions, considering local residents and environmental impacts.
2 Pollution Control	(1) Water Quality	(a) Does the water quality of dam pond/reservoir comply with the country's ambient water quality standards? Is there a possibility that proliferation of phytoplankton and zooplankton will occur? (b) Does the quality of water discharged from the dam pond/reservoir comply with the country's ambient water quality standards? (c) Are adequate measures, such as clearance of woody vegetation from the inundation zone prior to flooding planned to prevent water quality degradation in the dam pond/reservoir? (d) Is there a possibility that reduced the river flow downstream will cause water quality degradation resulting in areas that do not comply with the country's ambient water quality standards? (e) Is the discharge of water from the lower portion of the dam pond/reservoir (the water temperature of the lower portion is generally lower than the water temperature of the upper portion) planned by considering the impacts to downstream areas?	(a)Y (b) Y (c) - (d)N (e) -	(a) Water quality data is not obtained yet. However it is considered that contributing factor for degradation of water quality is small. (b)The quality of water discharged from the reservoir is considered as the same as the above. (c) NOT APPLICABLE (d) Since the river channel including reduced flow river caused by diversion is steep, narrow and surrounded by rocks, it is hard to occur stagnant area even if the water level of the river is lowered. So adverse impacts on water quality is not expected. (e) NOT APPLICABLE

Nasal

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Wastes	(a) Are earth and sand generated by excavation properly treated and disposed of in accordance with the country's regulations?	(a)Y	(a) All earth and sand generated by excavation will be used for backfill and mounding at the Project site in accordance with the local regulation.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a)N	(a) The project area is not located in protected area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) Is there a possibility that the project will adversely affect downstream aquatic organisms, animals, plants, and ecosystems? Are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that installation of structures, such as dams will block the movement of the migratory fish species (such as salmon, trout and eel those move between rivers and sea for spawning)? Are adequate measures taken to reduce the impacts on these species?	(a)N (b)N (c)N (d)N	(a)Most of area around the project area are cultivated and utilized as forest with rubber tree and coffee, orchard, upland rice land etc. Forest with relatively high degree of natural vegetation remaining are exist at limited area along with steep area along Nasal river but there is no ecologically important habitats. (b)According to UKL/UPL, Government Regulation No.7 and the result of hearing from local resident during field survey (April,2013), rare species such as Sumatran Tiger, Siamang were confirmed. However, considering limited land use change etc., impact due to project implementation is considered as insignificant. As mitigation measures, i) to minimize to divide the continuity of large diameter trees, ii) to break the construction temporarily when the rare species are found and observe/wait till they leave, iii) to consult with the expert, if the number of the report of sighting is increased, iv) to install sign board for reminder of road-kill, v) to establish a mechanism (responsible person, place, etc.) for information gathering of sighting by residents, and vi) to prepare enlightenment document material for conservation of the species and conduct education program, targeting related people and residents, will be performed. (c) It is considered that the river is not suitable for inhabitation of fishes since the river channel is steep and rock bed. At driving channel, culverts and covers will be installed to prevent collapse at crossing point of forest road. They are effective to avoid migration inhibition of small animals.
	(3) Hydrology	(a) Is there a possibility that hydrologic changes due to the installation of structures, such as weirs will adversely affect the surface and groundwater flows (especially in "run of the river generation" projects)?	(a)N	(a) Impacts on surface water flow will be minimized by proper installation of culvert at the driving channel. Adverse impacts on groundwater flow are also not expected because the driving channel has 4.0 meters depth.
	(4) Topography and Geology	(a) Is there a possibility that reductions in sediment loads downstream due to settling of suspended particles in the reservoir will cause impacts, such as scouring of the downstream riverbeds and soil erosion? Is there a possibility that sedimentation of the reservoir will cause loss of the storage capacity, water logging upstream, and formation of sediment deposits at the reservoir entrance? Are the possibilities of the impacts studied, and adequate prevention measures taken? (b) Is there a possibility that the project will cause a large-scale alteration of the topographic features and geologic structures in the surrounding areas (especially in run of the river generation projects and geothermal power generation projects)?	(a) - (b)N	(a)Sedimentation volume at intake dam is estimated as 167 m3/day and flushing of the sediment in the dam will be performed every two weeks. Therefore reductions in sediment loads downstream is considered to be minimized. (b) Since the hydro power plant and the weir is constructed utilizing rock beds, there is no adverse impacts on geological features. The driving channel that has 4.0m width and 4.0m depth is closed channel. Measures to prevent collapse will be installed at driving channel in steep areas. The water tank will be constructed utilizing flat plateau. The pipeline will be constructed on ground surface of slope land. Because of these things, adverse impacts on geological features are not expected.

Nasal

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a)N (b)Y (c)- (d)- (e)Y (f)- (g)- (h)- (i)- (j)Y	(a) There is no involuntary resettlement caused by project implementation. (b) Explanation of the Project was carried out at the first public consultation and land acquisition was agreed. Negotiation for land acquisition price based on the reacquisition cost and necessary compensation will be performed between target resident and the proponent with presence of the local government, before implementation of the Project. (c) The resettlement by the Project does not occur. However land acquisition for securing the project area, which is used as cultivated land, is necessary. Value negotiation with each land owner will be conducted in consideration of restoration of livelihoods and living standard, such as compensation for reacquisition cost, mediation and respiration fee. (d) The resettlement by the Project does not occur. All land owners affected by land acquisition will receive compensation. (e) Negotiation for procurement price and necessary compensation will be performed between target resident and the proponent with presence of the local government, before implementation of the Project. And agreement document for the compensation will be prepared for each land owner. (f) NOT APPLICABLE (g) The resettlement by the Project does not occur. Negotiation for procurement price and necessary compensation will be performed between target resident and the proponent with presence of the local government, before implementation of the Project. (h)Proper framework will be established including supervision by local government etc.. The project proponent has capacity to implement in cooperation with local government and budget has been secured for land acquisition. (i) Monitoring on an impact by land acquisition is planned before implementation of construction work. (j)The Project proponent will establish grievance mechanism for the project.

Nasal

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Living and Livelihood	(a) Is there any possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there any possibility that the project causes the change of land uses in the neighboring areas to affect adversely livelihood of local people? (c) Is there any possibility that the project facilities adversely affect the traffic systems? (d) Is there any possibility that diseases, including infectious diseases, such as HIV, will be brought due to the immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (e) Is the minimum flow required for maintaining downstream water uses secured? (f) Is there any possibility that reductions in water flow downstream or seawater intrusion will have impacts on downstream water and land uses? (g) Is there any possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? (h) Is there any possibility that fishery rights, water usage rights, and common usage rights, etc. would be restricted?	(a)N (b)N (c)N (d)N (e)N (f)N (g)N (h)N	(a)No adverse impacts on the living conditions of inhabitants are expected. Positive impacts by the project are employment of local people, road maintenance, tax income, promotion of local economy and so on. The Project proponent is going to employ local people as much as possible during construction phase. (b)Since the Project does not involve construction of any other off-site facilities including newly constructed roads, adverse impacts on geological features are not expected. (c) There is no transportation on the water since the river channel is steep around the Project area. In addition, it is hard for local people to access the Project site easily since the landform around the Project site is steep. At driving channel, culverts and covers will be installed to prevent collapse at crossing point of forest road. So adverse impacts on existing traffic systems are not expected. In addition, access road maintenance will be conducted by the Project proponent as CSR. (d) The Project proponent is going to make efforts to education and health supervision for all workers concerned. (e)the minimum flow will be maintained. (f)There is no use of the river water at reduced flow river caused by diversion and downstream. (g)There is no possibility of water quality deterioration such as appearance of stagnant area, and there is no river water use in the downstream. So the increase of possibility that water-borne or water-related diseases are introduced is not expected. (h) According to the interview with local residents on the field reconnaissance (March 2013), no fisheries is being managed around the project site. Water for livelihood is used from the wells for spring water.
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a)N	(a) There are no scenic areas within and around the Project site. In case that archaeological remains are found during construction, the Project proponent will deal with them appropriately in accordance with the Indonesia regulations .
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a)N	(a) There are no scenic areas within the Project site.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a)N (b)N	(a) , (b) According to the interview with local residents on the field reconnaissance (March 2013), there are no living areas of indigenous people and valuable places for indigenous people in the vicinity of the Project site.

Nasal

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a)Y (b)Y (c)Y (d)Y	(a) The Project proponent will comply with all Indonesian regulations and laws regarding working conditions. (b) Protective fence and safety signs will be installed in the Project site. (c) The Project proponent will provide education about health and safety and about social considerations to all workers. (d) The Project proponent will employ local people as much as possible. The Project proponent will direct workers from other areas to pay respect to local culture.
	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce the impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce the impacts?	(a)Y (b)N (c)N	(a) In order to mitigate impact during construction, the Project proponent will minimize the amount of works, and avoid working in pluvial period. (b)The Project site is located in secondary forests and crop fields. In addition, geography around the Project site is steep. So adverse impact on natural environment is not expected. (c)The Project proponent is going to make efforts to education for all workers in order to mitigate impacts during construction. The impact caused by vehicles during construction will be considered.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(2) Accident Prevention Measures	(a) Is a warning system established to alert the inhabitants to water discharge from the dam?	(a) -	(a) NOT APPLICABLE
	(3) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a)Y (b)Y (c)Y (d)Y	(a)Monitoring by the Project proponent is planned as following: ・ Pre-Construction Phase：Social environment (Status of Land Ownership, Livelihoods / Incomes, Complaints of the Population), Water quality (pH, SS, COD, DO, Total Nitrogen, Total Phosphorus, Heavy metals, Oil) ・ Construction Phase：Water quality (pH, SS, COD, DO, Total Nitrogen, Total Phosphorus, Heavy metals, Oil), Waste (Type of waste, volume, disposal way), Ecosystem (Flora, Water Biota, Wildlife, Rare species), Noise (Noise level), Topography and Geology (Physiograpfy), Social environment (Safety and security, Demography / Social Interaction, Incomes of the Population, Public Facilities, Community Complaints, Aesthetics) ・ Operation Phase： Water quality (pH, SS, COD, DO, Total Nitrogen, Total Phosphorus, Heavy metals, Oil), Ecosystem (Flora, Water Biota, Wildlife, Rare species), Noise (Noise level), Social environment (Safety and security, Land use, Livelihoods), Others (Electrical energy) (b)Methods and frequencies of the monitoring items above are specified in the monitoring form. (c)Organizational structure and cost resiponsiblity is planned in the Environmental Managmenet Plan. (d)The Environmental Management Plan in the UKL/UPL specified the frequecy of reporting at each pre-construction phase, construction phase and operation phase. The monitoring form and reporting frequency were [illegible]
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects in the mountains including large areas of deforestation). (b) In the case of dams and reservoirs, such as irrigation, water supply, and industrial water purposes, where necessary, pertinent items described in the Agriculture and Water Supply checklists should also be checked. (c) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) - (b) - (c) -	NOT APPLICABLE
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) -	NOT APPLICABLE

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are requested to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.