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List of Abbreviations and Acronyms

‘	Minutes (1/60 of a degree)
“	Seconds (1/3600 of a degree)
a.m.	Ante meridiem (before mid-day)
AB	Aktie Bolag (Swedish: Share holding company)
asl (a.s.l)	Above sea level
BA	Basal Area
BMWP	Biological Monitoring Working Party
BOD	Biological Oxygen Demand
C (^{o}C)	(Degrees) Celcius
COD	Chemical Oxygen Demand
DANCED	Danish Cooperation for Environment and Development
dB	decibel
DBH	Diameter at Breast Height (1.3 m above ground)
DHI	Danish Hydraulic Institute
DID	Department of Irrigation and Drainage
DO	Dissolved Oxygen
DOE	Department of Environment
E	East
e.g.	Exemplii gratia, for example
EIA	Environmental impact assessment
EMMP	Environmental Management and Monitoring Program
EPA	(US) Environmental Protection Agency
EPD	Environment Protection Department (Sabah)
EPFI	Equator Principles Financial Institutions
Et al	Et alii, and others
FMU	Forest Management Unit
FR	Forest Reserve
FSC	Forest Stewardship Council
g, kg, mg	Gram, kilogram, milligram
GBH	Girth at Breast Height (1.3 m above ground)
GIS	Geographical Information System
h	Hour
Ha	Hectare=100 ar=10,000 m^2(=2.2 acres)
i.a.	Inter alia, among others
i.e.	Id est, that is
ICZM	Integrated Coastal Zone Management (project)
INWQS	Interim National Water Quality Standards
IPCC	Intergovernmental Panel on Climate Change
ITP	Industrial Tree Plantation
IUCN	International Union for the Conservation of Nature
JKR	Jabatan Kerja Raya (Department of Public Works)
k, km, kV, kg	Kilo (=1000), Kilometres, Kilo Volt, Kilogram

KK	Kota Kinabalu
Kg	Kampong=village
l	Litre
L_{eq}	Maximum Permissible Sound Level
LIGS	Lembaga Industri Getah Sabah (Rubber Industry Board of Sabah)
LSL	Lower Storage Level
m, m^2, m^3	Metre, Square metre, Cubic metre
m, mg	Milli (1/1000), Milligram
M, MW, Mm^3	Mega (=1000,000), Mega Watt, Million m^3
MOL	Minimum Operational Level
MPN	Most Probable Number
MRGGP	Malaysian Recommended Guidelines for Gaseous Pollutants
MTCC	Malaysian Timber Certification Council
MYR	Malaysian Ringgit
N	North
NFM	Natural Forest Management
NPP	National Physical Plan
NTL	Normal Dam Tailwater Level
NTU	Nephelometric Turbidity Units
NTWL	Normal Tail Water Level
NWQSM	National Water Quality Standards for Malaysia
^{o}	Degrees
p.m.	Post meridiem (After mid day)
PAP	Project Affected Person
pcph	Passenger cars per hour
PCU	Passenger Car Unit
PFE	Permanent Forest Estate
PGA	Peak ground acceleration
PMF	Probable maximum flood
Q, Q_p, Q_m	Hydro discharge (Peak, mean)
RCC	Roller Compacted Concrete (dam)
RIL	Reduced Impact Logging
RIS	Reservoir Induced Seismicity
RL	Reduced Level
ROW	Right-of-Way
rpm	Revolutions per minute
SCORE	Sarawak Corridor of Renewable Energy
Sdn Bhd	Sendirian Berhad = Private Limited company
sec	Second
SEIA	Special Environmental Impact Assessment
SESB	Sabah Electricity Sdn Bhd
SFI	Sabah Forest Industries
Sg	Sungei=river
sp	Species

spp	Plural of species
SS	Suspended solids
t	Tons (1000 kg)
TOR	Terms of Reference
TPHP	Tenom Pangi Hydropower Plant
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UMS	Universiti Malaysia, Sabah
UNDRIP	United Nations Declaration of Indigenous Peoples' Rights
UPHEP	Upper Padas Hydro Electric Project
US	United States (of America)
USGS	United States (of America) Geological Service
USL	Upper Storage Level
USMS	Universiti Sains Malaysia Sabah=University of Science, Malaysia, Sabah
Vph, vpd	Vehicles per hour, vehicles per day
WHO	World health Organisation
XTL	Maximum Dam Tailwater Level
µ , µg	Micro (1/1,000.000), micro gram

EXECUTIVE SUMMARY

The present report constitutes a Special Environmental Impact Assessment for "***The Proposed Upper Padas Hydroelectric Project, Sabah***" carried out on behalf of Sabah Electricity Sdn Bhd by Chemsain Konsultant Sdn Bhd:

Project Proponent	**Advisor to the Project Proponent**
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EIA Consultant	**In collaboration with**
CHEMSAIN KONSULTANT SDN. BHD. Lot 7, Lorong Suria, Off Lorong Buah Duku 1 Taman Perindustrian Suria, Jalan Kolombong 88450 Kota Kinabalu Sabah, Malaysia	**DHI WATER & ENVIRONMENT (M) SDN. BHD.** 11th Floor, Wisma Perindustrian Jalan Istiadat, Likas 88400 Kota Kinabalu Sabah, Malaysia

The assessment covers all aspects of the current planning for implementation of the Project but cannot cover issues for which important decisions have not yet been taken. Therefore, issues such as access roads, quarries, borrow pits and soil deposits are only covered in generic terms as sites for these activities have not yet been identified. Once identified, detailed environmental impact assessments can be made for such activities.

Chemsain and DHI have for the purpose of this assessment fielded a team of 27 specialists supported by the two companies' technical staff and accredited laboratory.

After thoroughly studying secondary information and obtaining primary data from conducting field surveys, Chemsain Konsultant Sdn. Bhd. has found that:

- There are no significant high conservation values in the areas directly affected by Project activities.
- There are no communities that need to be resetteled for the purpose of this Project.
- The major impacts of the Project concern: Loss of production areas/habitats for the reservoir and transmission line right-of-way; altered flow regime and water quality in the Padas River. The altered flow regime and water quality is to a large extent positive to downstream users.

Based upon the above findings and associated mitigating measures, Chemsain Sdn. Bhd. concludes that:

- *The Project may be implemented in a social and environmentally acceptable manner provided the mitigation measures described in the environmental management plan are incorporated in Project planning and implementation.*

- *Main impacts that need mitigation measures to be incorporated into the present plans concern land tenure, water quality, water flow regimes, emission of green house gasses. These issues have further impact on particularly aquatic wildlife and consequential impact on human livelihoods.*
- *Main residual impacts concern catchment management, greenhouse gasses and the permanent risk of dam breach.*
- *Project benefits are likely to balance positively with environmental costs.*

Project Justification. The Project concerns the building of a 120 high Roller Compacted Concrete hydroelectric dam across the Padas River just above Kuala Tomani, a 150-210 MW power generation facility and associated transmission lines, infrastructures and water reservoir. The Project is justified in the forecast that Sabah's electricity demand will increase from about 830 MW today to around 1800 MW by year 2020. In anticipation of the growing electricity demand in Sabah, the Upper Padas Hydroelectric Project alongside with the proposed Liwagu Hydroelectric (with a capacity up to 210 and 165 MW, respectively) have been included in the Sabah Electricity Sdn. Bhd. conceptual development plans as priority projects for the next 10 years.

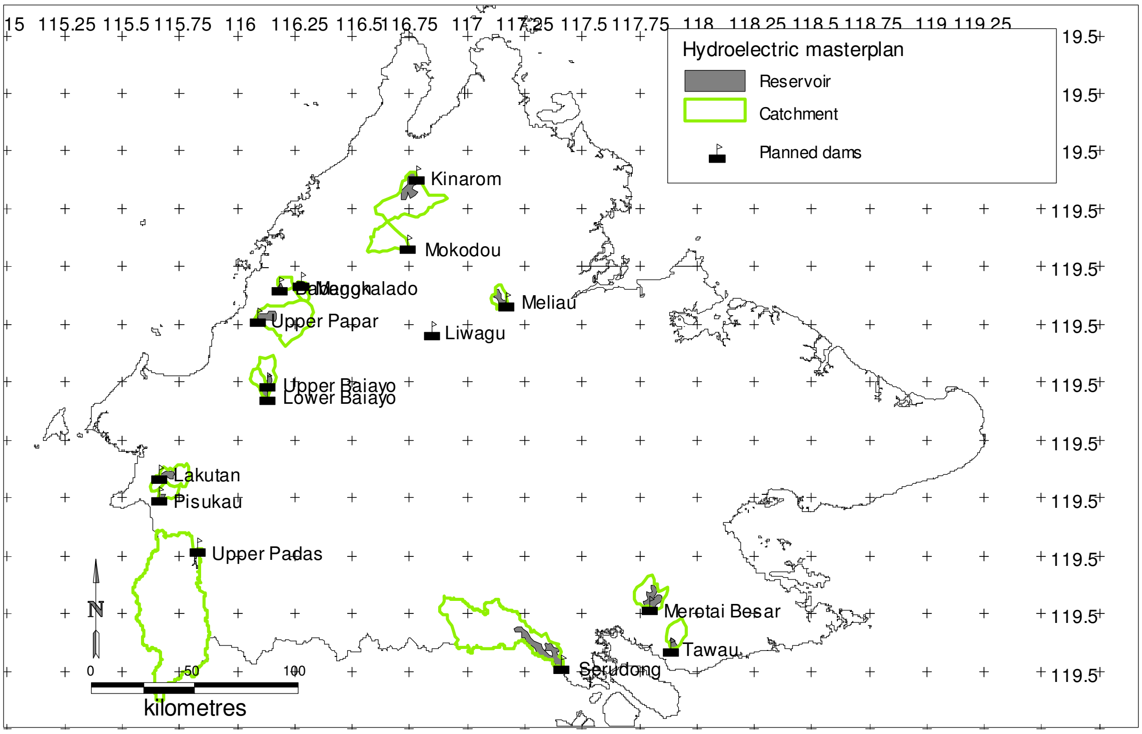
Alternative Options. Several options have been considered concerning overall technology, site selection and the detailed design.

As a state, Sabah will diversify its power generation but must gradually phase out the use of fossil fuels for supply and environmental reasons. Sun energy is not yet feasible energy source at a large scale and wind is not technically feasible in Sabah. This leaves, unless nuclear power is considered, hydropower as the future priority without ruling out coal and diesel plants for the present. There are several potential sites for hydropower generation in Sabah but most of these are only suited for smaller plants. Upper Padas and Liwagu are the most promising sites wherefore both these sites currently are being investigated. A different option, although still using hydropower, is the purchase of power from Sarawak's (Sarawak Corridor of Renewable Energy) dams, of which Bakun is nearing its completion and Murum is being built.

There are in principle two kinds of hydroelectric power generation systems. One principle, which is used further down on the Padas River at the Panggi Hydro Station is the 'flow-of-the-river' system, where the river current is directly used for power generation. This system is simple and dooes not have significant impoacts on river flow and water quality as there is no reservoir, only a dam that guides the water through the turbines. The lack of a reservoir makes this system vulnerable to both floods and droughts, a problem aften suffered by Panggi. The other principle, which has been selected for the Upper Padas Hydroelectric Project involves constructing a dam, which blocks the river and creates a reservoir and thus a buffer absorbing floods and still providing water during droughts.

Of the three main types of dams, Roller Compacted Concrete (RCC), Earthfilled Concrete Faced, and Rockfilled Concrete Faced, the earth filled option has been ruled out as it is considered unsafe to build in high rainfall areas. It is safe enough once it is completed but unstable during construction. The RCC dam has been selected for this Project as it is considered safe and more suited to the topography of the selected site. Rock and earth filled dams have a very large footprint compared to the RCC wall-type of design. Earth and rock filled dams must have the spill-way separate next to the dam while the spill-way may be built into the RCC dam design, a feature that suits the narrow site selected for this Project.

The advantage of the Upper Padas site is a narrow reservoir site associated with a large catchment of about 1,900 km^2. The reservoir will only be 17 km long and cover 6 km^2 but will hold 275 million m^3 of water, 220 of which will be live storage. There is relatively easy access, a simple land use pattern and no local communities are living where the reservoir will be made. There will thus be no resettlement of communities. The figure below indicates some of the most promising potential hydropower sites in Sabah including the location of the Upper Padas Project. The grey areas are the potential reservoirs and the green border line delimits the associated catchment area. As can be seen, the Padas reservoir is very small in comparison to the reservoir.



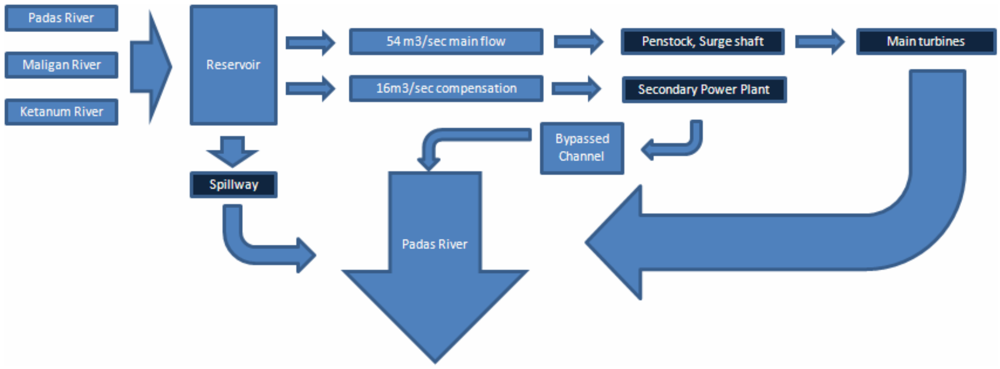
The Project is not yet finally designed as some alternatives are being considered. The number of turbines and thus the final capacity has not yet been finally decided upon. The level of compensation flow and thus the capacity of a secondary powerplant at the damsite (The main power station will be about 10 km downstream of the dam) is also under discussion.

For the construction methodology, final decisions on diversion tunnel(s), coffer dam(s), location of quarries, borrow pits and sites for deposit of soil from excavations, access road and transmission line alignment have not yet been made. While standard pylon designs currently in use by the Project Proponent are available, final design will only be made in conjunction with the tender process.

For the transmission lines, several alternatives have been considered before deciding in principle for the current proposal. Issues to consider have, apart from economy, topography and geotechnical considerations, concerned avoidance of environmentally sensitive areas and human settlements.

As a result, this assessment only covers access road building, quarries, borrow pits and soil deposit areas in general terms.

Project Process Principles. The diagram below shows the principles of the Project by following the flow of water through the system. Three rivers, Padas, Maligan and Ketanum will be slowed down to a reservoir as the dam is built across Padas River. The combined rivers currently flow with about 70 m^3 per second. A minimum of 16 m^3 of these will be allowed to be released for environmental reasons (compensation flow) into the river again directly below the dam. This water is not wasted for energy production as a small power generation unit will be built at the dam site for utilising this water's energy locally. The head for this water release is 88 m.



The remaining 54 m^3 per second will be lead through a 9 km tunnel system to a place near Tomani where it will be released through the main turbines thus bypassing about 9 km of river bed. The reason for this long transfer of the water before the mainpower station is to utilise an additional fall of the terrain of about 130 metres. The ecological disadvantage is that 9 km of the river is left dry if not for the compensation flow and the small tributaries joining Padas River on this stretch. A spillway in the dam acts as a safety valve in periods of excess water in the reservoir. After the main power station, all 70 m^3 per second are again joined and the river will flow normally although without seasonal fluctuations. Some fluctuations will happen in periods where excess water being released over the spillway.

Coffer Dams and Diversion. The construction methodology for the dam is not yet finally decided but the likelihood is that the dam will be constructed in the dry as opposed to 'on the river'. Two low, temporary 'coffer dams' will serve this purpose and keep the construction site as a dry dock.

The design of the cofferdams has not yet been made but the likelihood is that they will be made from simple soil and the one above the building site will be about 25 metres high and the one below about 15 metres high. The upper coffer dam will just be left to be inundated while the lower coffer dam will be removed, when construction of the main dam is completed.

The flow of the river will be maintained by constructing a 650 m long concrete lined diversion tunnel with a diameter of 12 m through the mountain, bypassing the construction site. There will be gates and facilities for blocking the inlet when the dam is completed and the reservoir shall be filled. There are not yet firm plans for the deposit of the almost 100,000 m^3 muck material from the diversion tunnel.

The flow of the river will only be partially blocked for reservoir filling when the main dam is completed.

Main Dam. The main dam will be a 120 m high roller compacted concrete dam, i.e. built from a mixture of cement, aggregate and fly-ash to which a small amount – compared to conventional concrete mixing – of water, which is compacted by heavy rollers. This type of concrete is superior to conventional concrete when large volumes are needed as curing and heat development may be better controlled. There are other, structural advantages too. The crest height will be at 475 m asl compared to the natural river elevation at the site of about 360 m asl. The crest length will be 440 metres.

A spillway comprising four 9.5 metre wide and 12 m high gates will be built into the damwall. The four main spillway gates will be of the radial lifting type. The gates shall be manoeuvred using hydraulic cylinders, presumably one mounted on each pier. A 300 m plunge pool will be established below the spill-way.

Also built into the dam wall will be various drainage, safety and monitoring features plus a smaller power generation facility to utilise the compensation flow.

To ensure a safe dam and reservoir, all soil must be removed down to the parent rock where the dam is built and on the sides and bottom of the dam wall. There are no concrete plans yet for the deposit of this excess soil. The construction of the dam is expectd to last about 38 months.

Reservoir. The dam will create a 6 km^2 reservoir stretching some 17 km upstream Padas River from the dam site. The reservoir will also cover short stretches of Maligan and Ketanum rivers. The reservoir will hold 275 million cubic metres of water when full, 220 million cubic metres of these will be active storage, i.e. a storage above the water intakes and thus available for power generation.

The upper storage level will be at 470 m asl, while the lower storage level will be at 430 m asl, 10 metres above the water intakes.

The reservoir is fed by a 1,900 km^2 large catchment area, which will not be under the jutrisdiction of the Project Proponent.

It is estimated that it will take about 1.5 months to fill the reservoir once the diversion tunnels are plugged. This will only happen when the main dam is completed and after clearing of the reservoir area of vegetation.

Bypassed Channel. While not a Project component, the dam will create a 10 km long 'bypassed channel' of the stretch of the Padas River between the dam and the main powerhouse. If not for the environmental compensation flow, which will be released at the dam, this stretch would only lead water from spills and from the small tributaries joining the Padas here.

Water Intake. The water intake will be close to the dam, 50 metres below the surface, i.e. 10 metres below the lower storage level. The water intake will be a separate structure connected to the dam wall.

Main Power House. A main powerhouse will be built on an excavated site near the Padas river close to Kg. Tomani. It will be equipped with three vertical shaft Francis turbines. The net head of the water driving the turbines will be 220 m as the terrain has fallen an additional 130 metres between the dam and the power house location. It is under consideration to install a fourth turbine, which would require adding additional height to the main dam.

Power Water-way. The water is lead from the intake to the main power house first through an underground headrace tunnel, later through an over ground penstock. Where these two join, a surge shaft is inserted to cater for fluctuations in the water pressure and level. As an emergency for penstock failure, a valve house has been provided with a butterfly valve, which will close the headrace tunnel if a failure should occur. This valve house shall be located 100 m downstream of the end of headrace tunnel.

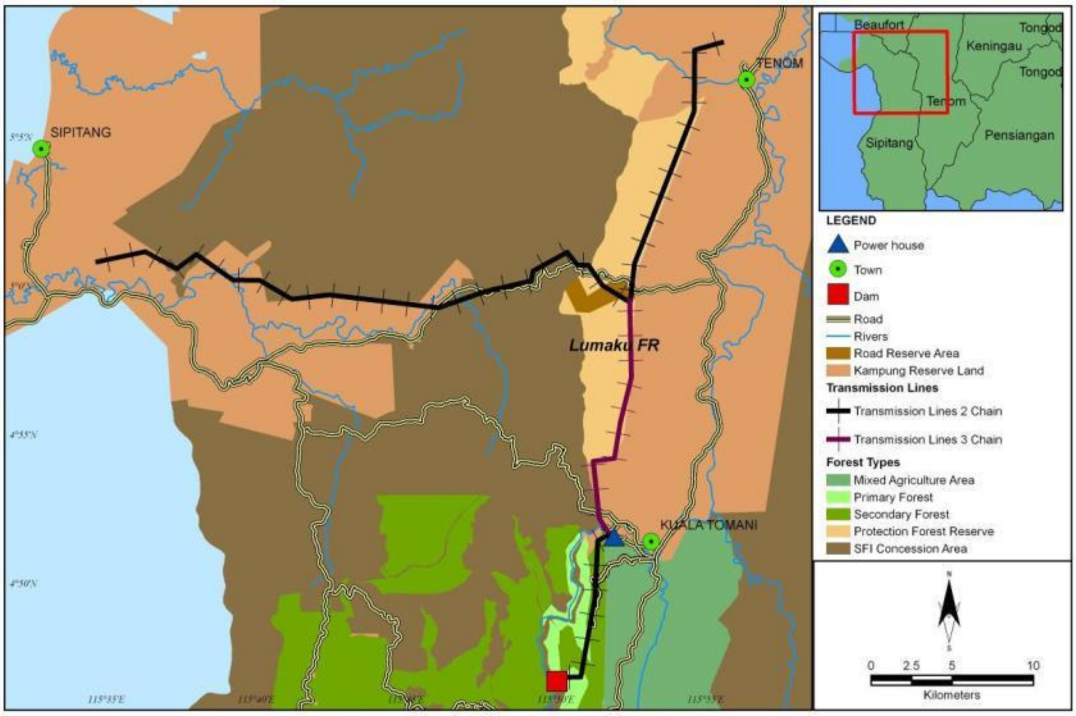
The headrace tunnel will have a horseshoe cross section of 22.3 m^2 and a length of 9.5 km, resulting in the excess of 200,000 m^3 excavated muck material. There are currently no concrete plans for the deposit of this material.

Secondary Power House. It is a requirement to release a minimum of the 90% exceedance flow, i.e. the flow, which is statistically present a minimum of 90% of the time, at the dam site. This flow is calculated as 16 m^3 per second or 23% of the available water. The reason for this is to maintain the aquatic habitat in the river as well as the relation between soil water and the river system. This water will be utilised in a secondary 14 MW power station to be built into the structure of the dam. The head of this water is about 88 metres as opposed to the 220 metres at the main power station. This difference is the cause of the desire of the Project Proponent to minimise the compensation flow requirements and guide the water through the main station instead, thereby increasing the efficiency by an additional 150%.

Tailrace Canal. In order to control the violent gush of water being released into the river after the main turbines a tailrace canal will be built. This will protect the river bed and banks from uncontrolled erosion.

Transmission Lines. The electricity generated by the secondary power house will be transmitted to the main power house through a 33 kV line and added to the power produced by the main turbines. The resulting power will be sent to Tenom and Sipitang through two separate transmission lines, a 132 kV line to Tenom and a 275 kV line to Sipitang. Spacing between pylons will be approximately 300 metres for the 3132 kV line and 365 metres for the 275 kV line. Both lines will require their own, separate right-of-way areas 20 metres on either side of the lines. Where the lines run parallel, the right-of-way areas cannot overlap each other, i.e. the spacing between the lines must be a minimum of 2 x 20 metres. There will be some land use restrictions imposed in the right-of-way, which will include a prohibition of any structure or vegetation taller than 2 metres.

The two lines are brought parallel to a point near the villages Paal and Bamban from where the Sipitang line is taken West to Sipitang and the Tenom line continues North to Tenom. At the termination of the lines, substations will be built and the connections to the remainder of the Sabah grid are made.



The table below summarises the technical specifications of the Project components.

Item	Description
(1) Catchment	
Catchment area to dam (km^3)	1,885
River channel length: headwaters to dam (km)	17
Average annual sediment load (t)	300,000
(2) Flows At Dam	
Mean flow (Q_m, m^3/s)	72
10% low flow (m^3/s)	21
1% AEP flood discharge (m^3/s)	3,100
Probable Maximum Flood (PMF) discharge (m^3/s)	9,000
Design spillway discharge (m^3/s)	11,800
Peak hydro discharge (Q_p, m^3/s)	70

Item		Description
(3) Dam		
Natural river elevation at dam (m)		360
Dam height (m)		120
Dam crest elevation (m)		475
Dam crest length (m)		440
(4) Headrace Tunnel		
No.		1
Size (diameter)		5.0
Length (m)		9,500
(5) Reservoir		
Reservoir NTWL (m) (Normal top water level)		470
Reservoir operating range (m)		40 (430 – 470)
Reservoir live storage:	(m^3 *10^6)	220
	(days at Q_p)	36
Reservoir length at NTWL (km)		12
Reservoir area at NTWL (km^2)		5.9
Reservoir capacity:	(Mm^3)	275
	(days @ Q_m)	44
Reservoir dead storage (Mm^3)		55
(6) Spillway		
Type		Free overflow + gated
Gates		4 No, each 12 m x 9.5 m
Gate sill elevation (meter above sea level)		455
(7) Diversion Tunnels		
No.		1
Size (diameter)		12
Length (m)		670
(8) Generation		
Tailrace level (m)		217
Gross generating head (m)		253
Peak rated power output (MW)		150

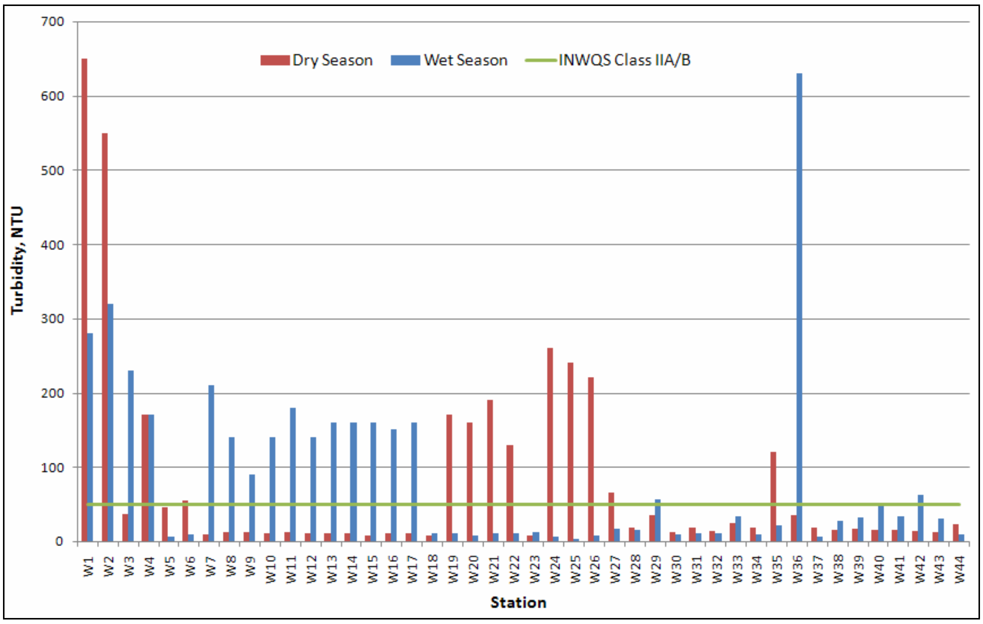
Physical Environment Description. The site for the dam and reservoir is selected in a geologically stable area with no significant seismic activity. In any event, roller compacted concrete dams are considered the most safe dams when the issue is seismic risks. Two soil types dominate the catchment area: The Maliau association in the hilly and mountainous southern part of the catchment area and the Crocker association in the north where the topography is more gentle. The two associations are rather similar and both considered of low suitability for agriculture. A third association, the Lokan association dominates the transmission line right-of-way. It is again quite similar to the aforementioned two associations but dominated by sharp ridges and steep slopes. The alignment from the power station to Tenom via Paal/Bamban follows the 610 m contour parallel to the Padas River, while the line from Paal/Bamban to Sipitang must cross several ridges and rugged terrain.

Rainfall is in the range of 2,000-2,500 mm per year as the Project is in the shadows of the Crocker Range where the rainfall exceeds 4,000 mm per year. Occasionally the El Niño phenomena cause prolonged droughts. The rains, which are mostly convection rains are otherwise fairly evenly distributed over the year. The southern part of the catchment area has slightly higher rainfall than the rest of the Padas basin East of the Crocker Range. There are no extreme winds. Mean monthly relative humidity is 86% on average so the evaporation is essentially also uniform throughout the year, with an average of 4.1 mm/day.

The 1,900 km^2 catchment, i.e. the area that drains through the single point on Padas river, where the dam will be built, feeds the Upper Padas river, Maligan and Ketanum rivers. These rivers are relatively fast flowing with many rapids and steep banks and valleys.

Mean flow at the dam site has been assessed to 71.6 m^3/s, median flow to 52.4 m^3/s and the 10% low flow (90% exceedance flow) 15.5 m^3/s. Variation through the year is large and there is a distinct low in the month of March. The large variations and frequent floods may cause frequent spilling at the dam.

Water quality is in general within the Malaysian Class IIA/IIB standards although there are some localised occurrences of faecal coliform bacteria. As all other rivers in Sabah, there is also a problem of high levels of suspended solids in the water due to widespread land conversion in the area.



The figure above shows the turbidity level in the river. Stations 1-26 are above the dam, 27-35 on Padas below the dam and 36 – 44 on Mengalong. The uneven distribution between wet and dry season measurements indicate localised land use activities during sampling rather than seasonal variations. In periods with no land use activities, the turbidity level will be low.

Biological Environment Description. Originally the catchment and right-of-way areas were covered by hill and lowland dipterocarp forests with patches of other types such as heath forest, Agathis and riverine habitats. There is still large areas of the natural forests left, particularly in the southern part of the catchment area on the Maliau soils but also on steep slopes in the north and on the Eastern side of the proposed reservoir. Most of these forests are no longer in their undisturbed state but to the West, there is a large virgin forest reserve, Sg. Maligan FR. The natural forest areas is species rich but poorly stocked and does not represent a particular conservation issue apart from the fact that all dipterocarp forest collectively are under pressure. The total above ground biomass in the dipterocarp forest covering the reservoir site, i.e. the area to be cleared and inundated, has been measured to 99 tons per ha compared to 250-450 tons per ha used as standard for tropical rainforests by the Intergovernmental panel on Climate Change.

The right-of-way for the transmission line from the power station to Tenom is entirely through a cultural landscape dominated by oil palm and rubber plantations. The alignment towards Sipitang i.e. equally dominated by cultural landscapes, i.e. non-natural vegetation dominated by a patchwork of secondary forest, ill kept rubber plantations and some oil palm development.

The Southern part of the catchment area is maintained under natural forest, i.e. hill dipterocarp forest and Agathis forest, while the Northern part is being converted to industrial tree plantation areas using mostly exotic species such as Acacia and Eucalyptus.

Two enclaves around Long Pasia and Kg. Maligan respectively are cleared several years ago and converted to small scale agriculture or tree crops. These are outside the direct Project activity areas but will have an impact on the Project as they are within the catchment area and the activities there are virtually unchecked.

There is relatively little wildlife in this area. Land conversion and inconsiderate hunting has impoverished the area's wildlife to the brink of extinction. The most common mammals are rodents and wild pigs. Forty six species of mammals were recorded throughout the surveyed areas. These included the Sun Bear, clouded leopard, Leopard cats, otters, martens, bear cat, civets various deer, bearded pig, monkeys, squirrels, rats and bats. Of the forty six species, twenty five (54%) are protected species under the Sabah Wildlife Conservation Enactment 1997.

Of particular interest is the presence of the Malayan Sun Bear and Clouded Leopard, which are priority species to Sabah as they are listed as 'Totally Protected Species' under the Wildlife Conservation Enactment and they are also classified as 'Vulnerable' on the IUCN Red List. Five species of primates including Gibbons were recorded.

There are occasionally some Tembedaus (wild ox, *Bos Javanicus*) crossing the area but they seem not to be resident. Neither avifauna nor herpetofauna in the reservoir area shows any signs of differentiating itself from similar habitats elsewhere in Sabah.

A total of 9 fish families represented by 22 genera and 35 species were present in the study area This is a significant increase in the number of families, genera and species caught when compared to the preliminary EIA study mainly due to the wider area sampled during this study period and an increase in the methods of fishing employed.

There are 16 species recorded from the area below the dam, 21 species recorded from the area to be inundated, 27 species from the area Above the reservoir and 12 species caught from sampling stations at Kampong Pangi area**.** More species is present in the area outside the reservoir compared to the area to be inundated. The diversity indices for aquatic wildlife do not differ much from similar indices elsewhere in Sabah or Sarawak and no fish sampled are listed as threatened.

The sampling of invertebrates showed a standard species composition but with low population numbers. This was to some degree in contradiction to the water quality data, which indicated better habitat conditions than mirrored in the actual population data. The classifications for the Padas River fell under Class IV and V based on the macro-benthos data, indicating a poor water quality / environment for the macro invertebrate community. This may be attributed to an earlier history of unchecked land conversion in the catchment area. It is known that the forest concessionaire, the Sabah Forest Industries, has undergone a change in environmental philosophy ownership and management in connection with a change of ownership. The benthic communities have, however, not yet had time to recuperate from earlier management regimes

The Human Environment. The Project – including the transmission lines – affects three administrative districts: Tenom, Beaufort and Sipitang. In Tenom the Padas River, with the proposed dam site and power station and the existing Pangi Hydroelectric Power Station, mainly runs through the sub-district Kemabong. The main areas, i.e. the reservoir and the catchment are part of the Forestry Department's Forest Management Unit number 07, Sipitang, which is licensed to the Sabah Forest Industries (SFI).

SFI has a license to convert the area to plantation forestry but is limited by environmental concerns such as slope limitations and river protection. These limitations plus other concerns have been incorporated into SFI's management plans and environmental impact assessments.

The areas to be converted are cleared and prepared in a manner that is chosen for its minimum long term negative impact: Non-commercial trees are crushed and left on the ground for decomposition, minimal controlled burning, planting in debris). Planting and silviculture is implemented with methodologies and choice of species that aim at fast canopy closure and protection of soils. The species used are exotics: Acacia and Eucalyptus from seeds and there is no thinning done as part of growth manipulation.

The table below shows approximate areas of various land use functions in the catchment area.

Forest Land Use	Area	Percent of Catchment Area
Natural Forest Management	94,578 ha	50 %
Industrial Tree Plantation	58,571 ha	31 %
State Land	25,898 ha	14 %
Virgin Forest Reserve	9,453 ha	5 %
Catchment area	**188,500 ha**	**100 %**

The two enclaves of small holder agriculture – state land in the above table - are dominated by traditional farming although conversion to rubber or oil palm is catching up. There are no environmental assessments or regulations covering such areas. The local farming areas will not be affected by the direct establishment of Project facilities or the reservoir. The communities do not use the river extensively for transport purposes but there is some degree of fishing in the rivers.

The transmission lines will affect rubber and oil palm schemes both on the Tomani-Tenom stretch and on the stretch connecting to Sipitang. There are, however, no settlements or areas under intensive agriculture in the path of the transmission lines. There are only plantations.

While the plantations between the dam, the power station, Kg. Paal/Bamban and Sipitang are small holder plantations, the main area between Kg. Paal/Bamban and Tenom is owned by one large company, Sime Darby.

Impact and Mitigation. The impacts of this Project are mainly:

- Issues of soils entering the waterways during excavation works for the dam, tunnels, powerhouses, roads, pylons and camps.
- Loss of habitat and production areas in the reservoir area and under the transmission lines.
- Changes to river flow and river water quality.
- Impacts of dense traffic to the dam site during construction.

In addition, the Project will put pressure on Sabah Forest Industries and the authorities to ensure sustainable soil management and protection in the catchment area. This includes concerns for soil management in the two state land enclaves.

Soil Management. Excavation of tunnels and for the dam abutments, for roads, powerhouses, camps etc. will produce massive amounts of soil, for which there presently are no plans for the disposal of. The excavation will also create bare areas, which are susceptible to slope failure or sheet erosion. Mitigation, which requires training and discipline among workers and contractors is a minimum clearance, phased clearance, gradient limitations of excavations as well as deposit areas, silt traps and final landscaping. The objective is protection of the water courses, their habitats and fish stocks and other qualities for human use and consumption.

Loss of Habitat. The loss of habitat to the reservoir, the bypassed channel or the transmission lines will be insignificant. What counts will be the fragmentation of habitat. Wildlife will no longer be able to cross the river at the reservoir site unless they are birds, fishes will no longer be able to pass the dam site, thus effectively creating two unrelated aquatic habitats: one above the dam and one below. There are no known mitigation measures for this. The dam and the powerhouse will, with its human activities and presence, also break the wildlife corridor along the river from the natural forests and virgin forest reserves in the south to the Gunung Lumaku forest reserve and other natural forest areas in the north. These issues are insignificant under the transmission lines.

Loss of Production Areas. The immediate socioeconomic impact is the loss of productivity under the transmission line and in the reservoir area. For Sabah Forest Industries this amounts to a total of about 650 ha, which the company hopes will be compensated in form of a replacement area. The company has a small state land enclave, Pangalubon, in mind. For the rubber and oil palm growers, the right-of-way limitations will prevent them from their present activities and unless they are also given replacement land cash compensation seems to be the only possible mitigation other than avoiding these areas totally when finally adjusting the alignment. Chemsain Konsultant advocates the line is primarily placed in the industrial tree plantation areas, secondarily in rubber or oil palm areas but that it avoids natural forest. The table below depicts the land use to be affected by the power lines.

Sector	Protection forest	Natural Forest	Industrial Tree Plantation	Oil Palm	Rubber	Total Length / Area
Secondary power house - Main power house	0 km 0 ha	1.9 km 7.60 ha			9.6 km 38.40 ha	11.50 km 46.00 ha
Main power House - Kg Bamban (16.01 km Double line)	0 km 0 ha			32.02 km 128.08 ha		16.01 km 128.08 ha
Kg Bamban - Tenom	0 km 0 ha			17.87 km 71.48 ha		17.87 km 71.48 ha
Kg Bamban - Sipitang	0 km 0 ha	8.83 Km 35.32 ha	5.45 km 21.80 ha	1.93 km 7.72 ha	20.55 km 82.20 ha	36.76 km 147.04 ha
Total	**0 km** **0 ha**	**10.73 km** **42.92 ha**	**5.45 km** **21.80 ha**	**51.82 km** **207.28 ha**	**30.15 km** **120.60 ha**	**98.15 km** **392.60 ha**

The inundation will cause the loss of 600 hectares of habitat in an area where natural habitat is increasingly scarce. Locally this may be felt but regionally, this is a small price to pay for the socio-economic benefits.

River Flow. The 12 km of river that is converted from a free flowing fast, rapid but shallow rapid-filled river to a docile lake with a deep anaerobic zone will be a completely new habitat and scenery. The current load of suspended solids is likely to settle in the upper reaches of the reservoir thus clearing the water but also decreasing the active storage and thus buffer for the Project in a dry spell. What was before forest floor will slowly turn into a soft benthic layer which sometimes is inundated, sometimes exposed. The forest near the present river will be inundated creating a fossil like forest slowly but anaerobic decomposing and thus saturating the water with methane and some carbon dioxide plus possibly mercury and other compounds.

The 9 km of ‘bypassed channel’ i.e. the segment of the Padas from the dam to the main power house will be transformed to a small river, about one quarter of its present size. The water is likely to be clear but still with a high content of methane after most methane has been released when the pressurized water is released through the secondary turbines. The river bed will thus change, the benthic stratum and thus the pelagic fishes too may change in composition and distribution.

The main flow of water, about 75% of the normal flow, will be released to join the water from the bypassed channel at a point after the main turbines. The change of water here will be the same as at the secondary power house: The water will be clearer but there is a problem with dissolved greenhouse gasses and other chemical compounds from decomposition of soil and biomass in the reservoir. Much will be released when the internal pressure of the water is released and the remainder methane is expected to be released through the river surface over the next 20-40 km. The impact on the river will not be significant as the flow short after the power house is joined by Tomani river and other water rich rivers. The management of the release of water through the turbines will, however, to some degree prevent seasonal fluctuations, thus contribute to the alleviation of flooding problems downstream. The latter may be a theoretical wish as floods are likely to occur when the reservoir is filled and water already flows over the spillway.

Green house Gasses. The creation of the reservoir will cause 600 ha of forest to be destroyed one way or another. Inundation of biomass may result in high concentrations of methane in the water while burning or natural decomposition will cause production of carbon dioxide. Of the two evils, carbon dioxide is the lesser and a complete clearing of the reservoir area is recommended. A total of 49,000 tons of carbon will be emitted as greenhouse gasses. Half of this from decomposition of waste in the forest, half through processed products. Emission of CO_2 equivalents through methane from anaerobic decomposition will be 314,000 tons while CO_2 emission from aerobic decomposition will be 140,000 tons. These amounts are not large but the cumulative effect of this and other activities in the State should be considered. The Project should consider off-setting this impact through active forest protection or forest planting elsewhere or in the catchment.

Traffic. Particularly the dam construction will create a dense traffic of heavy trucks carrying cement and other building materials to the site. This will inevitable cause a safety and nuisance concern for residents along the roads and similar concerns about the road condition. Mitigation again requires training and discipline, planning and respect for other people. Traffic must be planned with safety in mind and the Project must ensure not only the vehicles and drivers are of high standard but also the road itself.

The table below summarizes impacts and mitigation.

Project Stage	Project Activity	Potential Environmental Impacts	Proposed Mitigation Measures
Pre Construction Stage	- Disclosure and communication - Land Acquisition, tenure and user rights - Site investigations	- Social uncertainties and inequities	- Compensation payment - Replacement areas
Construction Stage	- Procurement - Transfer and mobilisation	- Consequential impact on procurement lines	- Regulated, 'Green' procurement
	- Earthworks - Civil works - River diversion	- Soil instability, increased suspended solids in waterways: Habitat destruction - Waste generation - Labour safety hazards	- Soil stabilization, slope protection, Siltation control, Transport safety, waste disposal plans, Hazardous waste control, Personal protection equipment, Labour training, Compensation flow, Access to bypass the construction site for river transport.
	- - Biomass disposal	- Loss of habitat - Greenhouse gasses	- Wildlife rescue, Off-set plantation or protection,
	- Decommissioning of temporary structures	- Waste generation - Soil instability	- Contractor control, clearing, revegetation
Impoundment Stage	- Closing diversion tunnels - Removal of cofferdams Flooding - Releasing compensation flow	- Flow disruption, impact on aquatic habitat and fisheries, Increased sedimentation (Cofferdams) - Greenhouse gasses - Loss of habitat	- Off-set (compensation) planting - Wildlife rescue - Timing of works
Operation and maintenance Stage	- Power generation	- Limitation to land use in catchment	- Catchment management - Compensation
	- Power transmission	- Limitation to land uses	- Right of way management support - Compensation
	- Periodic Maintenance	- Temporary access	- Compensation

Environmental Management. The present assessment report includes a proposal for an environmental management plan containing a management programme including necessary management policies, organisational aspects and issues of maintaining management capacity, labour issues, and an action plan or 'program for mitigation and enhancement procedures'.

Management Programme. The management programme includes policies and covenants ensuring the Project Proponent's commitment to sustainable environmental management and corporate social citizenship. The policies concern *i.a.* procurement, labour issues, legal issues, and environmental and social responsibility.

The plan recommends the establishment of an organisation within the Project Proponent to deal with catchment area and reservoir management. It emphasizes that it is the responsibility of the Project Proponent to ensure contractors and sub contractors oblige by the environmental conditions and implement the environmental management plan. This includes a number of policies on social and environmental corporate citizenship and responsibility and adherence to national and international requirements and to establish regulations for green procurement to prevent environmental or social degradation as a result from the Project's procurement.

Action Plan. The plan further contains an 'Action Plan' made up by a series of separate plans for *i.a.* soil protection, biomass removal, wildlife management, workers' health and protection, wastes management plan, community related plans, cultural heritage management plan and a plan for catchment management. These plans contain the most significant mitigating measures related to Project activities and expressed in an operational format. The action plan also includes plans for community engagement and grievance mechanisms.

Emergency Response. A particular part of the action plan is an emergency response plan, which leans on similar plans for the large dams in Sarawak. This is important, considering that large emergencies are of national concern and the organisations and procedures therefore must be synchronized. This issue also takes into account the likelihood of workers and sub contractors move from one dam construction to another and should therefore be familiar with emergency procedures.

The emergency response plan primarily establishes the organisation and alert procedures to handle smaller emergencies the first steps of alert and evacuation in case of a major emergency.

Catchment Area Management. Suspended solids in the head waters will quickly settle in the upper reaches of the reservoir, thus decreasing the active storage and subsequently increasing the risk of a water shortage in case of prolonged drought. The dam management therefore has a vested interest in soil management and protection in the catchment area which legally is outside the dam management's jurisdiction. The parties legally operating within the catchment areas are the Sabah Forest Industries and the villagers of Long Pa Sia and Kg. Maligan areas. The issue is already dealt with in Sabah Forest Industries' management plan and the associated environmental impact assessments whereas there are no such requirements for the villagers. There is also no guarantee the regulations imposed upon Sabah Forest Industries or implemented by Sabah Forest Industries are sufficient for the Hydro Electric Project purposes. The present assessment therefore recommends an organisation to be established comprising all involved parties including relevant government agencies and that soil conservation issues are dealt with on a collaborative basis in this forum.

Communication and Disclosure. A communication and disclosure series of dialogues has already been initiated by the Project Proponent. This process shall be continued and made permanent through the organisation that establishes joint catchment area management and through a grievance mechanism. The assessment stresses the importance of free, prior and informed dialogue, whereby affected parties are given a fair opportunity to express their views and proposals before final decisions are made.

Residual Impact. Even if all mitigation plans are implemented, there will be some residual impact.

Apart from loss of land and land-use rights, which will be mitigated through payment of compensation, then residual impact mostly concerns water quality, greenhouse gasses and the inherent risk of accidents and dam failure.

The residual impacts must be monitored and analysed for exceedance of agreed limits and the activities monitored for compliance with the environmental conditions required by the State. Verified monitoring reports must be submitted quarterly to the Environment Protection Department. The assessment includes recommended monitoring points for water and air sampling and a list of parameters to sample.

RINGKASAN EKSEKUTIF

Laporan kajian ini merupakan Penilaian Impak Alam Sekitar Khas bagi "***The Proposed Upper Padas Hydroelectric Project, Sabah***" yang disediakan untuk Sabah Electricity Sdn Bhd. oleh Chemsain Konsultant Sdn. Bhd.

Penggerak Projek	Penasihat kepada Penggerak Projek
SABAH ELECTRICITY SDN. BHD. Tingkat 6, Wisma SESB Jalan Tuanku Abdul Rahman 88673 Kota Kinabalu Sabah, Malaysia	**UPPER PADAS HYDROPOWER CONSULTANTS (UPHC)** Tingkat 7, Wisma SESB Jalan Tunku Abdul Rahman 88673, Kota Kinabalu Sabah, Malaysia
Perunding Alam Sekitar	**Dengan kerjasama**
CHEMSAIN KONSULTANT SDN. BHD. Lot 7, Lorong Suria, Off Lorong Buah Duku 1 Taman Perindustrian Suria, Jalan Kolombong 88450 Kota Kinabalu Sabah, Malaysia	**DHI WATER & ENVIRONMENT (M) SDN. BHD.** 11th Floor, Wisma Perindustrian Jalan Istiadat, Likas 88400 Kota Kinabalu Sabah, Malaysia

Kajian ini merangkumi semua aspek perancangan masa kini bagi implementasi Projek namun tidak dapat meliputi isu-isu dimana keputusan penting masih belum diambil. Oleh itu, isu-isu seperti jalan akses, kuari, lokasi sumber tanah dan pelupusan tanih hanya dapat diliputi secara umum memandangkan lokasi bagi aktiviti ini masih belum dikenalpasti. Apabila dikenalpasi, kajian penilaian impak alam sekitar yang lebih terperinci boleh dijalankan.

Chemsain dan DHI, bagi tujuan kajian ini telah melibatkan kumpulan pakar seramai 27 individu dengan sokongan kakitangan teknikal dan makmal yang diakreditasi.

Setelah menjalankan kajian terhadap maklumat sekunder dan data penting daripada tinjauan tapak, Chemsain Konsultant Sdn. Bhd. telah mendapati bahawa:

- Tidak terdapat nilai pemuliharaan tinggi yang penting di kawasan yang akan terjejas secara langsung daripada aktiviti Projek.
- Tidak terdapat komuniti yang perlu ditempatkan semula bagi tujuan Projek ini.
- Antara impak besar daripada Projek: Kehilangan kawasan hasil pengeluaran/habitat untuk takungan air dan hak laluan pada talian penghantaran elektrik, perubahan rejim aliran air dan kualiti air di Sungai Padas. Perubahan rejim aliran dan kualiti air akan memberikan kesan positif kepada pengguna air di bahagian hilir.

Berdasarkan penemuan dan langkah mitigasi berkaitan, Chemsain Konsultant Sdn. Bhd. merumuskan bahawa:

- *Projek ini boleh diimplementasikan dengan kaedah boleh terima secara social dan persekitaran dengan syarat langkah mitigasi yang diterangkan dalam pelan pengurusan alam sekitar adalah disepadukan dalam peringkat perancangan dan implementasi Projek.*

- *Impak utama yang memerlukan langkah mitigasi disepadukan dalam pelan sedia ada adalah pemilikan tanah, kualiti air, rejim aliran air, pelepasan gas rumah hijau. Isu-isu ini boleh memberikan impak kepada hidupan akuatik liar dan seterusnya kepada kehidupan manusia.*
- *Impak tertinggal utama melibatkan pengurusan kawasan tadahan air, gas rumah hijau dan risiko kekal berlakunya rekahan/kegagalan struktur empangan.*
- *Manfaat Projek boleh diseimbangkan secara positif dengan kos alam sekitar.*

Justifikasi Projek. Projek ini melibatkan pembinaan empangan hidroelektrik jenis *Roller Compacted Concrete* setinggi 120 m yang akan menyeberangi Sungai Padas, berhampiran Kuala Tomani, kemudahan janakuasa elektrik 150-210 MW selain rangkaian talian penghantaran elektrik, infrastruktur dan takungan air. Projek ini diasaskan berikutan ramalan permintaan elektrik di Sabah yang akan meningkat daripada 830 MW pada masa kini kepada 1800 MW menjelang tahun 2020. Berikutan itu, Projek Hidroelektrik Hulu Padas bersamaan dengan cadangan Hidroelektrik Liwagu (dengan kapasiti sehingga 210 dan 165 MW, masing-masing) telah dimasukkan dalam konsep pelan pembangunan Sabah Electricity Sdn. Bhd. sebagai projek-projek utama dalam tempoh 10 tahun akan datang.

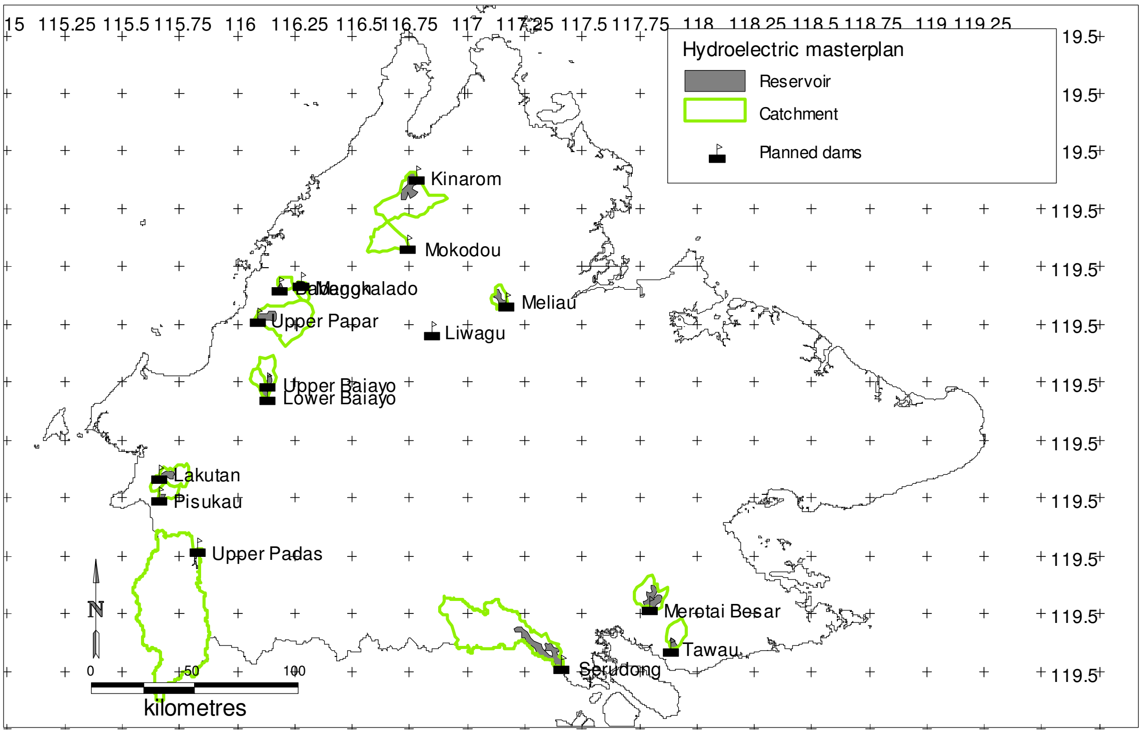
Cadangan Alternatif. Beberapa cadangan telahpun dipertimbangkan berkenaan dengan pemilihan teknologi, tapak lokasi dan pelan rekabentuk terperinci.

Sebagai sebuah negeri, Sabah perlu mempelbagaikan penghasilan tenaga dalam usaha mengurangkan kebergantungan kepada bahan api fosil untuk keperluan dan tujuan alam sekitar. Tenaga matahari masih belum menjadi sumber tenaga yang munasabah untuk dilaksanakan pada skala besar manakala tenaga angin adalah tidak munasabah dari segi teknikal di negeri Sabah. Dengan itu, selain pertimbangan terhadap tenaga nuklear, sumber tenaga hidro merupakan keutamaan masa hadapan dengan tidak menafikan kepentingan arang batu dan loji diesel bagi permintaan masa sekarang. Beberapa lokasi berpotensi bagi penjanaan tenaga hidroelektrik di Sabah telah dikenalpasti namun kebanyakannya hanya sesuai untuk penjanaan tenaga berskala kecil. Tapak Hulu Padas dan Liwagu merupakan lokasi paling berpotensi dimana kemungkinan penjanaan tenaga dari kedua-dua tapak ini sedang dilaksanakan/dikaji. Cadangan lain yang boleh dipertimbangkan walaupun masih menggunakan tenaga hidroelektrik adalah pembelian bekalan elektrik daripada Sarawak melalui siri empangan SCORE (Sarawak Corridor of Renewable Energy) dimana empangan Bakun sedang menghampiri tempoh siap pembinaan manakala empangan Murum masih dalam peringkat pembinaan.

Secara prinsip, terdapat dua jenis sistem penjanaan kuasa hidroelektrik. Prinsip pertama, yang sedang digunakan di bahagian hilir Sungai Padas iaitu di Stesen Hidroelektrik Pangi adalah sistem aliran sungai dimana arus sungai digunakan secara terus bagi penjanaan tenaga. Sistem ini adalah ringkas dan tidak mempunyai impak ketara terhadap aliran sungai dan kualiti air kerana tidak mempunyai takungan air tetapi hanya empangan yang memandu aliran air melalui turbin. Ketiadaan takungan air menyebabkan sistem ini terdedah kepada kejadian banjir dan kemarau, antara masalah yang dialami oleh Stesen Hidroelektrik Pangi. Prinsip lain, yang dipilih untuk Projek Hidroelektrik Hulu Padas melibatkan pembinaan empangan yang menghalang aliran sungai dan menghasilkan takungan air, seterusnya penampan yang menyerap banjir dan pada masa sama membekalkan air semasa musim kemarau.

Antara tiga jenis empangan utama, *Roller Compacted Concrete* (RCC), *Earthfilled Concrete Faced* dan *Rockfilled Concrete Faced*, cadangan pengisian tanah telah ditolak kerana dianggap tidak selamat untuk pembinaan di kawasan dengan jumlah hujan tinggi. Cadangan ini adalah selamat apabila empangan siap dibina tetapi tidak stabil semasa fasa pembinaan. Empangan RCC dipilih untuk Projek ini memandangkan ia adalah selamat dan lebih sesuai dengan ciri topografi di lokasi tapak. Empangan yang diisi dengan batuan dan tanih mempunyai tapak yang besar berbanding rekabentuk jenis dinding RCC. Empangan dengan batuan dan tanih harus mempunyai laluan limpahan berasingan bersebelahan dengan empangan manakala laluan limpahan ini boleh dibina terus ke dalam rekabentuk empangan RCC, antara ciri yang sesuai untuk lokasi sempit seperti Projek ini.

Kelebihan lokasi tapak Hulu Padas adalah ia mempunyai kawasan takungan air sempit dengan kawasan tadahan air seluas 1,900 km^2. Takungan air ini hanya sepanjang 17 km dan meliputi kawasan seluas 6 km^2 tetapi mampu menampung 275 juta m^3 air dimana 220 juta m^3 adalah simpanan semasa. Kawasan ini juga mempunyai laluan masuk yang agak mudah, corak guna tanah yang ringkas dan tiada komuniti setempat yang menetap di kawasan takungan air. Oleh itu, isu penempatan semula komuniti tidak timbul. Rajah di bawah menunjukkan lokasi-lokasi tapak hidroelektrik yang paling berpotensi di Sabah termasuk lokasi Projek Hulu Padas ini. Kawasan berlorek kelabu adalah kawasan potensi takungan air manakala sempadan bergaris hijau adalah had kawasan tadahan air. Seperti yang boleh dilihat, kawasan takungan Padas adalah amat kecil jika dibandingkan dengan kawasan takungan air lain.



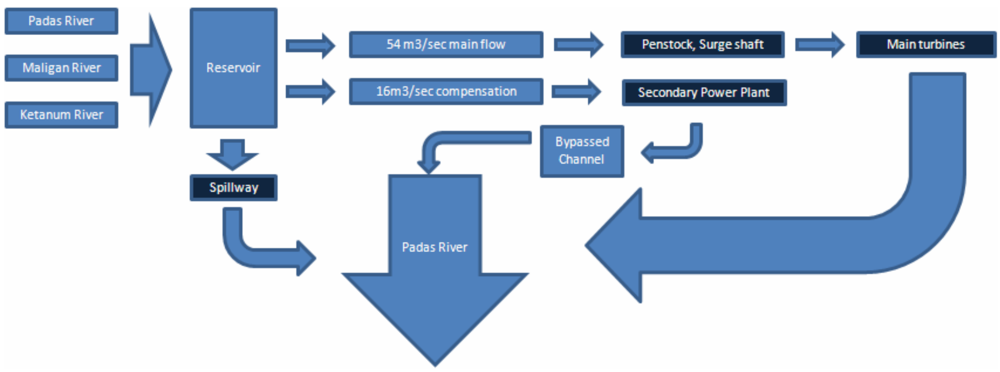
Projek ini belum mencapai tahap rekabentuk air dimana cadangan alternatif masih dipertimbangkan. Jumlah bilangan turbin dan seterusnya kapasiti akhir masih belum diputuskan. Paras ganti rugi aliran air dan seterusnya kapasiti janakuasa elektrik sekunder di kawasan empangan (lokasi janakuasa elektrik utama adalah terletak 10 km di bahagian hilir empangan) juga masih dipertimbangkan.

Untuk metodologi pembinaan, keputusan akhir bagi terowong pemesongan, empangan kekotak, lokasi kuari, sumber tanah dan pelupusan tanih daripada aktiviti pengorekan, jalan akses dan laluan rangkaian talian penghantaran elektrik masih belum dibuat. Walaupun rekabentuk pilon piawai yang digunakan oleh Penggerak Projek boleh didapati, namum rekabentuk akhir hanya boleh dibuat selaras dengan proses tender.

Bagi jaringan rangkaian talian penghantaran elektrik, beberapa alternatif telah dipertimbangkan sebelum memutuskan prinsipal cadangan masa kini. Isu-isu yang perlu dipertimbangkan selain ekonomi, topografi dan geoteknikal adalah untuk mengelakkan kawasan sensitif alam sekitar dan penempatan masyarakat.

Maka itu, kajian ini hanya meliputi isu pembinaan laluan akses, kuari, sumber tanah dan kawasan pelupusan tanih secara umum.

Prinsip Proses Projek. Rajah dibawah menunjukkan prinsip Projek dengan diikuti oleh aliran air melalui sistem. Tiga sungai iaitu Sg. Padas, Sg. Maligan dan Sg. Ketanum akan mengalir perlahan ke dalam takungan air semasa pembinaan empangan merentasi Sg. Padas. Pada masa kini, gabungan aliran ketiga-tiga sungai ini adalah 70 m^3 sesaat. Daripada ini, sekurang-kurangnya 16 m^3 aliran air akan dibenarkan mengalir melalui empangan ke dalam sungai semula di bahagian hilir empangan bagi tujuan alam sekitar (aliran ganti rugi). Air ini tidak yang dibazirkan bagi penjanaan tenaga dimana sebuah unit janakuasa yang lebih kecil akan dibina di kawasan empangan bagi pengunaan tenaga air ini secara setempat. Ketinggian pelepasan air ini adalah 88 m.



Baki 54 m^3 sesaat will be dialirkan menerusi sistem terowong sepanjang 9 km ke lokasi berhampiran Tomani dimana ia akan dilepaskan melalui turbin utama, seterusnya mengelakkan ia melalui kawasan dasar sungai sejauh 9 km. Sebab utama bagi pengaliran jauh air sebelum stesen janakuasa utama adalah untuk mengaplikasikan tambahan kejatuhan ketinggian 130 meter. Walaubagaimanapun, dari segi ekologi, kawasan sungai sepanjang 9 km ini akan menjadi kering jika tiada aliran ganti rugi dan anak-anak sungai yang bersambung dengan Sg. Padas di kawasan ini. Laluan limpahan di dalam empangan bertindak sebagai injap selamat jika terdapat kuantiti air yang melampau dalam takungan air. Selepas janakuasa utama ini, kesemua 70 m^3 sesaat aliran air akan menyertai semula dan sungai ini akan mengalir secara normal walaupun tanpa perubahan musim. Sesetengah perubahan akan berlaku pada masa dimana lebihan air dilepaskan melalui limpahan air.

Empangan Kekotak dan Lencongan Aliran Sungai. Metodologi pembinaan untuk empangan ini masih belum diputuskan tetapi besar kemungkinan empangan ini akan dibina di kawasan tapak kering. Dua jenis empangan kekotak bersifat sementara akan digunakan bagi tujuan ini bagi memastikan tapak pembinaan adalah dalam limbungan kering.

Rekabentuk akhir empangan kekotak masih belum ditentukan tetapi ia akan diperbuat secara ringkas daripada tanih dengan empangan kekotak yang terletak di atas kawasan pembinaan akan setinggi 25 meter dengan empangan kekotak di bahagian bawah setinggi 15 meter. Empangan kekotak pada bahagian atas akan dibanjirkan manakala empangan kekotak bawah akan dialihkan apabila pembinaan empangan utama siap sepenuhnya.

Aliran air sungai akan dikekalkan dengan pembinaan terowong pemesongan konkrit sepanjang 650 m dengan diameter 12 m merentasi gunung dan mengelakkan kawasan pembinaan. Pintu air dan kemudahan untuk menyekat aliran masuk akan disediakan apabila empangan telah siap dan kawasan takungan air akan diisi. Pada masa kini, perancangan bagi pengurusan sisa 100,000 m^3 daripada aktiviti pembinaan terowong pemesongan masih belum ditentukan.

Aliran air sungai hanya akan disekat separa untuk pengisian takungan air apabila empangan utama telah siap.

Empangan Utama. Empangan utama adalah empangan jenis *high roller compacted concrete* setinggi 120 m yang dibina daripada campuran simen, aggregat dan abu terbang dalam kuantiti yang kecil – jika dibandingkan dengan kaedah tradisional campuran konkrit – dengan air dan dimampatkan dengan jentera berat. Jenis konkrit ini adalah lebih baik daripada konkrit tradisional apabila kuantiti besar diperlukan kerana pemeliharaan dan janaan haba boleh dikawal dengan lebih baik. Dari segi kelebihan struktur, ketinggian puncak adalah pada 475 m asl berbanding paras sungai semulajadi di tapak Projek iaitu 360 m asl. Panjang puncak adalah 440 meter.

Limpahan air yang terdiri daripada empat pintu air dengan lebar 9.5 meter dan 12 m tinggi akan dibina ke dalam dinding empangan. Empat pintu limpahan air itu adalah jenis *radial lifting*. Pintu air akan dikawal dengan menggunakan silinder hidraulik, dengan setiap satu ditimbun atas tiang lain. Kolam terjunan setinggi 300 m akan diwujudkan di bawah limpahan air.

Selain itu, dinding empangan akan dilengkapi dengan pelbagai perparitan, langkah keselamatan dan pemantauan selain kemudahan janakuasa elektrik yang lebih kecil untuk mengoptimumkan aliran ganti rugi.

Untuk memastikan kawasan empangan dan takungan air adalah sentiasa selamat, semua tanih harus dialihkan sehingga kawasan batuan dimana empangan akan dibina dan di kedua-dua belah dan bawah dinding empangan. Pelan perancangan bagi pelupusan tanih lebihan daripada aktiviti ini masih belum dikenalpasti. Aktiviti pembinaan empangan dijangka akan mengambil masa selama 38 bulan.

Takungan Air. Empangan ini akan mewujudkan kawasan takungan air seluas 6 km^2 dengan keluasan sehingga 17 km di bahagian hilir Sg. Padas dari tapak empangan. Kawasan takungan air ini juga akan meliputi sebahagian kecil Sg. Maligan dan Sg. Ketanum. Takungan air ini akan mengandungi air sejumlah 275 juta kubik meter apabila penuh dimana 220 juta kubik meter adalah jenis simpanan semasa, iaitu simpanan di atas lokasi pengambilan air, maka boleh digunakan untuk janakuasa elektrik.

Paras simpanan atas adalah setinggi 470 m asl manakala paras simpanan bawah adalah pada 430 m asl, 10 meter di atas lokasi pengambilan air.

Jumlah air dalam takungan ini adalah dibekalkan oleh kawasan tadahan air seluas 1,900 km^2 yang bukan di bawah bidang kuasa Penggerak Projek.

Adalah dijangka bahawa pengisian air dalam kawasan tadahan air akan mengambil masa selama 1.5 bulan selepas terowong pemesongan ditutup. Ini hanya akan berlaku apabila empangan utama telah siap dan selepas aktiviti pembersihan vegetasi di kawasan takungan air telah dijalankan sepenuhnya.

***Bypassed Channel*.** Walaupun bukan merupakan sebahagian daripada komponen Projek, empangan ini akan mewujudkan *bypassed channel* sepanjang 10 km di Sg. Padas antara empangan dan rumah janakuasa utama. Laluan ini hanya akan membawa air daripada lokasi limpahan dan anak-anak sungai kecil yang bergabung dengan Sg. Padas di sini jika tidak kerana aliran ganti rugi alam sekitar yang akan dilepaskan di empangan tersebut.

Lokasi Pengambilan Air. Pengambilan air akan berlaku berhampiran dengan empangan, 50 meter di bawah aras permukaan iaitu 10 meter di bawah paras simpanan bawah. Pengambilan air merupakan struktur berasingan yang bersambung kepada dinding empangan.

Rumah Janakuasa Utama. Rumah janakuasa utama akan dibina di lokasi berhampiran Sg. Padas, berhampiran Kg. Tomani. Rumah janakuasa ini akan dilengkapi dengan tiga turbin Francis shaf menegak. Ketinggian pelepasan air yang akan menggerakkan turbin adalah 220 m memandangkan topografi tapak menurun sebanyak 130 meter antara empangan dan lokasi rumah janakuasa. Terdapat cadangan untuk memasang turbin keempat yang akan memerlukan tambahan kepada ketinggian empangan utama.

Kuasa Aliran Air. Air akan dialirkan daripada lokasi pengambilan air ke rumah janakuasa utama melalui terowong bawah tanah *headrace* dan seterusnya melalui *penstock* atas permukaan. Dimana kedua-dua komponen ini bergabung, *shaft surge* akan dimasukkan untuk menampung perubahan dalam paras dan tekanan air. Bagi mengelakkan sebarang kejadian kecemasan akibat kegagalan *penstock*, rumah injap dengan injap *butterfly* akan disediakan dimana ia akan menutup terowong *headrace* jika kegagalan berlaku. Rumah injap ini akan terletak 100 m di bahagian hilir hujung terowong *headrace*.

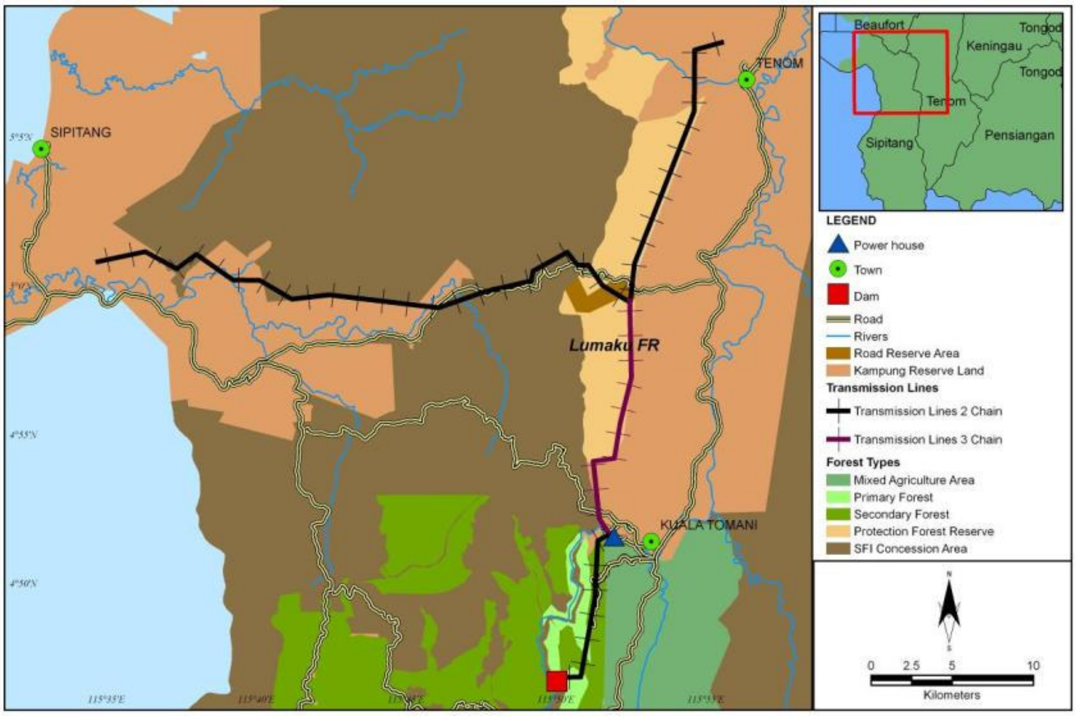
Terowong *headrace* ini akan mempunyai keratan rentas *horseshoe* seluas 22.3 m^3 dengan panjang 9.5 km yang akan membawa kepada lebihan bahan sisa sebanyak 200,000 m^3. Pelan perancangan bagi pelupusan bahan sisa ini masih belum dikenalpasti.

Rumah Jankuasa Sekunder. Adalah menjadi syarat untuk mematuhi pelepasan aliran air minimum melepasi 90% iaitu secara statistik memberikan aliran air minimum setiap masa sebanyak 90%. Aliran ini dikira berdasarkan 16 m^3 per saat atau 23% daripada air sedia ada. Sebab utama bagi syarat ini adalah untuk mengekalkan habitat akuatik di dalam sungai selain hubungkait antara tanih air dan sistem sungai. Aliran air ini akan dimanfaatkan melalui pembinaan loji janakuasa sekunder berkuasa 14 MW di dalam struktur empangan. Lokasi pelepasan air ini adalah 88 meter berbanding 220 meter bagi loji janakuasa utama. Perbezaan ini adalah disebabkan oleh keinginan Penggerak Projek untuk meminimakan keperluan aliran air ganti rugi dan mengalirkan air melalui loji janakuasa utama, seterusnya meningkat kecekapan tambahan sebanyak 150%.

Laluan *Tailrace*. Untuk mengawal aliran pancutan air deras daripada pelepasan air ke dalam sungai selepas turbin utama, sebuah laluan *tailrace* akan dibina untuk melindungi dasar sungai dan tebing daripada hakisan tidak terkawal.

Rangkaian Talian Penghantaran Elektrik. Tenaga elektrik yang terhasil dariapda rumah janakuasa sekunder akan dipancarkan ke rumah janakuasa utama melalui jaringan rangkaian 33 kV dan bergabung dengan kuasa yang dijana oleh turbin utama. Jumlah tenaga akan dihantar ke Tenom dan Sipitang melalui dua rangkaian talian penghantaran elektrik berasingan iaitu talian 132 KV ke Tenom dan talian 275 KV ke Sipitang. Jarak antara pilon-pilon adalah lebih kurang 300 meter untuk rangkaian 132 kV dan 365 meter bagi rangkaian 275 kV. Kedua-dua talian ini akan memerlukan hak laluan berasingan sebanyak 20 meter pada setiap sebelah. Dimana kedua-dua talian adalah selari, kawasan hak laluan tidak boleh merentasi sesama lain, maka jarak antara talian haruslah sekurang-kurangnya 2 x 20 meter. Terdapat batas guna tanah bagi hak laluan termasuk larangan pembinaan struktur atau tanaman melebihi ketinggian 2 meter.

Kedua-dua rangkaian adalah bergerak selari sehingga lokasi berhampiran Kg. Paal dan Bamban dimana rangkaian Sipitang akan bergerak pada arah barat ke Sipitang dan rangkaian Tenom akan diteruskan pada arah utara sehingga Tenom. Pada lokasi akhir talian penghantaran elektrik ini, stesen-stesen penurunan kuasa elektrik akan dibina dan seterusnya, sambungan ke grid Sabah akan dibuat.



Jadual berikut merumuskan spesifikasi teknikal untuk komponen-konponen Projek.

Komponen		**Penerangan**
(1) Tadahan Air		
Kawasan tadahan air hingga empangan (km^2)		1,885
Panjang saluran air sungai: *headwater* hingga empangan (km)		17
Purata tahunan muatan mendapan (t)		300,000
(2) Aliran Empangan		
Aliran min (Q_m, m^3/s)		72
10% aliran rendah(m^3/s)		21
1% AEP pelepasan banjir (m^3/s)		3,100
Pelepasan PMF (m^3/s)		9,000
Rekabentuk pelepasan air limpahan (m^3/s)		11,800
Pelepasan puncak hidro (Q_p, m^3/s)		70
(3) Empangan		
Paras semulajadi sungai di empangan (m)		360
Ketinggian empangan (m)		120
Paras puncak empangan (m)		475
Lebar puncak empangan (m)		440
(4) Terowong *Headrace*		
Bilangan		1
Saiz (diameter)		5.0
Panjang (m)		9,500
(5) Takungan Air		
Takungan air NTWL (Paras Air Atas Normal) (m)		470
Julat pengoperasian takungan air (m)		40 (430 – 470)
Simpanan air semasa takungan air	($m^3 * 10^6$)	220
	(hari pada Q_p)	36
Panjang takungan air pada NTWL (km)		12
Luas takungan air pada NTWL (km^2)		5.9
Kapasiti takungan air:	(Mm^3)	275
	(hari @ Q_m)	44

Komponen	Penerangan
Simpanan mati takungan air (Mm^3)	55
(6) Limpanan Air	
Jenis	Limpahan bebas + pintu
Pintu	Bilangan 4, setiap satu 12 m x 9.5 m
Paras ambang pintu (meter diatas paras laut)	455
(7) Terowong Pemesongan	
Bilangan	1
Saiz (diameter)	12
Panjang (m)	670
(8) Penjanaan	
Paras *Tailrace* (m)	217
Ketinggian Janaan Kasar (m)	253
Keluaran kadar kuasa puncak (MW)	150

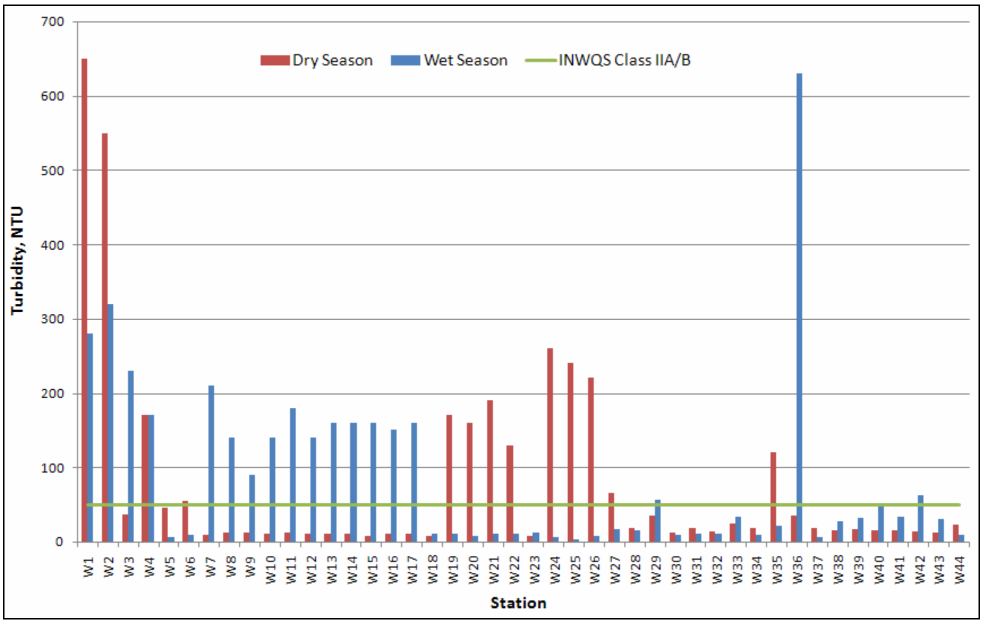
Penerangan Ciri Fizikal. Tapak bagi empangan dan takungan air ini adalah kawasan yang stabil secara geologi dengan ketiadaan aktiviti seismik yang ketara. Dalam semua keadaan, jenis empangan *roller compacted concrete* adalah empangan yang paling selamat jika terdapat isu risiko seismik. Dua jenis tanih utama mendominasi kawasan tadahan air: assosiasi Maliau di bahagian selatan yang bercerun dan bergunung dan assosiasi Crocker di bahagian utara dimana topografi adalah lebih lembut. Kedua-dua assosiasi ini adalah hampir sama dan dianggap kurang sesuai bagi aktiviti pertanian. Assosiasi ketiga iaitu Lokan mendominasi kawasan hak laluan talian penghantaran elektrik. Assosiasi ini adalah hampir sama dengan dua assosiasi awal tetapi didominasi oleh cerun curam dan rabung tajam. Laluan rangkaian talian penghantaran elektrik dari loji janakuasa ke Tenom melalui Paal/Bamban akan mengikuti kontur 610 m selari dengan Sg. Padas manakala talian penghantaran elektrik dari Paal/Bamban ke Sipitang harus merentasi beberapa rabung dan topografi mencabar.

Taburan hujan berjulat antara 2,000-2,500 mm setahun memandangkan Projek adalah dibayangi oleh Banjaran Crocker dimana jumlah hujan adalah melebihi 4,000 mm setahun. Fenomena El Nino yang mengakibatkan musim kemarau berpanjangan juga melanda kawasan ini sekali sekala. Taburan hujan perolakan adalah hampir sekata sepanjang tahun. Bahagian selatan kawasan tadahan air mempunyai jumlah hujan yang lebih tinggi berbanding kawasan lembah sungai Padas yang lain, di timur Banjaran Crocker. Kawasan tapak juga tidak mengalami keadaan angin kencang yang melampau. Kelembapan relatif min sebulan adalah sebanyak 86% secara purata dan dengan itu, penyejatan adalah sekata sepanjang tahun dengan purata 4.1 mm/sehari.

Kawasan tadahan air seluas 1,900 km^2 iaitu kawasan yang mengalir menerusi satu lokasi di Sg. Padas dimana empangan akan dibina adalah berpunca daripada bahagian hulu Sg. Padas, Sg. Maligan dan Sg. Ketanum. Sungai-sungai ini mengalir laju melalui pelbagai jeram, tebing tajam dan lembah.

Berdasarkan kajian, aliran min di tapak empangan adalah 71.6 m^3/s, aliran median hingga 52.4 m^3/s dan 10% aliran rendah (90% aliran lebihan) adalah 15.5 m^3/s. Kepelbagaian sepanjang tahun adalah besar dan perbezaan ketara adalah pada bulan Mac. Kepelbagaian besar dan kejadian banjir yang kerap berkemungkinan akan menyebabkan kekerapan limpahan air dari empangan.

Kualiti air secara umumnya adalah di bawah piawai Kelas IIA/IIB Malaysia walaupun terdapat kehadiran *faecal coliform bacteria* pada sesetengah lokasi. Seperti sungai-sungai lain di Sabah, terdapat juga masalah jumlah pepejal terampai yang tinggi di dalam air akibat perubahan guna tanah di banyak tempat.



Rajah diatas menunjukkan paras kekeruhan di dalam sungai. Stesen 1-26 adalah di bahagian hulu empangan, 27-35 adalah di Padas, hilir empangan dan 36-44 adalah di Mengalong. Ketidakseragaman agihan pengukuran semasa musim basah dan kering adalah disebabkan oleh aktiviti guna tanah setempat semasa persampelan berbanding kepelbagaian musim. Dimana kawasan yang tidak mempunyai aktiviti guna tanah, paras kekeruhan adalah rendah.

Penerangan Ciri Biologikal. Pada asalnya, kawasan tadahan air dan kawasan hak laluan adalah terdiri dari bukit-bukau dan tanah rendah hutan dipterokap dengan beberapa kawasan hutan *Agathis* dan habitat sungai. Terdapat sebahagian besar kawasan hujan semulajadi terutamanya di bahagian selatan tadahan air di tanih jenis Maliau, cerun tajam di bahagian utara dan di bahagian timur cadangan takungan air. Kebanyakan hutan ini adalah terganggu tetapi pada arah barat, terdapat hutan simpan semulajadi besar iaitu Hutan Simpan Sg. Maligan. Kawasan hutan semulajadi ini mempunyai kepelbagaian spesies tetapi mempunyai isu pemuliharaan yang sensitif selain semua hutan dipterokap secara kelompok mengalami tekanan persekitaran. Jumlah biomas atas permukaan di dalam hutan dipterokap yang diliputi oleh kawasan takungan air iaitu kawasan yang perlu diterangkan dan dibanjiri telah dikira sebanyak 99 tan bagi setiap hektar berbanding dengan piawai yang biasa digunakan bagi hutan hujan tropika oleh *Intergovernmental Panel on Climate Change* iaitu 240-450 tan bagi setiap hektar.

Kawasan hak laluan bagi transmisi rangkaian elektrik dari stesen janakuasa ke Tenom adalah melalui landskap pertanian yang didominasi oleh tanaman kelapa sawit dan getah. Rangkaian elektrik ke Sipitang juga didominasi oleh landskap vegetasi bukan semulajadi daripada hutan sekunder, ladang getah yang tidak diusahakan dengan baik dan sebahagian kawasan kelapa sawit.

Bahagian selatan kawasan tadahan air dikekalkan di bawah hutan semulajadi iaitu hutan dipterokap berbukit dan hutan *Agathis* manakala bahagian utara telah ditukar kepada kawasan penanaman pokok industri dengan menggunakan spesies eksotik seperti Acacia dan Eucalyptus.

Dua enklaf yang mengelilingi Long Pasia dan Kg. Maligan masing-masing telah dibersihkan beberapa tahun lalu dan ditukar guna kepada aktiviti ertanian atau tananam pokok berskala kecil. Kawasan ini terletak diluar kawasan aktiviti Projek tetapi mempunyai impak ke atas Projek memandangkan ia terletak di dalam kawasan tadahan air dan aktiviti kawasan ini adalah tidak dipantau.

Dari segi hidupan liar pula, aktiviti penukaran guna tanah dan pemburuan telah menyebabkan spesies hidupan liar di kawasan ini terancam. Spesies mamalia umum adalah rodensia dan babi hutan. Empat puluh enam spesies mamalia telah direkodkan di kawasan tinjauan termasuk *Sun Bear*, *clouded leopard*, *leopard cats*, anjing air, *martens*, beruang kucing, musang, pelbagai kijang, *bearded pig,* monyet, tupai, tikur dan kelawar. Daripada empat puluh enam spesies ini, dua puluh lima (54%) adalah spesies terlindung di bawah Enakmen Pemeliharaan Hidupan Liar Sabah 1997

Daripada spesies ini, kehadiran *Malaysian Sun Bear* dan *Clouded Leopard* yang merupakan spesies penting di Sabah menimbulkan minat memandangkan spesies ini adalah terlindung sepenuhnya di bawah Enakmen Pemeliharaan Hidupan Liar selain diklasifikasikan sebagai "*Vulnerable*" di dalam *IUCN Red List*. Lima spesies primat termasuk siamang juga direkodkan.

Terdapat juga spesies Tembadau (sapi liar, *Bos Javanicus*) yang merentasi kawasan Projek tetapi bukan sebagai habitat spesies. Tiada spesies avifauna atau herpetofauna di kawasan takungan air yang menunjukkan ciri berbeza daripada habitat serupa yang lain di Sabah.

Sejumlah 9 keluarga ikan yang diwakilkan oleh 22 genus dan 35 spesies telah dikesan di kawasan kajian. Terdapat peningkatan ketara dalam jumlah keluarga, genus dan spesies ikan yang ditangkap jika dibandingkan dengan kajian awal EIA akibat kawasan kajian yang lebih besar semasa tempoh kajian dan peningkatan kaedah tangkapan ikan yang digunakan.

Bagi hidupan liar akuatik, sejumlah 16 spesies telah direkodkan di bahagian hilir empangan, 21 spesies di kawasan yang akan dibanjirkan, 27 spesies di kawasan hulu takungan air dan 12 spesies dari stesen persampelan di kawasan Kg Pangi. Jumlah spesies yang lebih besar ditemui di luar kawasan yang akan dibanjirkan jika dibandingkan dengan kawasan yang akan dibanjirkan. Indeks kepelbagaian bagi hidupan akuatik liar di tapak Projek adalah tidak banyak berbeza dengan indeks lain di Sabah dan Sarawak selain tiada spesies ikan yang disampel dikategorikan sebagai terancam.

Persampelan invertebrata menunjukkan komposisi spesies piawai tetapi dengan jumlah populasi rendah. Ini adalah bercanggah dengan data kualiti air yang menunjukkan keadaan habitat lebih baik berbanding dengan data populasi sebenar. Klasifikasi bagi Sg. Padas adalah dibawah Kelas IV dan V berdasarkan data makrobentos yang menunjukkan kualiti air/persekitaran yang kurang memuaskan. Ini mungkin disebabkan oleh sejarah penukaran guna tanah yang tidak dipantau di kawasan tadahan air. Pemegang konsesi hutan iaitu Sabah Forest Industries telah mengalami perubahan dari segi falsafah alam sekitar dan pengurusan selaras dengan perubahan pemilikan syarikat. Komuniti bentik pula tidak mempunyai masa untuk sembuh/pembiakan semula daripada rejim pengurusan sebelumnya.

Persekitaran Manusia. Projek ini termasuk rangkaian talian penghantaran elektrik akan memberi kesan kepada pentadbiran tiga daerah: Tenom, Beaufort dan Sipitang. Di Tenom, Sg. Padas dengan cadangan lokasi empangan dan stesen janakuasa selain Stesen Hidroelektrik Pangi akan melalui kawasan sub-daerah Kemabong. Kawasan utama iaitu takungan air dan tadahan air merupakan sebahagian daripada Unit Pengurusan Hutan 07 dibawah Jabatan Perhutanan, Sipitang yang dilesenkan kepada Sabah Forest Industries (SFI).

SFI mempunyai lesen untuk menukar kawasan tapak ke hutan ladang tetapi dengan kesedaran alam sekitar seperti had cerun dan perlindungan sungai. Had-had ini dengan kebimbangan lain telah disepadukan dalam pelan pengurusan SFI dan kajian impak terhadap alam sekitar.

Kawasan yang perlu dibangunkan akan dibersihkan dan disediakan dengan kaedah yang akan meminimakan impak negatif jangka panjang. Pokok yang tiada nilai komersil akan dihancurkan dan dibiarkan di permukaan bagi pereputan semulajadi, pembakaran terkawal yang minima dan penanaman dalam puing. Penanaman dan pemeliharaan tanaman akan dilaksanakan dengan metodologi dan pemilihan spesies yang bertujuan untuk membentuk permukaan perlindungan dengan cepat bagi perlindungan tanih. Spesies yang akan digunakan adalah jenis eksotik: Benih Acacia dan Eucalyptus selain *thinning* tidak akan dijalankan sebagai manipulasi tumbesaran.

Jadual berikut menunjukkan anggaran kawasan dengan pelbagai fungsi guna tanah di kawasan tadahan air.

Guna Tanah Hutan	Kawasan	Peratus dari Kawasan Tadahan
Pengurusan Hutan Semulajadi	94,578 ha	50 %
Penanaman Pokok Industri	58,571 ha	31 %
Tanah Negeri	25,898ha	14 %
Hutan Simpan Asli	9,453 ha	5 %
Kawasan Tadahan	**188,500 ha**	**100 %**

Dua enklaf pertanian berskala kecil – tanah negeri di dalam jadual di atas didominasi oleh pertanian tradisional walaupun perubahan kepada tanaman getah dan kelapa sawit sedang meningkat. Tiada kajian alam sekitar atau peraturan dibuat bagi kawasan-kawasan ini. Kawasan pertanian setempat tidak akan terjelas daripada pembinaan kemudahan Projek atau takungan air. Komuniti setempat tidak menggunakan sungai secara kerap bagi tujuan pengangkutan namun terdapat aktiviti penangkapan ikan di sungai.

Rangkaian talian penghantaran elektrik akan menjejaskan skim tanaman getah dan kelapa sawit di kedua-dua belah Tomani-Tenom dan sepanjang laluan ke Sipitang. Tidak terdapat sebarang penempatan atau kawasan dengan tanaman meluas di bawah laluan talian penghantaran elektrik kecuali ladang-ladang.

Walaupun ladang sedia ada antara empangan, stesen kuasa, Kg. Paal/Bamban dan Sipitang adalah ladang berskala kecil, kawasan utama antara Kg. Paal/Bamban dan Tenom adalah dimiliki oleh sebuah syarikat besar iaitu Sime Darby.

Impak dan Mitigasi. Impak utama daripada Projek ini adalah:

- Isu kemasukan tanih ke dalam alur air semasa kerja pengorekan untuk empangan, terowong, rumah janakuasa, pilon dan kem.
- Kehilangan habitat dan kawasan pengeluaran di kawasan takungan air dan dibawah rangkaian talian penghantaran elektrik.
- Perubahan kepada aliran and kualiti air sungai.
- Impak peningkatan trafik ke tapak empangan semasa peringkat pembinaan.

Selain itu, Projek ini juga akan memberi tekanan kepada Sabah Forest Industries dan pihak berkuasa untuk memastikan pengurusan tanih dan perlindungan kawasan tadahan air yang betul dan baik. Ini termasuk kebimbangan terhadap pengurusan tanih di dua kawasan enklaf tanah negeri.

Pengurusan Tanih. Aktiviti pengorekan untuk terowong, sisi empangan, jalan raya, rumah janakuasa, kem dan sebagainya akan menghasilkan jumlah tanih yang besar dimana pada masa kini, belum terdapat pelan bagi pelupusan tanih tersebut. Aktiviti ini akan mewujudkan kawasan lapang yang akan terdedah kepada kegagalan cerun atau hakisan tanih. Langkah mitigasi, yang memerlukan latihan dan disiplin antara pekerja dan kontraktor adalah pembersihan minima, pembersihan berfasa, had gradien pengorekan dan tapak pelupusan, perangkap kelodak dan landskap akhir. Objektif langkah ini adalah untuk perlindungan aliran air, habitat dan jumlah ikan selain kualiti air bagi penggunaan manusia.

Kehilangan Habitat. Isu kehilangan habitat kepada komponen takungan air, *bypassed channel* atau rangkaian talian penghantaran elektrik adalah tidak signifikan. Kesan terhadap habitat adalah lebih penting. Hidupan liar tidak akan mampu menyeberangi kawasan takungan air kecuali burung, terutamanya ikan yang tidak akan dapat melalui kawasan empangan, seterusnya mewujudkan dua habitat akuatik yang tidak berhubungkait iaitu di bahagian hulu dan hilir empangan. Tiada langkah mitigasi yang diketahui bagi isu ini. Empangan dan rumah janakuasa akan memecahkan koridor hidupan liar di sepanjang sungai dari hutan simpan semulajadi di bahagian selatan ke Hutan Simpan Gunung Lumaku dan kawasan hutan semulajadi lain di bahagian utara dengan kehadiran dan aktiviti manusia. Isu-isu ini adalah tidak signifikan bagi laluan talian penghantaran elektrik.

Kehilangan Kawasan Pengeluaran. Impak sosio-ekonomi secara terus adalah kehilangan kawasan pengeluaran di bawah laluan rangkaian talian penghantaran elektrik dan kawasan takungan air. Bagi Sabah Forest Industries, jumlah kehilangan kawasan adalah sehingga 2000 ha dimana syarikat ini berharap akan digantikan dengan kawasan baru yang lain seperti Pangalubon, sebuah kawasan enklaf tanah negeri. Bagi pengusaha getah dan kelapa sawit, batas hak laluan akan membantutkan aktiviti sedia ada kecuali jika ganti rugi yang sewajarnya diberikan sebagai langkah mitigasi atau mengelakkan kawasan ini secara terus daripada rangkaian talian penghantaran elektrik. Chemsain Konsultant mencadangkan bahawa laluan rangkaian ini harus ditempatkan terutamanya di kawasan ladang pokok industri dan seterusnya di kawasan ladang getah atau kelapa sawit tetapi mengelakkan kawasan hutan semulajadi. Jadual berikut menunjukkan jenis guna tanah yang akan terjejas daripada laluan rangkaian talian penghantaran elektrik.

Sector	Hutan Yang Terlindung	Hutan Semulajadi	Ladang Pokok Industri	Kelapa Sawit	Getah	Jumlah Panjang/Luas
Rumah Janakuasa Sekunder – Rumah Janakuasa Utama	0 km 0 ha	1.9 km 7.60 ha			9.6 km 38.40 ha	11.50 km 46.00 ha
Rumah Janakuasa Utama - Kg Bamban (Talian Berkembar	0 km 0 ha			32.02 km 128.08 ha		16.01 km 128.08 ha
Kg Bamban - Tenom	0 km 0 ha			17.87 km 71.48 ha		17.87 km 71.48 ha
Kg Bamban - Sipitang	0 km 0 ha	8.83 Km 35.32 ha	5.45 km 21.80 ha	1.93 km 7.72 ha	20.55 km 82.20 ha	36.76 km 147.04 ha
Jumlah	**0 km** **0 ha**	**10.73 km** **42.92 ha**	**5.45 km** **21.80 ha**	**51.82 km** **207.28 ha**	**30.15 km** **120.60 ha**	**98.15 km** **392.60 ha**

Kawasan yang akan dibanjiri akan melibatkan kehilangan kawasan habitat sebanyak 600 hektar dimana keadaan habitat semulajadi adalah semakin sukar. Dari segi setempat, kehilangan kawasan ini akan dirasai tetapi dari segi wilayah, ia adalah pengorbanan kecil untuk kepentingan sosio-ekonomi.

Aliran Air Sungai. Sungai sepanjang 12 km yang asalnya sungai aliran bebas, laju dan mengandungi jeram cetak akan ditukar kepada tasik tenang dengan zon anerobik dalam yang akan mempunyai permandangan dan habitat baru. Muatan pepejal terampai pada masa kini akan cenderung untuk tenggelam di bahagian atas takungan air dan seterusnya membersihkan air. Tetapi ini akan mengurangkan jumlah simpanan semasa air dan penampan bagi Projek semasa musim kemarau. Permukaan lantai hutan sebelum ini akan bertukar secara perlahan kepada lapisan bentik halus yang akan terdedah atau dibanjiri pada masa-masa tertentu. Hutan berhampiran sungai sedia ada akan dibanjiri dan seterusnya mewujudkan hutan seperti fosil secara perlahan tetapi mengalami pereputan anerobik. Dengan itu, air akan mengalami ketepuan dengan metana dan sedikit karbon dioksida selain kemungkinan komponen raksa atau bahan lain.

Bypassed channel sepanjang 9 km iaitu salah satu segmen Padas daripada empangan ke rumah janakuasa utama akan ditukar kepada sungai kecil, lebih kurang satu perempat daripada saiz sedia ada. Air akan masih jernih tetapi dengan kandungan metana yang tinggi memandangkan kebanyakan metana telah dilepaskan apabila tekanan air dilepaskan melalui turbin-turbin sekunder. Keadaan dasar sungai akan mengubah lapiran bentik dan seterusnya komposisi dan pengagihan ikan pelagik.

Aliran air utama iaitu lebih kurang 75% daripada aliran normal akan dilepaskan untuk bergabung dengan air daripada *bypassed channel* di lokasi selepas turbin-turbin utama. Perubahan air disini akan sama seperti rumah janakuasa sekunder. Air akan masih jernih tetapi mempunyai masalah dengan gas-gas rumah hijau terlarut dan komponen kimia lain daripada pereputan tanih dan biomas dalam takungan air. Kebanyakan gas ini akan terlepas apabila tekanan dalaman air dilepaskan dan baki metana dijangka akan dibebaskan melalui permukaan sungai di sepanjang 20-40 km. Impak terhadap sungai adalah tidak signifikan memandangkan aliran adalah pendek selepas rumah janakuasa dengan Sg. Tomani dan sungai-sungai lain. Pengurusan pelepasan air melalui turbin-turbin akan mengelakkan perubahan musim secara separa dan seterusnya menyumbang kepada pengurangan masalah banjir di bahagian hilir. Pengurangan masalah banjir adalah cuma secara teori memandangkan banjir juga berkemungkinan akan berlaku apabila kawasan takungan air diisi dan air sedang mengalir menerusi laluan limpahan.

Gas-Gas Rumah Hijau. Kewujudan kawasan takungan air akan mengakibatkan kehilangan kawasan hutan seluas 600 hektar. Kehadiran biomas akan membawa kepada kandungan metana tinggi di dalam air manakala pembakaran atau pereputan semulajadi akan menyebabkan penghasilan karbon monoksida. Antara dua kesan utama ini, jumlah karbon dioksida adalah lebih sedikit dan pembersihan penuh kawasan takungan air adalah dicadangkan. Sejumlah 49,000 tan karbon akan dilepaskan sebagai gas rumah hijau. Hampir separuh adalah terbentuk daripada pereputan sisa di dalam hutan manakala baki adalah melalui hasil proses. Pelepasan CO_2 adalah bersamaan dengan metana daripada pereputan anerobik adalah 314,000 tan manakala pelepasan CO_2 daripada pereputan aerobik adalah 140,000 tan. Jumlah ini adalah tidak besar tetapi kesan kumulatif ini dan aktiviti-aktiviti lain di negeri ini harus dipertimbangkan. Projek ini harus mempertimbangkan keseimbangan impak melalui aktiviti perlindungan hutan secara aktif atau penanaman hutan di kawasan lain atau dalam kawasan tadahan air.

Trafik. Aktiviti pembinaan empangan akan mewujudkan jumlah trafik yang padat akibatan peningkatan bilangan kenderaan berat yang membawa simen dan bahan pembinaan lain ke tapak Projek. Ini secara langsung akan menyebabkan masalah trafik dan gangguan bagi penduduk di sepanjang jalan selain kebimbangan terhadap keadaan jalan raya. Langkah mitigasi memerlukan latihan dan disiplin, perancangan dan sifat hormat kepada orang lain. Trafik harus dirancang dengan pertimbangan terhadap keselamatan dan Projek harus memastikan jalan yang dibina adalah berdasarkan piawai tertentu selain kenderaan sentiasa dalam keadaan baik dan pemandu yang berhemat.

Jadual berikut merumuskan impak-impak dan langkah-langkah mitigasi.

Peringkat Projek	Aktiviti Projek	Potensi Impak Alam Sekitar	Cadangan Langkah-Langkah Mitigasi
Peringkat Pra-Pembinaan	- Pendedahan dan komunikasi - Pengambilan tanah, pemilikan dan hak pengguna - Penyiasatan tapak	- Ketidaktentuan dan ketidaksaksamaan sosial	- Penbayaran ganti rugi - Penggantian kawasan
Peringkat Pembinaan	- Pemerolehan - Pemindahan dan Pergerakan	- Impak langsung terhadap talian pemerolehan	- Pengawalan, pemerolehan hijau
	- Kerja tanah - Kerja sivil - Perubahan sungai	- Ketidakstabilan tanih, peningkatan pepejal terampai dalam aliran air, kemusnahan habitat - Penghasilan sisa - Bahaya keselamatan pekerja	- Penstabilan tanih, perlindungan cerun, pengawalan hakisan, keselamatan pengangkutan, pelan-pelan pelupusan sisa, pengawalan sisa berbahaya, peralatan perlindungan diri, latihan pekerja, aliran ganti rugi, laluan pengangkutan sungai sementara tanpa melalui tapak pembinaan
	- Pelupusan biomas	- Kehilangan habitat - Gas-gas rumah hijau	- Penyelamatan hidupan liar, penyeimbangan atau perlindungan ladang.
	- Pembukaan struktur sementara	- Penghasilan sisa - Ketidakstabilan tanih	- Pengawalan kontraktor, pembersihan, penanaman semula
Peringkat Pengisian/Penyimpan Air	- Penutupan terowong pemesongan - Pengaliran empangan kekotak - Kebanjiran - Pelepasan aliran ganti rugi.	- Gangguan aliran, impak kepada habitat akuatik dan ikan, peningkatan pemendapan (empangan kekotak) - Gas-gas rumah hijau - Kehilangan habitat	- Penyeimbangan (ganti rugi) penanaman - Penyelamatan hidupan liar - Jadual bekerja
Peringkat Operasi dan Penyelenggaraan	- Penghasilan kuasa	- Had guna tanah dalam kawasan tadahan	- Pengurusan kawasan tadahan - Pembayaran ganti rugi
	- Penghantaran elektrik	- Had guna tanah	- Sokongan pengurusan hak laluan - Pembayaran ganti rugi
	- Penyelenggaraan berkala	- Laluan akses sementara	- Pembayaran ganti rugi

Pengurusan Alam Sekitar. Laporan kajian sedia ada ini meliputi cadangan pelan pengurusan alam sekitar yang melibatkan program pengurusan seperti polisi pengurusan, aspek pengurusan dan isu mengekalkan kapasiti pengurusan, isu pekerja dan pelan tindakan atau program bagi mitigasi dan peningkatan tatacara.

Program Pemantauan. Program pemantauan termasuk polisi-polisi dan kontrak bagi memastikan komitmen Penggerak Projek dalam pengurusan alam sekitar yang berkekalan dan tanggungjawab korporat. Polisi-polisi yang terlibat termasuk pemerolehan, isu pekerja, isu undang-undang dan tanggungjawab sosial dan alam sekitar.

Program ini mencadangkan suatu organisasi tertentu diwujudkan dalam struktur Penggerak Projek untuk menangani isu kawasan tadahan air dan pengurusan takungan air. Ia memfokuskan kepada tanggungjawab Penggerak Projek dalam memastikan kontraktor dan sub-kontraktor mematuhi semua syarat-syarat alam sekitar dan melaksanakan pelan pengurusan alam sekitar. Ini termasuk sejumlah polisi dalam tanggungjawab korporat sosial dan alam sekitar, pematuhan terhadap keperluan nasional dan antarabangsa selain mewujudkan garis panduan bagi pemerolehan hijau bagi mengelakkan kesan negatif terhadap alam sekitar dan sosial akibat aktiviti Projek.

Pelan Tindakan. Pelan ini mengandungi Pelan Tindakan yang terdiri daripada beberapa siri pelan-pelan berasingan bagi perlindungan tanih, pembersihan biomas, pengurusan hidupan liar, perlindungan dan kesihatan pekerja, pelan pengurusan sisa, pelan berkait komuniti, pelan pengurusan warisan kebudayaan dan pelan bagi pengurusan kawasan tadahan air. Pelan-pelan ini mengandungi langkah-langkah mitigasi paling signifikan dengan aktiviti-aktiviti Projek dan dicirikan dalam format operasi. Pelan tindakan ini juga mempunyai pelan-pelan bagi penglibatan komuniti dan mekanisma rungutan.

Tindakan Kecemasan. Satu bahagian spesifik dalam pelan tindakan adalah pelan tindakan kecemasan yang hampir serupa dengan pelan bagi empangan-empangan besar di Sarawak. Ini adalah penting memandangkan kejadian kecemasan besar adalah merupakan kebimbangan nasional dan perlu ada penyelarasan dari segi organisasi dan garis panduan tindakan. Isu ini juga mengambil kira kebarangkalian pekerja dan sub-kontraktor bergerak dari pembinaan satu empangan ke empangan lain dimana mereka harus tahu mengenai tatacara kecemasan.

Pelan tindakan kecemasan adalah menjurus kepada mewujudkan organisasi dan tatacara berjaga-jaga untuk mengawal kejadian kecemasan yang lebih kecil selain langkah-langkah amaran dan pemindahan jika berlaku kecemasan besar.

Pengurusan Kawasan Tadahan Air. Pepejal terampai di *headwaters* akan tenggelam dengan cepat di bahagian atas takungan air, seterusnya mengurangkan jumlah simpanan semasa dan meningkatkan risiko kekurangan air semasa musim kemarau berpanjangan. Maka, pengurusan empangan mempunyai kepentingan dalam pengurusan dan perlindungan tanih di dalam kawasan tadahan air yang bukan di bawah bidang kuasa pengurusan empangan. Entiti yang beroperasi secara sah di dalam kawasan tadahan air adalah Sabah Forest Industries dan perkampungan kawasan Long Pa Sia dan Kg. Maligan. Isu-isu ini telah ditangani dalam pelan pengurusan Sabah Forest Industries dan kajian impak alam sekitar yang berkaitan dengan penduduk kampung tidak mempunyai keperluan untuk melaksanakan kajian ini. Undang-undang dan keperluan yang dikenakan atau dilaksanakan oleh Sabah Forest Industries tidak menjamin samada ia adalah mencukupi untuk tujuan Projek hidro elektrik ini. Maka, kajian ini mencadangkan suatu organisasi yang terdiri daripada semua pihak yang terlibat termasuk agensi-agensi kerajaan diwujudkan untuk memastikan semua isu pemeliharaan tanih ditangani secara usaha sama dalam forum ini.

Komunikasi dan Pendedahan. Suatu siri komunikasi dan dialog pendedahan telah dimulakan oleh Penggerak Projek. Proses ini akan diteruskan dan dikekalkan menerusi organisasi yang ditubuhkan bagi pengurusan kawasan tadahan air secara bersama dan melalui mekanisma rungutan. Kajian ini menekankan kepentingan dialog-dialog yang mengandungi maklumat tepat mengenai Projek diberikan untuk memastikan pihak-pihak yang terjejas diberikan peluang adil untuk memberikan pandangan dan cadangan sebelum keputusan akhir dibuat.

Impak Tertinggal. Walaupun semua pelan-pelan mitigasi dilaksanakan, akan terdapat sedikit impak tertinggal.

Selain daripada kehilangan tanah dan hak guna tanah yang boleh ditangani melalui pembayaran ganti rugi, impak tertinggal adalah berkenaan kualiti air, gas-gas rumah hijau dan risiko kemalangan dan kegagalan empangan.

Impak-impak tertinggal ini harus dipantau dan dianalisis bagi memastikan ianya tidak melampaui had-had yang telah dipersetujui dan aktiviti dipantau bagi memastikan pematuhan terhadap syarat-syarat alam sekitar oleh Kerajaan Negeri. Laporan pemantauan yang disahkan harus dikemukakan sekali dalam setiap tiga bulan kepada Jabatan Perlindungan Alam Sekitar. Kajian ini meliputi cadangan lokasi pemantauan bagi kualiti air dan udara selain senarai parameter untuk persampelan.

CHAPTER 1 GENERAL INFORMATION

1.1 INTRODUCTION

This chapter introduces the proposed Project, its statement of need, status, and schedule. This chapter also provide the details of the Project Proponent, the SEIA consultants and the Special Environmental Impact Assessment (SEIA) process.

1.2 SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT TITLE

The proposed Project is titled “***The Proposed Upper Padas Hydroelectric Project, Sabah***”. For brevity in this SEIA report, the proposed Project will be referred to as the “Proposed Hydroelectric Project” or simply, the “Upper Padas Dam”, the “Project” or simply the “UPHEP”.

1.3 STATEMENT OF NEED

Sabah is one of the fastest developing states in Malaysia recording an average annual growth of 8% in the past two decades. Its electricity demand has been forecasted to increase from about 830 MW today to around 1800 MW by year 2020 (see **Table 1.3-1**). About 60-70% of the total demand is from the West Coast Grid in the northwest of Sabah. The present power generation capacity of the existing power plants connected to the West Coast Grid (**Figure 1.3.1**), including those run by Independent Power Producers is about 501MW.

Source: SESB Website.

Figure 1.3.1 Existing Electric Grid

Studies[1] commissioned by Sabah Electricity Sdn. Bhd. have indicated that Sabah has a considerable hydropower potential and the Sabah Power Development Masterplan of 1984 identified a total of 68 potential hydropower schemes with a commendable potential of some 1,900MW capable of providing an average of 11,700GWh/year. The Master Plan indicates that the most promising sites are situated in the Padas River located south of Tenom and in the Liwagu River basin, which is at the centre of Sabah.

The only major existing hydropower station in Sabah is the Tenom Pangi hydropower plant. This power plant is situated in the lower reaches of the Padas River close to Tenom. The installed capacity is 66 MW (3 x 22MW) out of which only some 15MW is firm capacity at 95% average availability and about 5MW at 99% average availability due to the practically non-existing river regulating facilities. As the Upper Padas Hydroelectric Project is located upstream of Tenom Pangi hydropower plant, the Upper Padas Hydroelectric Project operation will regulate some of the inflow to Tenom Pangi hydropower plant resulting in an increase of its energy generation and firm capacity.

In anticipation of the growing electricity demand in Sabah, the Upper Padas Hydroelectric Project alongside with the proposed Liwagu Hydroelectric Project (with a capacity up to 210 and 165MW, respectively) have been included in the Sabah Electricity Sdn. Bhd. conceptual development plans as priority projects for the next 10 years. The Liwagu Hydroelectric Project is tentatively scheduled to be commissioned in the 2017 and thus allowing the eastern area to be connected to the West Coast Grid. While the Liwagu Hydroelectric Project will interconnect the east and west coasts of Sabah, the Upper Padas Hydroelectric Project is expected to extend the transmission network to link-up with the southern and south-eastern parts of the State and hence facilitate the materialisation of a state-wide transmission system.

Table 1.3-1 Peak Demand Forecast

Financial Year	Peak Demand (MW)	Growth (%)	MW Increase
2005	572.00	7.76	41
2006	584.00	2.10	12
2007	656.00	12.33	72
2008	710.00	8.23	54
2009	767.00	8.03	57
2010	830.00	8.21	63
2011	898.00	8.19	68
2012	971.00	8.13	73
2013	1051.00	8.24	80
2014	1137.00	8.18	86
2015	1220.00	7.30	83
2016	1321.00	8.28	101
2017	1428.00	8.10	107

[1] *Pre-Feasibility Studies, SWECO, 1989; Feasibility Study, SWECO, 1994*

Financial Year	Peak Demand (MW)	Growth (%)	MW Increase
2018	1543.00	8.05	115
2019	1666.00	7.97	123
2020	1800.00	8.04	134
Average period growth rates, % p.a.			
2006-2010		7.78	
2010-2020		8.06	

Major Project Division, Sabah Electricity Sdn. Bhd. 2008

1.4 BRIEF PROJECT INTRODUCTION

The Project site (comprising reservoir, dam, powerhouses and transmission lines) is located in the southwest corner of Sabah within the Sipitang and Tenom District. The geographical position of the proposed Project is between longitude 115° 30' E and 116° 00' E and between latitude 4° 40' N to 5° 10' N (see **Map 1.4- 1 Project Site Location**).

The principles of the Project is first to raise the surface of the water to about 120 metres above the present level by blocking the Padas river with a dam and to create a buffer of water in a reservoir. The water is then under pressure sent through a penstock and headrace tunnel to the main turbines about 9 km away from the dam before being released into the river again. A smaller amount of water equivalent of the 90% exceedance flow is released at the dam as an environmental compensation flow to avoid drying out the river between the dam and the main turbines. This environmental compensation flow is utilised in a secondary power generation facility. (See **Figure 1.4.1**)

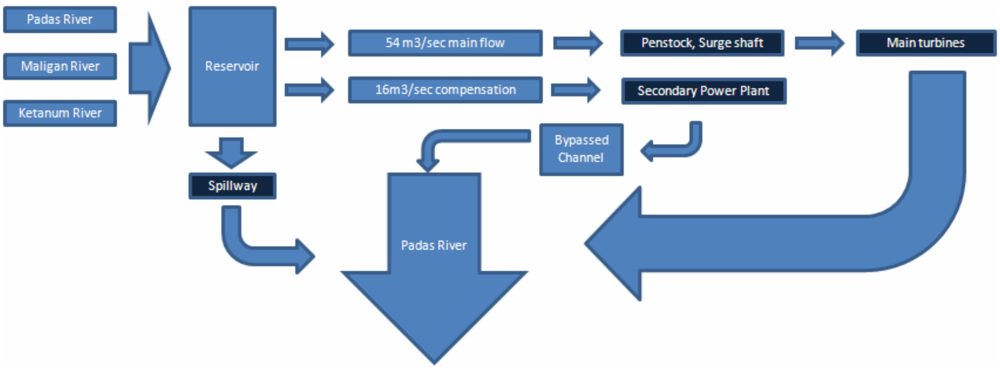


Figure 1.4.1 Process Chart: Water Flow during Operational Period

The Upper Padas HEP catchment area measures about 1,885 km^2.

The nearest major settlement is Tomani on the north bank of the Padas River and to reach a town, one must travel to Tenom, which is easily accessible via three major roads; (i) Kota Kinabalu-Sipitang-Tenom Road, (ii) Kota Kinabalu-Tenom Road; and (iii) Kota Kinabalu-Kimanis-Keningau-Tenom Road. The average distance from Kota Kinabalu to Kuala Tomani is approximately 210 km.

The reservoir area falls under the Sipitang commercial forest reserve, which is licensed to Sabah Forest Industries (SFI). The reservoir covers approximately 5.9 km^2 or 590 ha, involving three rivers: Padas River, Maligan River and Ketanun River. The area immediately east of the planned reservoir is topographically steep, making it unsuitable for logging and forest plantation activities. This area, which covers about 911 ha, has therefore been delineated by SFI as conservation area.

The proposed dam site is located within Sipitang District approximately 8.5 km downstream of the confluence of Padas River and the Maligan River and about 17 km southwest of the Kuala Tomani Bridge. See **Map 1.4- 2 Project Components**.

Presently there is no proper access road to the dam site. Access to the vicinity can be made through the internal logging roads (under SFI management). However, the final access route to the site remains characterised by rough and very steep terrain.

The proposed powerhouse site is located within Tenom District, next to a small island in the Padas River about 16 km downstream of the dam site and another 3 km upstream of the Kuala Tomani Bridge. The area is accessible by the existing rubber estate access from Kuala Tomani along the south side of Upper Padas River. At present, there is no access road between the powerhouse and dam site and the nearest village to the powerhouse is Kg. Katambalang Baru which is about 1.5 km (measured in direct distance) from the site.

The proposed combined corridor for the transmission lines from the main powerhouse is about 15 km (in direct distance) up to the intersection point of Sipitang-Tenom Road at Kg. Paal. From this point, the total length of lines to Tenom is approximately 17 km, while the total length of lines to Sipitang is approximately 33 km. See **Map 1.4- 3 Proposed Transmission Line Alignment**.

The implementation of this Project will necessitate establishment of local quarries, borrow pits and access roads. The sites for these necessities have not yet been identified, wherefore a detailed environmental impact assessment for these activities cannot be included in this document. A separate environmental impact assessment will be required for quarries, borrow pits and the access road once these are identified and before the Project commences construction.

1.4.1 CURRENT PROJECT STATUS

The Project is still in its planning and investigation stage. The survey works for topography and river cross-sections have been completed. The Geotechnical and Soil Investigation study, which also identify potential sites for quarry and borrow areas is on-going. Investigations to determine suitable sites for quarries, borrow pits and the access road are similarly on-going, wherefore these components will be covered separately.

1.4.2 PROJECT SCHEDULE

The overall target of the construction schedule is to minimise the total construction time and to bring the Project to full commercial operation in less than four years. The engineering consultant, Upper Padas Hydropower Consultant is of the opinion that the earliest date for generation of units on line would be by late 2016. The Project schedule is shown in **Figure 1.4.2** below.

ID	Task Name	Duration
1	Earliest estimation of start up	0 days
2	**Dam and power generation**	**968 days**
3	Start-up works	14 mons
4	Construction design	25 mons
5	Access roads	9 mons
6	Diversion arrangements	8 mons
7	Dam and spillway	38 mons
8	Intake	15 mons
9	Head race tunnel	32 mons
10	Surge shaft	9 mons
11	valve house	3 mons
12	Penstocks	21 mons
13	Power houses	34 mons
14	Tailrace	8 mons
15	**Switchyards and transmission lines**	**880 days**
16	Survey	6 mons
17	Acquisition of user rights	12 mons
18	Route clearing	6 mons
19	Pylon construction and stringing	12 mons
20	Substation construction	4 mons
21	Testing and commissioning	4 mons
22	**Reservoir**	**429 days**
23	Biomass clearing	6 mons
24	Biomass decomposing/drying	12 mons
25	Reservoir filling	1.5 mons
26	**Operation**	**88 days**
27	Operation at USLE Elevation 456	0 days
28	Testing and commissioning	4 mons
29	Operation at FSL Elevation 470	0 days

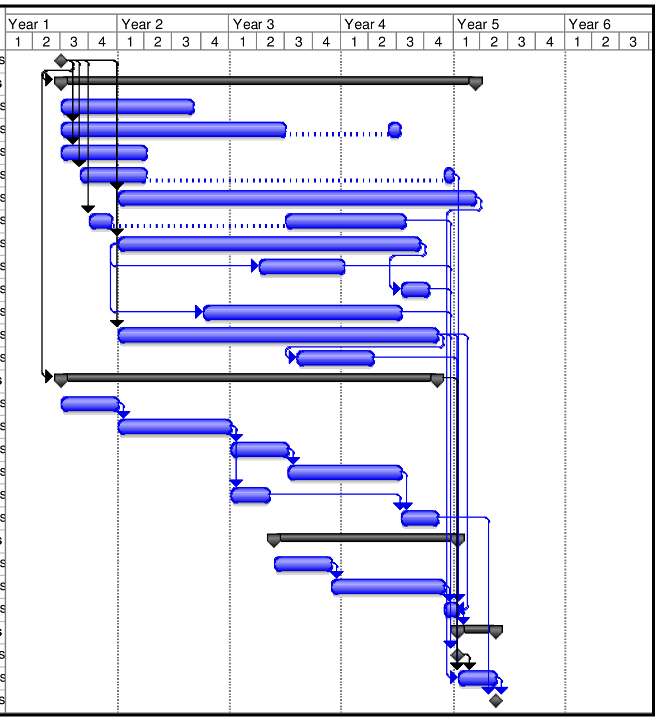


Figure 1.4.2 Project Schedule

1.5 SEIA PROCESS

The preparation of a special environmental impact assessment (SEIA) begins with the preparation and submission of a Scoping Note to the Environment Protection Department (EPD). Upon receiving approval from Environment Protection Department, the Terms of Reference (TOR) shall be submitted for panel and public review. The terms of reference and SEIA review panel includes governmental agencies, academicians and NGOs. The public are also invited to view the report and submit their comments to the Environment Protection Department. The SEIA report will then be prepared based on the approved TOR. Upon submission, this report shall also be subjected to panel and public review. **Figure 1.5.1** depicts the SEIA process of this Project. Presently, the process is at "Preparation and Submission of SIIA report".

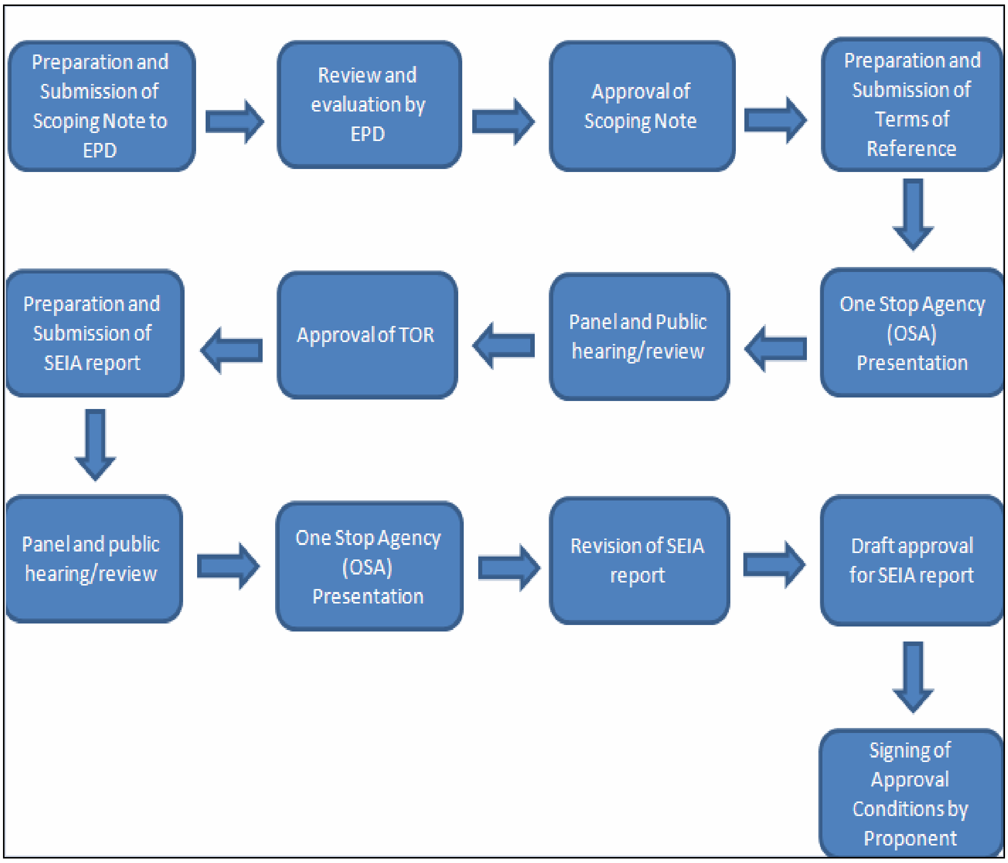


Figure 1.5.1 SEIA Process

1.6 SEIA REPORTING

The following **Table 1.6-1** shows the contents of the SEIA report which are arranged based on the Environment Protection Department's guidelines[2]. Additional sections are also included to fulfil the World Bank requirements.

[2] *Handbook on Environmental Impact Assessment in Sabah, Second Edition, 2005*

Table 1.6-1 SEIA Report

Chapter	Title	Description of Chapter
Volume 1: Main Report		
1	General Information	Outlines the information related to the conduct of the study such as Project Proponent, Engineering consultant, Environmental consultants and public hearings.
2	Policies, Legal and Organisational Framework	A requirement by the World Bank, this chapter also provides description of the legislative and policy context in which the Project is being proposed and with which the Project must comply (state, federal and international level). The section also briefly identifies the main institutional partners that will be mobilised for implementation, management, and supervision and monitoring of the Project.
3	Project Description	Provides a description of the Project including its related management policies, and project options
4	Existing Environment	This chapter includes description of land use and the existing physical and biological environment. The description is divided into six zones: 1. Sabah and the Region 2. Catchment area for the Reservoir 3. Construction site for Dam and Powerhouse 4. Reservoir Area 5. Transmission Line right-of-Way 6. The water of Padas, Maligan, Ketanum and Mengalong river
5	Environmental Impact Assessment	Describes the impact assessments of the environmental issues identified in the scoping and TOR of the study. For better understanding, this is be into five sections: (i) Investigation and Preparation Stage (ii) Construction Stage (iii) Impoundment Stage (iv) Operation Stage (v) Abandonment
6	Social Baseline and Impact Assessment	Describes the characteristics of the local communities, public consultations and the impact assessment on the social and human environment.
7	Environmental Management	This chapter describes the environmental management plan; which includes management programs, action plans, community engagement and cost of environmental management. This chapter shall also describe the capacity sufficiency of the government agencies related to this Project.
8	Residual Impacts, Monitoring and Reporting	This chapter discusses on the residual impacts during preparation, construction, reservoir impoundment and the operation of dam. Monitoring and reporting of these impacts as well as of compliance are also described.

Chapter	Title	Description of Chapter
9	Cost Benefit and Analysis	This chapter looks into the environmental economics of the impacts, cashflow analysis and the sensitivity analysis.
10	Conclusion	Chapter 10 summarises the overall conclusion of the assessment.
Volume 2: Appendices		
1	Baseline Environmental Data and Information	
2	Methodology and Analysis of Data	
3	List of References	
4	Scoping Note, Terms of Reference	
5	Approval Letters	
6	Malaysian Environmental Standards	
7	Project Design Drawings	

1.7 PROJECT PROPONENT

Details pertaining to the Project Proponent are as follows:

SABAH ELECTRICITY SDN. BHD.
6th Floor, Wisma SESB
Jalan Tuanku Abdul Rahman
88673 Kota Kinabalu
Sabah, Malaysia

Telephone: 088–282 380
Facsimile: 088–266 473

Contact Person: Ir. Abdul Nasser B Abdul Wahid (General Manager)

The consultant for the engineering aspects is:

Upper Padas Hydropower Consultants (UPHC)
7th Floor Wisma SESB
Jalan Tunku Abdul Rahman
88673, Kota Kinabalu
Sabah, Malaysia

Telephone: 088–250 822
Fax: 088–250 825

Contact Person: Mr. Alan Gray (Project Manager)

1.8 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) CONSULTANT

Chemsain Konsultant Sdn Bhd has been appointed as the Environmental Consultant for this SEIA study for the proposed Project. Chemsain has collaborated with DHI Water & Environment (M) Sdn Bhd for this assessment. Details of the SEIA Consultants are as follows:

CHEMSAIN KONSULTANT SDN BHD
Lot 7, Lorong Suria, Off Lorong Buah Duku 1
Taman Perindustrian Suria, Jalan Kolombong
88450 Kota Kinabalu
Sabah, Malaysia

EPD Registration Number: F001
Expiry Date: 30.09.2010

Telephone: 088–381 277, 381 278
Facsimile: 088–381 280
E-mail: consult.kk@chemsain.com

Contact Person: Ir. Brian Chong Sin Hian (Director)

In collaboration with:

DHI Water & Environment (M) Sdn Bhd
11th Floor, Wisma Perindustrian
Jalan Istiadat, Likas
88400 Kota Kinabalu
Sabah, Malaysia

EPD Registration Number: F008
Expiry Date: 30.09.2010

Tel: 088–260 780
Fax: 088–260 781

Contact Person: Mdm Tania Golingi (Manager, Environmental Services)

The list of consultants involved in the preparation of this SEIA report, together with their fields of expertise and registration details are shown in **Table 1.8-1** while **Table 1.8-2** lists the consultants that are not fully registered as EIA consultants under the EPD's requirement. Due to change of staffing during the preparation of this report, the list of consultants differs from the original list presented in the approved TOR.

Table 1.8-1 List of Consultants Registered with Environment Protection Department

Consultant	Qualifications	Registered Areas	Report Contribution	Signature
Ir. Brian S. H. Chong Reg. No: S0002 Expiry Date: 30.09.10	M. Sc. Environmental Engineering	Hydrology and Waste Management	Project Manager & Waste Management	
Dr. John S. T. Chan Reg. No: S0001 Expiry Date: 30.09.10	PhD (Chemistry)	Water Quality	Environmental Mgmt & Monitoring Plan	
Rebecca Poong Reg. No: S0008 Expiry Date: 30.09.10	B. Sc. Environmental Science	Land Use	Project Coordinator & Land Use Assessment	
Jessica Y. Malagkas Reg. No: S0007 Expiry Date: 30.09.10	B. Engineering (Chemical)	Occupational Safety and Health & Chemical Engineering	Occupational Safety and Health	
Claire L. Fabian Reg. No: S0169 Expiry Date: 27.01.11	B. Sc (Hons) Env. Sc	Social Economic & Landuse	Assistant Project Coordinator & Report Compilation	
Lim Sze Fook Reg. No: S0005 Expiry Date: 30.09.10	B. Sc (Hons) of Physics Certificate of Training in Meteorology	Air Quality	Microclimate, Air Quality	
Geh Poh Khong Reg. No: S0099 Expiry Date: 07.02.11	B. Sc (Geology)	Geology	Soil Erosion, Geology & Seismicity	
Julien J. Frachisse Reg. No: S0109 Expiry Date: 27.05.10	MSc. Master Hydraulics and Water Engineering	Hydrology, Hydraulic & GIS	Hydrological Impact &Modelling	
Tania Golingi Reg. No: S0027 Expiry Date: 30.09.10	B.Sc. (Hons) (Environmental Science)	Ecology	Ecology & Integrated Impacts Assessment	
Velerie Siambun Reg. No: S0029 Expiry Date: 30.09.10	BSc. (Hons) (Applied Science)	Biology	Public Consultation & Stakeholder Engagement	
Felix Ku Kok Hou Reg. No: S0150 Expiry Date: 14.11.10	B.Eng. (Hons) (Civil & Environment)	Hydraulic and GIS	Numerical Modelling	
Lawrence Fung Reg. No: S0149 Expiry Date: 14.11.10	B.Sc. (Forestry)	Forestry and GIS	Terrestrial Flora	

Consultant	Qualifications	Registered Areas	Report Contribution	Signature
Willison Kung Reg. No: S0151 Expiry Date: 14.11.10	MSc. Marine Geochemistry (Environmental) BSc. Marine Science	Marine	River Benthos	

Table 1.8-2 List of Consultants Not Registered with Environment Protection Department

Consultant	Qualification	Report Contribution
Anders Malmgren Hansen	M.Sc. in Sanitary Engineering and Operation Research	Technical Advisor
Professor Dr. Mohd. Shahwahid Haji Othman	B. Sc (Forestry) MA (Economics) M. Sc (Resource Management) PhD (Resource Management & Policy)	Cost Benefit & Analysis
Profesor Madya Dr. Lee Nyanti @Janti Ak. Chukong	B. Sc (Biology) M. Sc (Natural) Resources PhD (Aquaculture)	Fish Fauna & Riverine Fisheries
Profesor. Madya Dr. Lim Po Teen	B. Sc (Hon.) (Marine Science) M. Sc (Marine Science) PhD (Fisheries Sciences)	Macroflora Assessment
Eivind Oluf Kofod	M.Sc. Forestry	Forestry and Institutional Strengthening
Samuel Paul Bathgate Curtis	Master (Environmental Engineering Management) B. Sc (Environmental Health)	Health Impact Assessment/Entomology
Paul Porodong	M.A Anthropology and Sociology	Social Impact and Forest Community Assessment
Pooh Yih Fang	B. Eng (Civil)	River and Land-Based Traffic
Alan Kerroux	M. Sc HydroInformatics	Hydraulic Modelling
Mohd Zambri Mohd Akhir	B.Sc. Aquatic Biology	Macrobenthos Assessment
Aaroun Leiking	BEng. (Hons.) in Civil Engineering	Hydraulic Modelling
Murray B. Menzies	M. Sc (Water Resources); B.Eng (Civil)	Reviewer of hydraulic and hydrology studies
Finn Hansen	Technical University, Denmark, 1975-1981	Hydrology and Dam break
Lester Teh	BSc. (Hons.) in Marine Science	Ecology

CHAPTER 2 POLICIES, LEGAL AND ORGANISATIONAL FRAMEWORK

2.1 INTRODUCTION

This chapter describes the legislative and policy context in which the Project is being proposed and with which the Project must comply. The chapter also briefly identifies the main institutional partners that will be mobilised for implementation, management, supervision and monitoring.

2.2 INSTITUTIONAL FRAMEWORK

The major institutions with social, environmental and technical responsibilities in implementation of this Project are listed in the sections below. An assessment of the structure and capacity of these institutions is included at the end of the chapter.

Private Organizations

Sabah Electricity Sdn. Bhd.: The Proponent for this Project but does not have any direct jurisdiction over the catchment area. The Sabah Electricity Sdn Bhd will have legal jurisdiction over land use under the transmission lines.

Sabah Forest Industries Sdn. Bhd.: (Partnering with Ballarpur Industries Limited): Forest concessionaire of the catchment area except for some areas reserved as virgin jungle reserves and state lands for settlement areas. See **Table 4.4-18**.

State (Sabah) Institutions

Environment Protection Department: Government institution responsible for upholding environmental quality in the State. The Department controls the environmental impact assessment system and is responsible for monitoring of compliance and residual impacts.

Sabah Forestry Department: Government institution responsible for licensing and control of commercial forestry operations in the state. The Department issues management regulations; directives for annual cuts and working areas; and monitors compliance.

Department of Irrigation and Drainage: State Government institution entrusted with the management and regulation of the State's water resources. This includes catchment area management, protection areas and river corridor (Riparian reserves) planning and management for the purpose of volume and flow regimes as well as water quality.

Town and Regional Planning Department: State department responsible for overall development planning at state level and planning advisory services at state, regional and local levels.

Sabah State Water Department: State department entrusted with the responsibility of providing treated water to the consumers in Sabah. The department operates i.a. a water intake at Beaufort.

Sabah Wildlife Department: State Government institution responsible for maintaining biological diversity in the state, whether flora or fauna.

Sabah Fisheries Department: State department responsible for management of sustainable fisheries, aquaculture and the aquatic environment. The department is primarily concerned with commercial fish species.

Local Authorities: Included as **Section 7.6.1**.

Federal Institutions

Department of Minerals and Geoscience: This department issues licences for quarry activities and for the use of explosives and controls compliance of the licence conditions.

Department of Environment (Sabah): Federal department responsible for environmental protection within the 'Concurrent List' of division of state and federal responsibilities. The Department covers *i.e.* handling of scheduled wastes.

2.3 NATIONAL POLICY ON THE ENVIRONMENT

n the promotion of environmentally sound and sustainable development, Malaysia has established the necessary legal and institutional arrangements such that environmental factors are considered at the early stages of Project planning. The National Policy on the Environment which integrates three elements of sustainable development; (i) economic; (ii) social and cultural development; and (iii) environmental conservation was formulated and approved in year 2002.

This Policy aims at continuous economic, social and cultural progress and enhancement of the quality of life of Malaysians through environmentally sound and sustainable development. The Policy is based on eight (8) inter-related and mutually supporting principles set to harmonise economic development goals with environmental requirements (see **Figure 2.3.1 National Policy on the Environment**). In keeping abreast with the country's rapid economic development and to meet with the nation's aspiration for an improved quality of life, the National Policy on the Environment serves as an important guide to all stakeholders to ensure that the environment is clean, safe, healthy and productive.

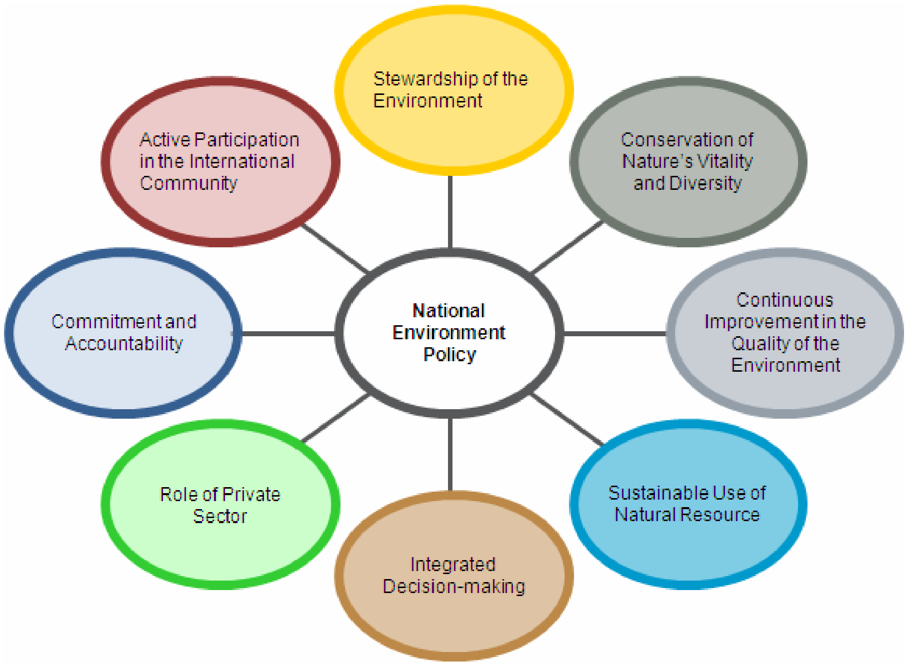


Figure 2.3.1 National Policy on the Environment

Source: Environmental Requirements: A Guide for Investors, Department of Environment, Ministry of Natural Resources and Environment, October 2007.

2.4 ENVIRONMENTAL QUALITY ACT, 1974

In Malaysia, the Environmental Quality Act, 1974 is a legal framework to manage the environment of which the most significant mechanism is the implementation of Environmental Impact Assessment. Under the law, an Environmental Impact Assessment is a mandatory requirement under Section 34A of the Environmental Quality Act, 1974 for activities prescribed in the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987.

For the State of Sabah, the Order is only applicable for certain prescribed activities listed under the Schedule as stated in item 3 (a) and item 4 of the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. Nevertheless, there are other applicable environmental quality regulations cited under the Environmental Quality Act, 1974 which restricts the discharge of wastes into the environment. To date, thirty-five sets of regulations have been introduced and enforced.

2.5 FEDERAL LEVEL AUTHORITY

At the Federal level, the institution that deals with environmental issues and particularly monitoring is the Department of Environment (DOE) under the Ministry of Natural Resources and the Environment (NRE). DOE is the primary authority with regards to the protection environment in Malaysia. It is headed by a director-general who is appointed under Section 3 (1) of the Environmental Quality Act, 1974. The Department consists of State offices of which there is also one in Sabah.

2.6 STATE LEVEL AUTHORITY

The Department of Environment, Sabah was established in 1995 after reorganization at the federal level. Thus, Sabah has its own federal but state-level agency to handle its environmental issues and regulations. At the state level, the Department of Environment is responsible for enforcing the Environmental Quality Ac 1974 within the state.

In 1996, the State of Sabah passed the Conservation of Environment Enactment 1996 which came into force on the same date the Environmental Conservation Department was established. In 2003, the department was renamed the Environment Protection Department following the passing of the Environment Protection Enactment 2002 to replace the Conservation of Environment Enactment 1996.

In line with the provision in the Federal Constitution that land matters are under the jurisdiction of the State, the Environment Protection Department plays a major role in ensuring that the environmental dimension is adequately incorporated into the planning, implementation and control of development activities and the exploitation of natural resources. At the same time, the Department also performs a coordinating role in addressing environmental issues and problems at the sector level through a concerted and integrated strategic approach as well as through the fostering of a network for interdepartmental cooperation and smart partnership.

The Department also plays a major role in advising the State Government through the Environment Protection Council on the strategies and action plans necessary to address current critical environmental issues, and to enhance environmental management in Sabah[3].

The Natural Resources Office and the Lands and Surveys Department under the Chief Minister Department, the Department of Irrigation and Drainage (for rivers, coastal erosion and engineering), the Department of Industrial Development and Research (industrial development planning) the Ministry of Local Government and Housing, Local Authorities (the Municipal councils) and the Town and Regional Planning Department (planning at town and district levels) are also involved directly in state level environmental issues.

2.7 LEGISLATIVE REQUIREMENT OF THE PROJECT

The proposed Project is a prescribed activity under the State's Environment Protection Department – Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005, Second Schedule:

Item 8: POWER GENERATION:-

(a) ***Dams over 15 meters high and ancillary structures covering an area of 40 hectares or more;***

(b) Artificial lakes or reservoirs with surface area covering 50 hectares or more; or

(c) Diversion of streams, rivers or watercourses.

[3] *http://www.sabah.gov.my/jpas/about/default.htm*

As this Project has the special magnitude and sensitivity regarding the environmental impacts which may extend beyond the geographical boundaries of the site and/or can adversely affect the welfare of local communities, this Order requires the Project Proponent to submit a Special Environmental Impact Assessment to be submitted to the Environment Protection Department, Sabah for approval prior to Project commencement.

2.7.1 SPECIAL ENVIRONMENTAL IMPACT ASSESSMENT STUDY GUIDELINES

The Special Environmental Impact Assessment study and report shall be undertaken in accordance to the guidelines issued by the Environment Protection Department and Department of Environment. These include:

- **Handbook for Environmental Impact Assessment in Sabah** published by Environment Protection Department Sabah (November 2005).
- **Environmental Impact Assessment Guidelines for Logging and Forest Clearance Activities** published by Environment Protection Department Sabah (January 2002).
- **A Handbook of EIA Guidelines** published by the Department of Environment (2007).
- **Environmental Impact Assessment Guidelines for Dams and/or Reservoirs Projects** published by the Department of Environment (September 1995).
- **Environmental Impact Assessment Guidelines for Transmission Lines for Thermal Power Generation and/or Transmission Projects** published by Department of Environment (September 1995).

2.8 OTHER APPLICABLE ENVIRONMENTAL QUALITY REGULATIONS

2.8.1 NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA (NWQSM)

There are no surface water quality standards in Malaysia. However, to determine the water quality status, rivers are classified based on a Water Quality Index and the National Water Quality Standards for Malaysia.

The Water Quality Index is computed based in six main parameters: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (NH_3-N), pH, Dissolved Oxygen (DO) and Suspended Solids (SS).

The Malaysian system of river classification is shown in **Table 2.8-1**. The National Water Quality Standards is included in **Appendix 5-2: National Water Quality Standards for Malaysia**.

Table 2.8-1 Malaysian System of River Classification and National Water Quality Standards for Malaysia

Classification	Beneficial Use	Description
Class I	Water Supply I Fishery I	Practically no treatment necessary. Very sensitive species.
Class IIA Class IIB	Water Supply II Fishery II Recreational	Conventional treatment required. Sensitive aquatic species. Recreational use with body contact.
Class III	Water Supply III Fishery III	Extensive treatment required. Common, of economic value, and tolerant species, livestock drinking.
Class IV	Irrigation	
Class V	None of the above	

2.8.2 THE PLANNING GUIDELINES FOR ENVIRONMENTAL NOISE LIMIT AND CONTROL

The Department of Environment has published three (3) sets of documents to provide guidance on acceptable noise limit for various types of land use and human activities. The Planning Guidelines for Environmental Noise Limit and Control provide noise acceptance criteria for quantitative assessment of noise to define disturbance or otherwise. The Guidelines for Noise Labelling and Emission Limits of Outdoor Sources prescribed comprehensive methodology to measure and report noise emissions from outdoor sources. The Planning Guidelines for Vibration Limits and Control gives vibration acceptance criteria for quantitative assessment of vibration.

Maximum Permissible Sound Level (L_{eq}) by Receiving Land Use for Planning and New Development is presented in **Table 2.8-2**.

Table 2.8-2 Schedule 1 - Maximum Permissible Sound Level (L_{eq}) by Receiving Land Use for Planning and New Development

Receiving Land Use Category	Day Time (7.00 am – 10.00 pm)	Night Time (10.00 pm – 7.00 am)
Noise Sensitive Areas, Low Density Residential, Institutional (School, Hospital), Worship Areas.	50 dBA	40 dBA
Suburban Residential (Medium Density) Areas, Public Spaces, Parks, Recreational Areas.	55 dBA	45 dBA
Urban Residential (High Density) Areas, Designated Mixed Development Areas (Residential – Commercial).	60 dBA	50 dBA
Commercial Business Zones	65 dBA	55 dBA
Designated Industrial Zone	70 dBA	60 dBA

2.8.3 MALAYSIAN RECOMMENDED GUIDELINES FOR GASEOUS POLLUTANTS (MRGGP)

There are no ambient air quality standards in Malaysia. The Malaysian government, however, established ambient air quality guidelines in 1988. Pollutants addressed in the guidelines include ozone, carbon monoxide, nitrogen dioxide, sulphur dioxide, total suspended particles, particulate matter under 10 microns, lead and dust fall. The averaging time, which varies from 1 to 24 hours for the different air pollutants in the MRGGP, represents the period of time over which measurements is monitored and reported for the assessment of human health impacts of specific air pollutants. **Table 2.8-3** presents the Malaysian Recommended Guidelines for Gaseous Pollutants.

Table 2.8-3 Malaysian Recommended Guidelines for Gaseous Pollutants

Pollutant and Method	Averaging time	Malaysian Guidelines	
		(ppm)	($\mu g/m^3$)
Ozone AS 2524	1 hour 8 hour	0.10 0.06	200 120
Carbon Monoxide (CO) AS 2629	1 hour 8 hour	30 9	35 mg/m^3 10 mg/m^3
Nitrogen Dioxide (NO_2) AS 2447	1 hour 24 hour	0.17 0.04	320 10
Sulphur Dioxide (SO_2) AS 2523	10 Minutes 1 hour 24 hour	0.19 0.13 0.04	500 350 105
Particulates AS 2724.3	24 hour annual	- -	260 90
Particulate Matter as PM_{10} AS 2724.6	24 hour 1 year	- -	150 50
Lead AS 2800	3 month	-	1.5

2.8.4 ENVIRONMENTAL QUALITY (SEWAGE) REGULATIONS 2009

This regulation is applicable to any premises which discharges sewage onto or into any soil, or inland waters, other than any housing or commercial development or both having a population equivalent of less than 150 (one hundred fifty).

In terms of interpretation, sewage refers to any liquid waste or wastewater discharge containing human, animal, domestic or putrescible matter in suspension or solution, and includes liquids containing chemicals in solution either in the raw, treated or partially treated form[4].

This regulation also stipulates that written notification to the Department of Environment is required prior to discharge or release of sewage onto or into any soil, or inland waters.

2.8.5 ENVIRONMENTAL QUALITY (SCHEDULED WASTE) REGULATIONS 2005

Scheduled wastes refer to the wastes listed in these regulations. The regulations is applicable to activities related to handling and management of scheduled waste such as notification of the generation, disposal, treatment, storage and labelling, recovery of material or product from scheduled wastes and compounding of offences which shall be in accordance with the procedure described in Environmental Quality (Compounding of Offences) Rules 1978 [P.U. (A) 281/1978].

[4] *Environmental Quality (Sewage) 2009; 2(1).*

2.8.6 ADDITIONAL RELATED STATUTES AND REGULATIONS

2.8.6.1 ELECTRICITY SUPPLY ACT, 1990

The Electricity Supply Act is an Act to provide for the regulation of the electricity supply industry, the supply of electricity at reasonable prices, the licensing of any electrical installation, the control of any electrical installation, plant and equipment with respect to matters relating to the safety of persons and the efficient use of electricity.

2.8.6.2 SABAH LAND ORDINANCE

The Sabah Land Ordinance, in particular Section 30(1)(bb) is used in relation to wayleave and Right-Of-Way issues. The government departments, which are mandated by this Ordinance include Land and Survey Department, Assistant Collector of Land Revenue, State Attorney General, Jabatan Hasil Bumi (Tax Department) and the State Secretary's Office.

The process of obtaining wayleave procurement is as follows:

a) Sabah Electricity Sdn. Bhd. will apply for wayleave by servicing notices to the landowners whose land is affected by the proposed transmission line route.

b) The landowners can object/appeal to the applications.

c) If no objection is received from the landowners within the stipulated time, the wayleave right is obtained by Sabah Electricity Sdn. Bhd.

d) If any objection is received from landowners within the stipulated time, the Assistant Collector of Land Revenue will conduct an inquiry.

e) The Assistant Collector of Land Revenue will then give an order to grant Sabah Electricity Sdn. Bhd. the wayleave with/without conditions.

f) After the above, joint count of crops and buildings for valuation and compensation will be carried out.

Compensation hearing/enquiries will be arranged by the Assistant Collector of Land Revenue who will also order Sabah Electricity Sdn. Bhd. to pay the amount of compensation.

2.8.6.3 SABAH WATER RESOURCES ENACTMENT 1998

The Sabah Water Resources Enactment ensures the sustainable management of water resources and protection of the aquatic environment. The enactment consists of eight parts: (I) Preliminary; (II) Administration; (III) The Right to Water; (IV) Authorization of Water Activities; (V) Procedural; (VI) Catchment Planning and Protection; (VII) Activities in and on Water Bodies; (VIII) General. Section 4 of the enactment provides for the establishment of the Water Resources Council, whose main functions shall be:

- To advise the Minister on the management and use of water resources;
- To report the Minister on the condition of water resources;
- To make recommendations for improving the quantity and quality of water for the benefits of human use, the aquatic flora and fauna and the aquatic environment, including wetlands and floodplains; and

- To adopt and review plans for the orderly and effective development of water resources.

In particular, the State Government holds the right to control the use and flow of water:

- In water bodies;
- Occurring naturally on the surface of the ground; and
- Conserved by any works.

On the other hand, the owner or occupier of land or premises is entitled, free of charge and without requiring a licence, to exercise a private right to take, use and control for household and agricultural purposes:

- Groundwater under the land or premises; and
- Where the land or premises has frontage to a water body, water from such water body.

The Chairman of the Council is currently the Chief Minister, who is also the Director of Water Resources.

The Council does not have any executive mandate but is consultative in all matters concerning utilisation of water resources. The Council can thus recommend the Government to introduce policies and laws as and when needed. For the present Project, the Council is assumed to guide the Government in the approval process and to recommend additional regulations if found needed.

2.8.6.4 SABAH INLAND FISHERIES AND AQUACULTURE ENACTMENT, 2003

This enactment gives the Sabah Department of Fisheries wide power to manage and regulate all the fisheries activities in the inland waters of Sabah. This enactment is also foreseen to assist in better implementation of sustainable inland fisheries resources management. Before the enactment was passed, the Sabah Department of Fisheries implemented a Community-Based Resource Management program on many of the riverine fisheries in Sabah. The program empowers the local communities to rehabilitate/restore and manage the riverine fisheries in their rivers. This program has received strong support from the local politicians, community leaders, state government and most of the government enforcement agencies. This Community-Based Resource Management system has also been incorporated in the Sabah Inland Fisheries and Aquaculture Enactment 2003, where the State's Fisheries Director is given the power to appoint community leaders to manage the Community Fisheries Management Zone in the inland waters of Sabah.

2.8.6.5 OCCUPATIONAL SAFETY AND HEALTH ACT, 1994

The provision of the Occupational Safety and Health Act 1994 are based on the self-regulation scheme. Its primary responsibility is to ensure safety and health of work lies with those who create the risks and those who work with the risks.

Through a self-regulating scheme that is designed to suit the particular industry or organization, this Act also aims to establish effective safety and health organization and performance.

The concept of self-regulation encourages cooperation, consultation and participation of employees and management in efforts to upgrade the standards of safety and health at the workplace.

The Occupational Safety and Health Act 1994 is enforced by the Department of Occupational Safety and Health (DOSH), a government department under the Ministry of Human Resources Malaysia. This Department will ensure through enforcement and promotional works that employers, self-employed persons, manufacturers, designers, importers, suppliers and employees always practice safe and health work culture, and always comply with existing legislation, guidelines and codes of practice.

The Department will also formulate and review legislation, policies, guidelines and codes of practice pertaining to occupational safety, health and welfare as a basis in ensuring safety and health at work.

The Department of Occupational Safety and Health (DOSH) is also the secretariat to National Council for Occupational Safety and Health, a council established under Section 8 of the Occupational Safety and Health Act 1994.

The National Council for Occupational Safety and Health shall have power to do all things expedient or reasonably necessary for or incidental to the carrying out of the objects of this Act.

2.8.6.6 LABOUR ORDINANCE (SABAH CAP.67)

The Labour Ordinance (Sabah Cap. 67) objectives are to:

- Ensure any agreement or employment contract between employer and employee is valid in accordance with provisions of the legislation;
- To provide for terms and minimum employment conditions;
- To provide for minimum benefits for employees;
- To specify control procedures on employment of employees including non-resident employees; and
- To provide for procedures for recovery under the laws.

Other than to specify minimum benefits and protection to safeguard employee interests, the Labour Ordinance (Sabah Cap 67) also specifies other provisions concerning conditions of employment and employer responsibilities, such as the maintenance register of employees, house accommodation, and sufficient supply of wholesome water and safety and health procedures at the place of work. This Ordinance also specifies procedures for recovery and penalty due to employer's failure to comply with the provisions regarding employees' right.

2.9 INTERNATIONAL REQUIREMENTS

2.9.1 CONVENTIONS AND OTHER INTERNATIONAL AGREEMENTS

Malaysia has signed a number of international social and environmental conventions and agreements, which all require approval and follow-up legislation from the national parliament. Similarly, Malaysia is a member of international organisations and NGOs, working for social or environmental causes.

Sabah Wildlife Department and the Sabah Parks Board of Trustees are members of the International Union for the Conservation of Nature (IUCN).

Malaysia is a signatory to CITES, The Convention on International Trade in Endangered Species. In Sabah, the Wildlife Department is the enforcing authority.

Malaysia is a signatory to the RAMSAR convention on Wetlands and is a country member of the NGO Wetlands International. The Trusan Kinabatangan, Kuala Segama-Maruap Mangrove Forest Reserve and the Kulamba Wildlife Forest Reserve in Sabah are the biggest Ramsar sites in Malaysia.

Malaysia is also a signatory to the UN Convention on Climate Change with the Director General of the Malaysian Meteorological Service as the focal point. As signatory of the UN Framework Convention on Climate Change, Malaysia has ratified the Kyoto Protocol in September 2002. The Government of Malaysia strongly supports Clean Development Mechanism activities and has implemented an institutional framework for this.

Malaysia ratified the Convention on Biological Diversity in 1994.

Malaysia has supported the adoption of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) both during the Human Rights Council and the General Assembly.

Malaysia is a member of the International Commission on Large dams and has established a Malaysian Committee on Large Dams in the Tenaga National Berhad (The national power company).

2.9.2 REQUIREMENTS OF INTERNATIONAL FINANCIAL INSTITUTIONS

The following shall provide a summary of the environmental and social requirements of the key International Financial Institutions that are expected to be involved in the Project:

- International Finance Corporation of the World Bank;
- Asian Development Bank; and
- Private Financial Institutions.

2.9.3 INTERNATIONAL FINANCE CORPORATION AND ITS PERFORMANCE STANDARDS

The source of finance for the Project is not determined yet but appears certain to include one or more lending banks subscribing to the Equator Principles. The World Bank Group statutes and regulations require the World Bank to follow prescribed environmental procedures when involved with international assistance projects. The International Finance Corporation is part of World Bank Group and is the private sector financing arm of the World Bank Group. Compliance with the International Finance Corporation's environmental and social framework is a requirement for project sponsors. The International Finance Corporation policy framework includes:

- Policy and Performance Standards on Social and Environmental Sustainability;
- Policy on Disclosure of Information; and
- Environmental, Health and Safety Guidelines

The Performance Standards clarify what is expected of project sponsors and detail requirements that project sponsors will be required to fulfil in order to receive and retain International Finance Corporation support. There are eight performance standards, as shown below:

- Performance Standard 1 – Social and Environmental Assessment and Management System;
- Performance Standard 2 – Labour and Working Conditions;
- Performance Standard 3 – Pollution Prevention and Abatement;
- Performance Standard 4 – Community Health and Safety;
- Performance Standard 5 – Land Acquisition and Involuntary Resettlement;
- Performance Standard 6 – Conservation of Biodiversity and Sustainable Natural Resource Management;
- Performance Standard 7 – Indigenous Peoples; and
- Performance Standard 8 – Cultural Heritage.

International Finance Corporation currently uses two guidelines for environmental, safety and health aspects:

- Pollution, Prevention and Abatement Handbook (1998); and
- Additional environmental, health and safety guidelines that International Finance Corporation has prepared since 1993 and for which there are no parallel guidelines in the Pollution, Prevention and Abatement Handbook.

The guidelines mentioned above are, however, specific to particular industries or sectors and at present, there are no particular guidelines for construction of dams. In this case, the World Bank's *General Environmental Guidelines* and the International Finance Corporation's *Occupational Health and Safety Guideline* are referred to, with necessary modifications to suit the Project. Apart from the listed guidelines above, additional publications that the International Finance Corporation has produced to assist project sponsor in terms of environmental and social review are:

- Guidance Note for each Performance Standard;
- Environmental and social review procedure (internal);
- Good practice publications;
- Manual for implementing Environmental Management Systems; and
- Policies and guidelines glossary.

The Policy on Disclosure of Information outlines the International Finance Corporation's commitments and responsibility to disclose information about itself as an institution and to encourage project sponsors to initiate early and ongoing engagement with the community/communities that are affected by a project

2.9.4 WORLD BANK SAFEGUARD POLICIES

The World Bank includes two development institutions owned by 184 member countries – the International Bank for Reconstruction and Development and the International Development Association and their operations are guided by a comprehensive set of environmental and social policies and procedures. The policies and guidelines known as Operational Policies are set out in the Bank's Operational Manual.

The World Bank, by definition only lends to states, but accepts lending through intermediaries, so-called FI loans. It is then the duty of the intermediary, i.e. The primary borrower, to ensure, through own efforts, that the sub-borrower conforms with the required standards.

The Bank has identified ten key policies critical to ensure that potentially adverse environmental and social impacts are identified, minimised and mitigated. These key policies are known as the "Safeguard Policies":

- Environmental Assessment;
- Cultural Property;
- Disputed Areas;
- Forests;
- Indigenous Peoples;
- International Waterways;
- Involuntary Resettlement;
- Natural Habitats;
- Pest Management; and
- Safety of Dams

The Upper Padas Hydroelectric Project primarily triggers four of these safeguard policies, i.e. the policies on

Environmental Assessment. This policy requires projects with significant or potentially significant environmental impacts to be subjected to an Environmental Impact Assessment taking into account the natural environment as well as social aspects at local, regional and global levels. The World Bank environmental impact assessments differ from standard Sabah assessments in the requirements for institutional assessments, a public consultation process and the requirements of including costs of environmental management. The policy makes it very clear that the Bank cannot appraise a project proposal unless the public disclosure process has been carried out satisfactorily.

The World Bank Environment Assessment Policy defines a number of issues to be covered in the report: executive summary; project description; baseline data; environmental impacts, analysis of alternatives; and environmental management plan;

Forests. The Forest Policy of the World Bank is not limited to forestry projects but equally much to all projects, which have or may have impacts on the health and quality of forests or which are to bring about changes to the management of forest areas. The Upper Padas Hydro Electric Project will require clearance of a forest area for the reservoir and it will require stringent management regimes in the catchment area. Of importance is that the Bank does not get involved in any destruction, degradation or conversion of any critical habitats.

The current Project will utilise water as a non timber forest product or environmental service from the forested area in the catchment. But it will use this water in a non-destructive way, i.e. only the flow, not the mass of water will be used as in water for irrigation or water supplies.

Natural Habitats. The policy on natural habitats are triggered as the forestry policy: The Project does not directly manage natural habitats or biodiversity but it does affect natural habitats by clearing for the reservoir and by attempting to further protect remnant, natural habitats – even if it is for the sake of soil protection. The main issue of the policy is to protect critical habitats, which is not an issue for the Upper Padas Hydroelectric Project.

Safety of Dams. This policy defines the Upper Padas dam as a ‘large dam’, wherefore it triggers the requirements of the policy for additional safety considerations.

The present study has investigated whether there are issues triggering policies such as the policies for indigenous peoples, cultural property and involuntary resettlement. The study does not find these policies are triggered in any significant manner.

2.9.5 ASIAN DEVELOPMENT BANK

Asian Development Bank adopted the environmental assessment process which is the main key in mainstreaming the environment into Asian Development Bank project leading operations. This environmental assessment evaluates the project’s potential risks and impacts in its area of influence, examines project alternatives and identifies ways of improving project selection, siting, planning, design and implementation.

To mainstream the environment review system and to optimize the use of staff resources, projects are categorized into A, B, and C with category A and selected category B projects classified as environmentally sensitive projects. An Environmental Impact Assessment and a summary of it are required for category A projects, while an Initial Environmental Examination and its summary are required for environmentally sensitive category B projects. In addition to encouraging stakeholder participation throughout the project cycle, the summary of environmental assessment reports are circulated to interested parties 120 days before the Asian Development Bank Board considers the project.

To manage the environmental inputs to a project or program, Asian Development Bank has developed an environmental review system covering all stages of the project cycle from the preparation of the country operation strategy, to project identification, appraisal, implementation, completion, and post-evaluation. Inputs of environment specialists to programs and projects throughout the project cycle are monitored using the Environment and Social Monitoring Information System.

2.9.6 PRIVATE BANKING

The Equator Principles (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. The Equator Principles are considered the financial industry standard for sustainable project finance.

About 80 private financial institutions have adopted these principles for financing projects with a capital of more than 10 million USD. These financial institutions are known collectively as Equator Principles Financial Institutions.

In recent years, the Equator Principles have become the financial industry benchmark for determining, assessing and managing social & environmental risk in project financing.

This Project financing, a method of funding in which the lender looks primarily to the revenues generated by a single project both as the source of repayment and as security for the exposure, plays an important role in financing development throughout the world. Project financiers may encounter social and environmental issues that are both complex and challenging, particularly with respect to projects in the emerging markets.

The Equator Principles Financial Institutions (EPFIs) have consequently adopted these Principles in order to ensure that the projects they finance are developed in a manner that is socially responsible and reflect sound environmental management practices. By doing so, negative impacts on project-affected ecosystems and communities should be avoided where possible, and if these impacts are unavoidable, they should be reduced, mitigated and/or compensated for appropriately. The EPFIs review these Principles from time-to-time based on implementation experience, and in order to reflect ongoing learning and emerging good practice. The Principles are intended to serve as a common baseline and framework for the implementation by each EPFI of its own internal social and environmental policies, procedures and standards related to its project financing activities. Loans are not provided to projects where the borrower will not or is unable to comply with the respective social and environmental policies and procedures that implement the Equator Principles.

There are 10 principles which in many ways are coordinated with the International Finance Corporation performance standards.

CHAPTER 3 PROJECT DESCRIPTION

3.1 INTRODUCTION

The Upper Padas Hydroelectric Project is initiated by the Sabah Electricity Sdn Bhd, following identification of the Padas River (south of Tenom) as one of the most promising sites for hydroelectricity generation in the Sabah Power Development Master Plan Study from 1984 (**Figure 3.1.1**). Sabah Electricity Sdn Bhd subsequently commissioned a feasibility study in 1994 to determine the optimum layout for the Upper Padas Hydroelectric Project taking into consideration financial, technical and environmental aspects. Findings from the feasibility study have shown that the Project is technically and economically viable with limited social and environmental impacts. Consequently, the feasibility study recommended, among others, the commissioning of a more detailed Environmental Impact Assessment study.

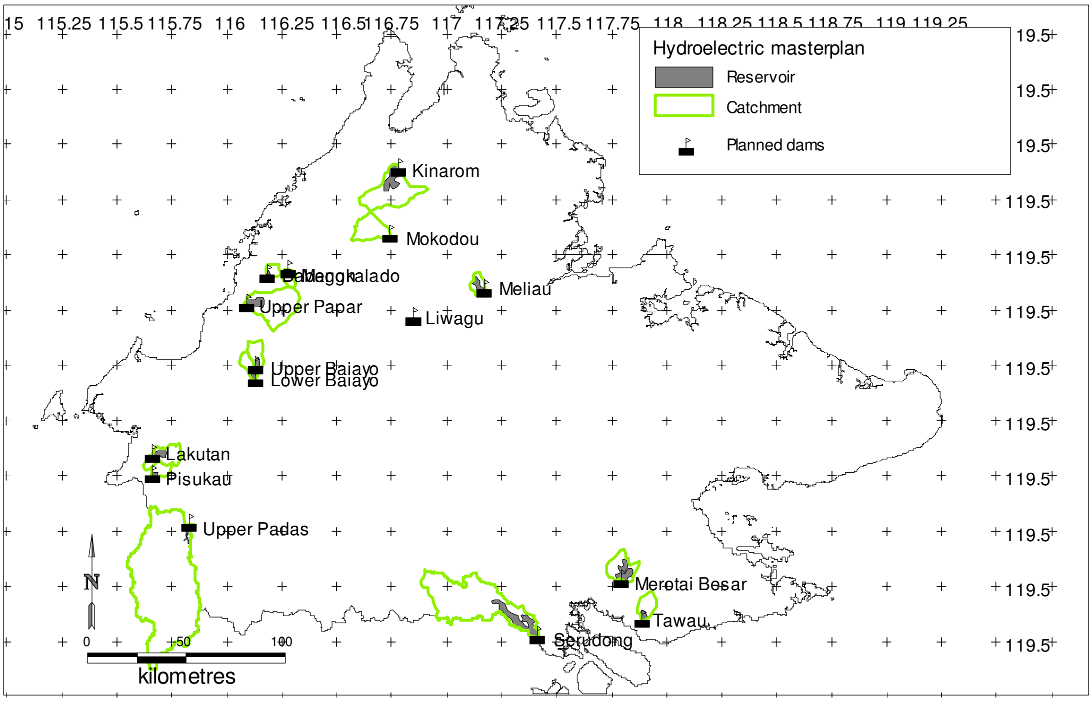


Figure 3.1.1 Potential Hydroelectric Project Sites, Catchments and Reservoirs

The Padas River lies in southern Sabah and originates near the border with Sarawak. At Tenom, the Padas River (3,500 km^2) is joined by the Pegalan River (4,300 km^2) which flows north-to-south through Tambunan and Keningau. Below Tenom, the river enters a 45-km long gorge before opening out on to the floodplain at Beaufort. Immediately downstream of Tenom is the 66 MW run-of-river Tenom Pangi hydropower station, constructed in 1984 to take advantage of the gradient of the river through the gorge.

The river reaches the sea 66 km downstream from Beaufort. The main stem of the river is about 220 km long and has a total catchment area of 8,950 km^2. **Figure 3.1.2** shows a longitudinal profile along Padas River from the headwaters to the ocean.

Changes in slope within the catchment (steep in the upper reaches and Padas Gorge, flat in the Tenom and Beaufort floodplains), marks a transition in the river system. In the steep reaches, velocities are higher, meanders are less extensive and typically river sediments are coarser. The flatter downstream zone has slower current velocities, more pronounced meanders and typically finer sediments. More extensive flooding across the wider floodplains occurs.

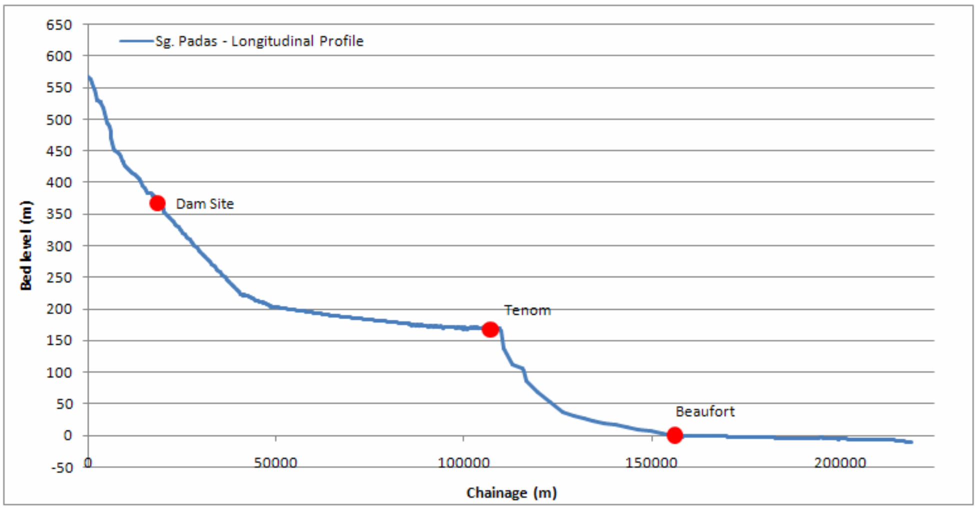


Figure 3.1.2 Longitudinal Profile of Padas River

3.1.1 PROJECT CONCEPT

In order to generate electricity from the kinetic energy in moving water, the water has to be moving with sufficient speed and volume to turn a generator. To increase the force of moving water, impoundments or dams are used to raise the water level creating a height differential. When the water behind a dam is In order to generate electricity from the kinetic energy in moving water, the water has to be moving with sufficient speed and volume to turn a generator. To increase the force of moving water, impoundments or dams are used to raise the water level creating a height differential. When the water behind a dam is released, it runs through a pipe called penstock and is delivered to the turbine. Hydroelectricity can also be generated without dams, a concept known as "run-of-the-river". Portions of the water from fast-flowing rivers, often at or near waterfalls, can be diverted through a penstock to a turbine set in the river or off to the side. The generating station at Tenom Pangi, with installed capacity of 66 MW (3 x 22 MW) is an example of this concept.

The Upper Padas Hydroelectric Project is to be designed with a dam, reservoir, penstock, powerhouse and transmission lines.

The Tenom-Sipitang transmission lines is proposed to provide the generated to the SESB Grid via a proposed corridor up to Kg. Paal, Tenom before it separates to Tenom and Sipitang districts respectively. Both lines are proposed to be a 275 kV double circuit. At present, the transmission lines alignment and the locations of substations are still in a planning stage and are yet to be finalized (see **Section 3.7.2** for key factors to determine transmission lines alignment and locations of substations).

The Project site (comprising reservoir, dam, powerhouses and transmission lines) are located in the southwest corner of Sabah within Sipitang and Tenom Districts. The geographical position of the proposed main components is shown in **Table 3.1-1**.

Table 3.1-1 Geographical Position for Main Components

Component	Longitude	Latitude
Reservoir	115° 47′ 49″ - 115° 50′ 8″	4° 41′ 29″ - 4° 46′ 52″
Dam	115° 49′ 50″	4° 46′ 46″
Main Powerhouse	115° 51′ 51″	4° 51′ 35″
Secondary Powerhouse	115° 49′ 55″	4° 46′ 58″
Transmission Lines	115° 34′ 35″ - 115° 54′ 37″	4° 46′ 49″ - 5° 7′ 55″

The Upper Padas HEP catchment area measures about 1,885 $km^{2.}$ (**Figure 3.1.3**). Slightly deviating figures are used in some sections of this report as different map sources have been used for different purposes.

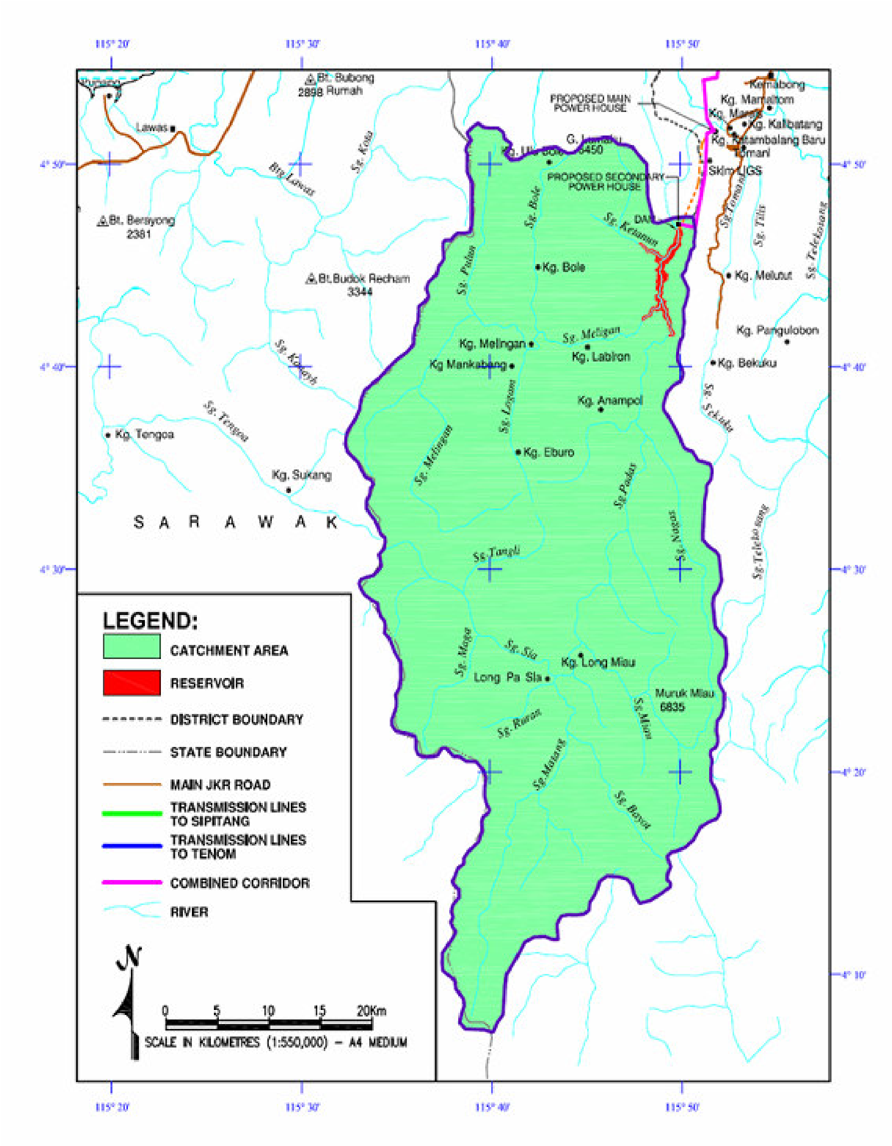


Figure 3.1.3 Catchment Area

The nearest settlement is Tomani on the north bank of Padas River. To reach the town, one must travel to Tenom, which is easily accessible via three major roads; (i) Kota Kinabalu-Sipitang-Tenom Road; (ii) Kota Kinabalu-Tenom Road; and (iii) Kota Kinabalu-Kimanis-Keningau-Tenom Road. The average distance from Kota Kinabalu to Kuala Tomani is approximately 210 km.

The reservoir area falls under Sipitang commercial forest reserve, which is licensed to the Sabah Forest Industries (SFI). The reservoir is expected to cover approximately 5.9 km^2 or 590 ha, involving three rivers: Padas, Maligan and Ketanun. The area immediately east of the reservoir is topographically steep, making it unsuitable for logging and forest plantation activities. This area, which covers about 911 ha, has now been delineated by SFI as a conservation area in the company's plantation development plan.

The proposed dam site is located within Sipitang District and is approximately 8.5 km downstream of the confluence of Padas River and the Maligan River. It is about 17 km southwest of the Kuala Tomani bridge. See **Map 1.4- 1 Project Site Location**.

The dam site is located at 360 meter above sea level.

Presently there is no proper access road to the dam site. Access to the vicinity can be made through the internal logging roads under SFI management. However, the final access route to the site remains rough and through very steep terrain.

The proposed powerhouse site is located within Tenom District, next to a small island in the Padas River about 16 km downstream of the dam site or 3 km upstream of the Kuala Tomani bridge. See **Map 1.4- 1 Project Site Location**.

The area is accessible by the existing rubber estate access from Kuala Tomani along the south side of Upper Padas River. At present, there is no access road between the powerhouse and dam site and the nearest village to the powerhouse is Kg. Katambalang Baru which is about 1.5 km (measured in direct distance) from the site.

The proposed combined corridor for the transmission lines from the main powerhouse is about 15 km (in direct distance) up to the intersection point of Sipitang-Tenom Road at Kg. Paal. From this point, the total length of lines to Tenom is approximately 17 km, while the total length of lines to Sipitang is approximately 33 km.

3.1.2 RESERVOIR CHARACTERISTICS

The reservoir terrain and reservoir area – volume characteristics are shown in **Figure 3.1.4, Figure 3.1.5** and **Figure 3.1.6**.

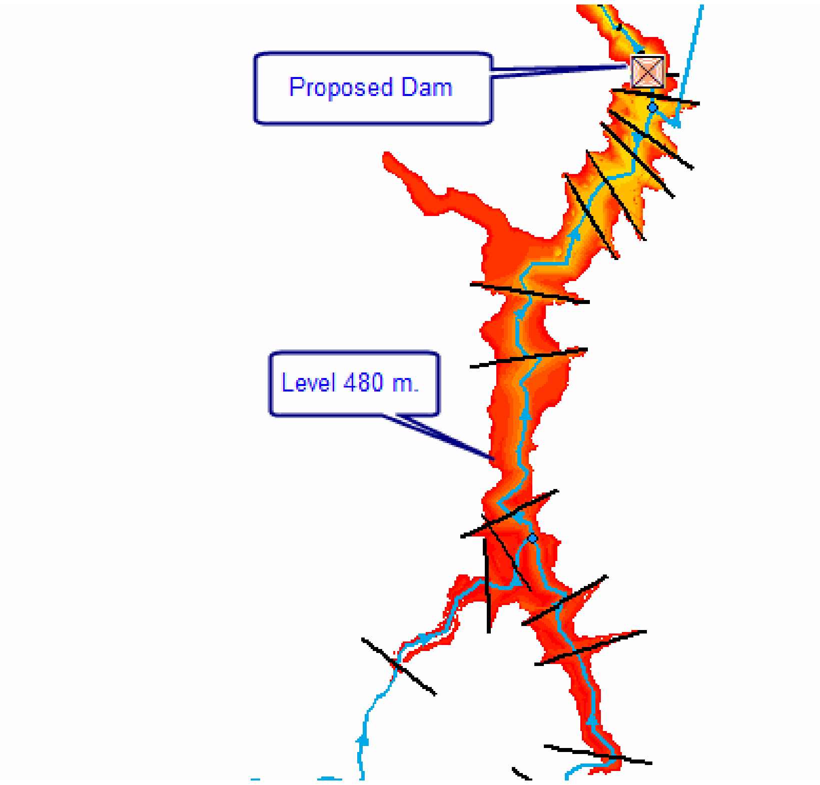


Figure 3.1.4 Reservoir Terrain

Note: Graph generated from SRTM, Topographic Maps and River Profile from SWECO (2000)

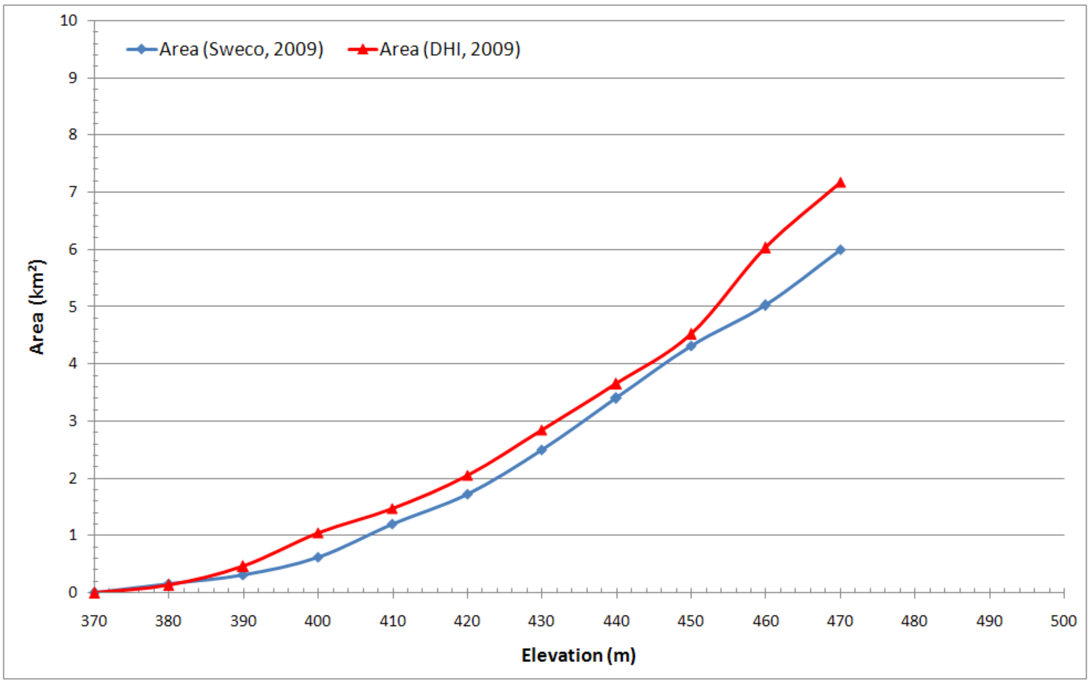


Figure 3.1.5 Surface Area Of Upper Padas Reservoir

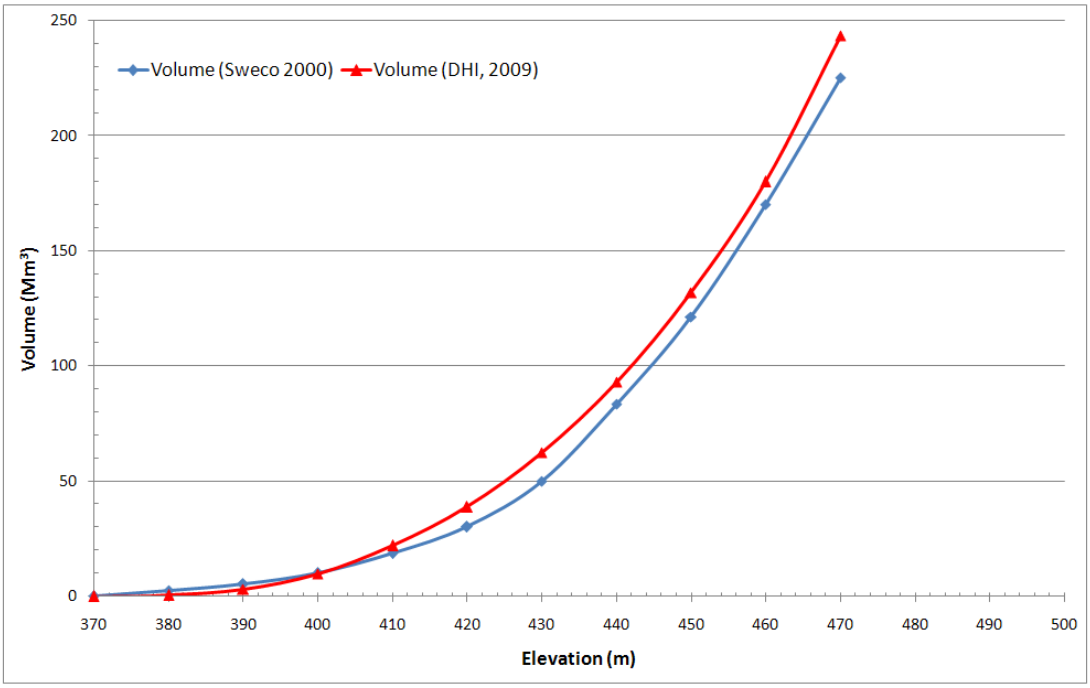


Figure 3.1.6 Volume of Upper Padas Reservoir

Table 3.1-2 sets out details of the proposed Hydroelectric Project and its contributing catchment. These details relate to the hydro development option favoured by the last feasibility study report undertaken by the consultant SWECO[5] and serves as the basis for the EIA findings in this Report.

Table 3.1-2 Details of Proposed UPHEP and Its Contributing Catchment

Item	Description
(1) Catchment	
Catchment area to dam (km^2)	1,885
River channel length: headwaters to dam (km)	17
Average annual sediment load (t)	300,000
(2) Flows At Dam	
Mean flow (Qm, m^3/s)	72
10% low flow (m^3/s)	21
1% AEP flood discharge (m^3/s)	3,100
PMF discharge (m^3/s)	9,000
Design spillway discharge (m^3/s)	11,800
Peak hydro discharge (Q_p, m^3/s)	70

[5] *Feasibility Study on Upper Padas River Hydropower Project – Final Report", SWECO International, November 2000.*

Item		Description
(3) Dam		
Natural river elevation at dam (m)		360
Dam height (m)		120
Dam crest elevation (m)		475
Dam crest length (m)		440
(4) Headrace Tunnel		
No.		1
Size (diameter)		5.0
Length (m)		9,500
(5) Reservoir		
Reservoir NTWL (m) (Normal top water level)		470
Reservoir operating range (m)		40 (430 – 470)
Reservoir live storage:	($m^3 *10^6$)	220
	(days at Q_p)	36
Reservoir length at NTWL (km)		12
Reservoir area at NTWL (km^2)		5.9
Reservoir capacity:	(Mm^3)	275
	(days @ Q_m)	44
Reservoir dead storage (Mm^3)		55
(6) Spillway		
Type		Free overflow + gated
Gates		4 No, each 12 m x 9.5 m
Gate sill elevation (meter above sea level)		455
(7) Diversion Tunnels		
No.		1
Size (diameter)		12
Length (m)		670
(8) Generation		
Tailrace level (m)		217
Gross generating head (m)		253
Peak rated power output (MW)		150

**Figures in italics are as derived by DHI (all others are from the SWECO report)*

3.2 CONCEPTUAL DESIGN

3.2.1 DAM AND SPILLWAY

The selected dam type will be Roller Compacted Concrete dam which, compared to e.g. rock filled concrete faced dams, has advantages such as shorter construction time and a considerably higher safety factor against dam break if overtopping due to extreme floods should occur. The overall drawing plan for dam site area, upstream and downstream part, surge shaft, gallery and powerhouse area are presented in **Appendix 6: Project Design Drawings**. The Roller Compacted Concrete dam will be designed to have an upstream slope tentatively at 6.0V:1.0H and a downstream slope at 1.0V:0.83H. The recommended layout of the dam and spillway includes the following descriptions:

- Roller Compacted Concrete dam with a main gated spillway in the central part. The total length of the dam crest is approximately 440 m with maximum height of approximately 120 m.
- Main spillway with 4 gates 12 m x 9.5 m (height x width), with the spillway crest at 458.5 meter above sea level.
- A plunge pool with a total length of 300 m and with a bottom elevation of approximately 340 meter above sea level.
- The different still water levels used for the design of the dam (not to be mistaken as head for power production) are as the following:
    - Maximum Flood Surcharge, (10,000 yrs flood): +473.5 meter above sea level
    - Upper Storage Level, USL: +470 meter above sea level
    - Lower Storage Level, LSL: +430 meter above sea level
    - Minimum Dam Tailwater Level: +360 meter above sea level
    - Normal Dam Tailwater Level, NTL: +370 meter above sea level
    - Maximum Dam Tailwater Level, XTL: +380 meter above sea level
    - Maximum Silt Level (after 100 years): +400 meter above sea level (to be confirmed)

The layout of the spillway arrangements is based on the following criteria:

- The discharge capacity shall be sufficient to discharge the estimated 10,000 year flood i.e. approximately 3,155 m^3/s and no particular freeboard allowance, i.e. reservoir level of 473.5 meter above sea level. The dam and spillway shall be designed to withstand the passage of the Probable Maximum Flood but the dam crest shall be allowed to overtop. There will be no risk of dam failure but significant damages will be tolerated.
- The spillway shall be capable of discharging and estimated 1,000-year flood, i.e. 2,560 m^3/s, with one gate closed and without any damages to the Project. This criteria emanates from international experience of gate openings being either clogged with trees or debris, or gates remaining in the closed position when needed to be open due to electrical or mechanical failure.
- The discharge capacity shall be at least 2,560 m^3/s at the Upper Storage Level in the reservoir to avoid frequent significant variations in reservoir water level and provide reasonable flexibility in water management.
- The plunge pool shall be designed for a 1,000-year flood, at Upper Storage Level in the reservoir. This indicates that some damages on the plunge pool at high Probable Maximum Flood-discharges are likely to occur. However, these damages have been considered not to endanger the stability of the dam structure.
- The four main spillway gates are proposed to have 9.5 m width and a height of 12 m and will be of the radial lifting type. The gates shall be manoeuvred using hydraulic cylinders, presumably one mounted on each pier.

3.2.2 POWER WATERWAY

The power waterway component includes power intake structure; headrace tunnel; surge shaft and penstock. Further descriptions of these components are presented in the following sections below.

3.2.2.1 *POWER INTAKE*

The intake structure shall be located a few meters upstream from the dam on the right riverbank at elevation of 419 meter above sea level and the structure will be connected to the dam by a concrete slab, which also will serve as access to the intake. The intake will be protected by coarse trash-racks with free openings and the front of the structure will be inclined 1H : 5V to facilitate the use of an automatic trash-rack cleaning machine. The intake will also be equipped with vertical wheel gate for normal operation and operated with single-action hydraulic cylinders.

3.2.2.2 *HEADRACE TUNNEL*

The headrace tunnel is assumed to be excavated by drill and blast technique and concrete lined along its entire length of 9.5 km. The tunnel is proposed to be constructed as a horse shoe shaped tunnel with a roof invert diameter of 5.0 m corresponding to a cross sectional area of 22.3 m^2. The vertical alignment of the tunnel is governed by the level of the intake at the upstream end and by the downward surges in the surge shaft at the downstream end. In order to have as short construction adit as possible at the tunnel midpoint, the vertical alignment is kept as high as possible in the upstream part, and the tunnel is lowered due to low surges only close to the surge shaft. The construction adit will be given an inclination of 1V : 8H or less, and will be connected to the existing rubber estate roads.

3.2.2.3 SURGE SHAFT

The proposed surge shaft will have an upper part with a diameter of 30 m for high levels and a surge gallery in the lower part for downward surges. All part of the surge shaft will be concrete lined and will be designed for a high groundwater table on the outside.

3.2.2.4 PENSTOCK

A penstock located above ground will be the recommended for this Project. The penstock starts at the connection with the surge arrangement and then proceeds about 200 m underground until it reaches the ground surface. The penstock will then go across the hill slope in an open cut down to the powerhouse over a total length of about 720 m. For the Upper Padas Hydroelectric Project, the part of the penstock located inside the tunnel has been given a diameter of 5.0 m, and for the remaining part the diameter has been optimised at 4.4 m down to a bifurcation at the powerhouse.

As an emergency for penstock failure, a valve house has been provided with a butterfly valve, which will close the headrace tunnel if a failure should occur. This valve house shall be located 100 m downstream of the end of headrace tunnel.

3.2.3 POWER HOUSE

In order to shorten the penstock as much as possible, the powerhouse is proposed to be located in the mid part of the river channel south of the island dividing the Padas River. The power house will be founded on competent rock at an elevation of 203 m above sea level. The elevation of the natural ground level is about 225 m above sea level, which will require an approximately 23 m deep pit for the powerhouse. The proposed dimension of the power house is about 25 m x 48 m with a height of 31 m.

The main access road to the power house is proposed to be aligned along the south bank of Padas River from the existing gravel road from the existing bridge at Tomani. This road is proposed to be upgraded.

Primarily, the size and functions of the equipments to be installed govern the layout of the power house. The layout has been designed in a traditional manner and is consequently divided into Turbine Floor, Generator Floor, and Machine Hall Floor, with an Erection Hall at a higher elevation than the Machine Hall Floor.

At the northern part of the power house, a doorway (5 m high and 5 m wide) will be arranged for transportation into the Erection Hall. Access to the operation staff building and to the Control Room will be through the stairs at the Erection Hall.

The power house will be provided with three (3) identical units of the vertical shaft Francis-turbine type. The turbines have been designed for the intended regulation of the Upper Padas Hydroelectric Project, which imply that operation at full load or nearly full load will be a dominating mode of operation. The rated net head is 220 m and the total discharge through the main turbines is in the range of 54 to 84 m^3/s for a total rated output of about 150 – 210 MW. The turbines setting will be confirmed on the basis of gauge readings and hydraulic model tests. Between the turbines a dewatering pit shall be constructed. This pit will be supplied with pumps for leakage water and two (2) pumps units for dewatering of the spiral casings and draft tubes.

The Generator Floor will consist of these equipments:

- Generators, 65 MVA, 11 kV, 500 rpm
- Braking equipment
- Compressed air system
- Oil cooling system for bearings
- High pressure oil system for generator
- Neutral terminals
- Cables for the power output to switchgear
- Oil system room
- Fire fighting equipment
- Storage
- Mechanical and Electrical Workshops
- Ventilation room
- Battery and DC-room
- Potable water treatment room
- Separate room for the auxiliary system

The Machine Hall will consist of these equipments:

- Generator cover and excitation equipment
- Local control unit in the Machine Hall
- Local unit computers in the Machine Hall
- Generator switchgear in three separate switchgear rooms
- Electric/ventilation shaft
- Staff facilities
- Ventilation room

The Control Room will be located beneath the unloading bay at the same elevation as the machinery hall. For observation of equipments, the Control Room will be provided with glassed windows with full overview of the machinery hall area. The Control Room will consist of:

- Station computer
- Telecommunication system
- Substation computer

- Relay protection cubicles
- Local control cubicles
- Control equipment for fire fighting

Apart from the above, office, resting area and kitchen will be located in the Control Room.

3.2.4 SECONDARY POWER STATION TO UTILIZE THE MINIMUM WATER RELEASE

Following multiple discussions with the Department of Irrigation and Drainage, the minimum discharge and release of water at the dam site for environmental flow has been agreed by Drainage and Irrigation Department to be at 16 m^3/s (See **Appendix 4-3: Approval Letter**). This will be discharged to the Padas River channel immediately downstream of the dam on a continuous basis. To exploit the energy potential from the environmental release and the average pressure head of some 88 m created by construction of the dam, it is proposed to construct a secondary power station having an installed capacity of some 14 MW. The power station will likely be configured in two units and will provide an annual energy production of some 103 GWh.

The proposed location for the secondary power station will be close to the downstream toe of the dam on the eastern dam abutment. The intake for the secondary power station will be tentatively located close to the intake structure for the main power station, on the upstream side of the dam, also on the eastern abutment. Power from the secondary power station will be evacuated by a 33-kV transmission line to the main substation located close to the main power station.

3.2.5 TAILRACE CANAL

The tailrace canal leads the turbine discharge back to Padas River. The water velocity in the tailrace canal will be low and evenly distributed to prevent unnecessary head losses and deposits of sediments in the canal.

The tailrace canal will have a length of approximately 290 m and bottom width of 10 m. The tailrace canal will mainly be excavated in weathered rock and any suitable surplus rock will be used to construct access road and foundation for the switchyard as well as to protect the powerhouse from high floods during construction as well as during future operation.

3.2.6 COFFERDAMS FOR THE CONSTRUCTION OF POWER HOUSE

On the upstream of the power house, the deposit area for rock from excavation of the penstock trench and the tailrace canal will form a cofferdam with an assumed level of elevation of 230 meter above sea level, in order to protect the power station from high floods during the construction as well as during the future operation period.

At the downstream side of the power house, no cofferdam will be required since most of the excavation of the tailrace canal can be performed in dry conditions behind the upstream cofferdam. When the downstream end of the tailrace canal will be excavated, and the connection to the main river channel constructed, these works may be performed underneath water.

3.2.7 SWITCHYARD

The switchyard will be located just upstream of the powerhouse on compacted rockfill. The rockfill used for the switchyard will mainly be taken from the excavated pits around the powerhouse area and from the penstock trench. Access to the switchyard will be established from the access road to the powerhouse.

3.2.8 TRANSMISSION LINES

There will be three transmission lines:

- A 33 kV line connecting the secondary power house with the main power house. The line will consist of simple poles spaced at about 30-60 metres depending on terrain.

- A 132 kV line connecting the main power house via Kg. Paal to the grid at Tenom (32 km). The pylons or towers will be about 30-35 metres tall and spaced about 300 metres apart. The footprint of each pylon will be about 6x6 metres. A 1 chain wide (20 metres) wayleave area, where no vegetation or structure may exceed 6 feet (2 metres) will be established to each side of the transmission centre-line. According to Electricity Supply Act, 1990, the ground clearances for the 66-132 kV and 132-275 kV lines are 6.70 meters and 7.0 meters respectively. Flashover may occur if you get closer and this can cause injury or even death. Minimum working clearance from the live conductor is 4.75 meters.

- A 275 kV line connecting the main power house via Kg. Paal to the grid at Sipitang (48 km). The pylons or towers will be about 40 metres tall and spaced about 365 metres apart. The footprint of each pylon will be about 10x10 metres. A 1 chain wide (20 metres) wayleave area, where no vegetation or structure may exceed 6 feet (2 metres) will be established to each side of the transmission centre-line.

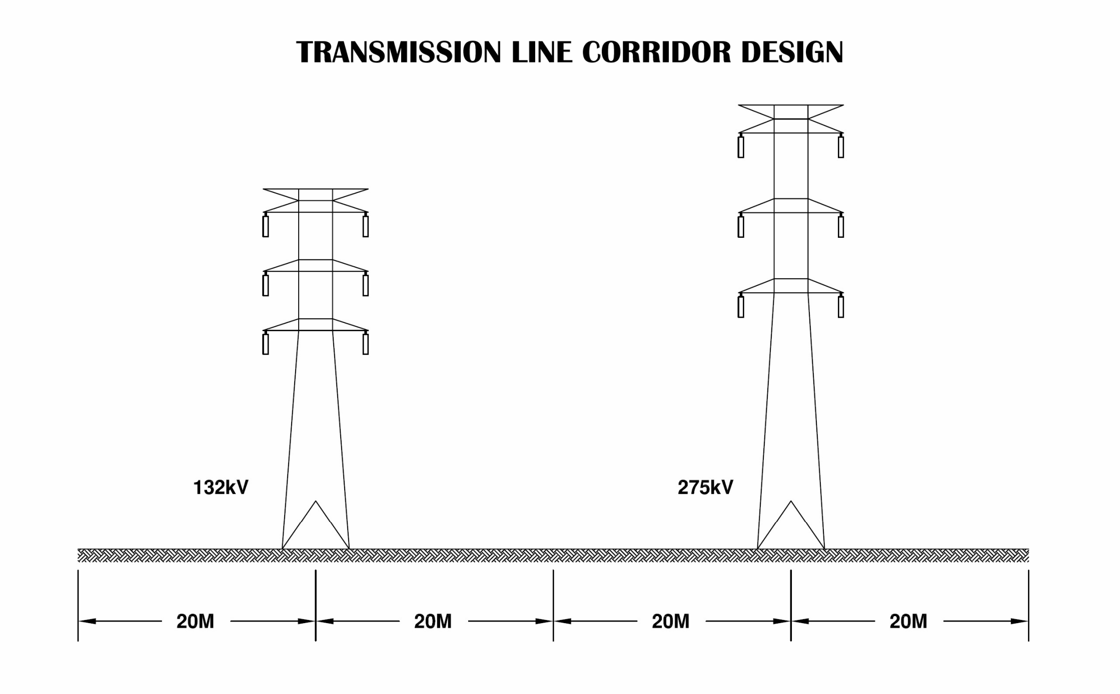


Figure 3.2.1 Transmission Line Corridor Principle

Each line will have separate, non overlapping right-of-way area, meaning that the combined right-of-way for the double corridor between the power house and Kg. Paal will be 80 metres wide (**Figure 3.2.1**).

A sub-station will be required at each end-point where the transmission lines connect to the grid. An area of approximately 15-20 ha at Sipitang and 12-15 ha at Tenom shall be allocated for this purpose. However, the exact land area has not been determined at present.

3.2.9 DRAINAGE SYSTEM

A suitable drainage system for the penstock and powerhouse sites will be constructed to collect surface water and divert it into the tailrace or the Padas River.

The drainage system will mainly comprise ditches, culverts for road crossings, sedimentation ponds, interceptors and energy dissipaters, as well as embedded pipes and main drainage culverts. Tentatively the drainage system will be designed based on the immediate runoff of an hourly precipitation of 100 mm.

3.2.10 ACCESS ROADS

At present, there is no proper access road leading up to the dam site. During the site investigation stage, temporary tracks will be required to provide access for further geotechnical and site investigation works, particularly to the left and right banks of the dam site and along the headrace tunnel. The tracks will be used for transporting drilling and related equipment and technical supervision during that period.

For construction purpose, one or two short temporary connecting roads to the penstock line will also be constructed for access to penstock erection sites and for the construction of anchor blocks and foundation plinths of the penstock.

For permanent access to the dam site, a new road shall be constructed starting from the existing road within the rubber estate located south of Kuala Tomani. The road length is estimated to be 9.0 km; width of 6.0 m and will traverse the east of Padas River. The existing roads within the rubber estates will be upgraded as appropriate for providing permanent access to the dam site. Prior to the excavation of tunnel adit[6] at the midpoint of the headrace tunnel, a temporary access road of 0.5 km length will be constructed to connect to the existing rubber estate roads. The powerhouse is currently accessible by a 3 km long logging road from the bridge at Tomani, along the southern part of Padas River.

3.2.11 INFRASTRUCTURE AND FACILITIES

Areas for construction facilities will be as close to the sites as possible. These include temporary roads and bridges, workshops, batching plants, offices and permanent housing, construction camps and communication systems. The Feasibility Study has assumed that the flat area on the northern part of the proposed powerhouse will be used to accommodate the bulk of the temporary facilities for construction at the powerhouse site which includes; workshops, storage area, crushing and screening plant, stockpile area for aggregates, batching plant, etc. At the dam site itself, these facilities are foreseen to be located upstream of the dam on the right bank.

The number of working staff and the necessary accommodation for workers during the construction period is estimated around 1,500 – 2,500 people. The construction camp at the dam site will house approximately 500 people with the required plot size is estimated around 1.0 hectare.

During operation stage, permanent housing shall also be constructed near the dam site for approximately 10 – 20 people with an area of about 0.3 hectare.

The location of quarries, disposal and borrow areas shall be identified as part of the Geotechnical and Soil Investigation study which is still on-going. Quarry and earthwork activities are subjected to EIA approval from the Environment Protection Department as it is a prescribed activity under the Second Schedule of the Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005:

Item 9: Quarries

(i) Quarrying of aggregates, limestone, silica, quartzite, sandstone, sand, marble or stones or commercial or construction purposed within 3 km of:

- *Any existing settlement, residential, commercial or industrial area, major roads, or any buildings for public purposes or*
- *Any area for which a licence, permit or approval has been granted for development of settlement, residential, commercial or industrial area, major roads, or any buildings for public purposes.*

[6] *Tunnel entrance.*

(ii) Earthwork involving extraction, removal, filling or dumping of earth with a volume of 40,000 cubic metres or more; or

(iii) Excavation or dredging of sand or rock materials from watercourses, streams, rivers, coastal area or sea for commercial or construction purposes.

Hence, upon identification of these areas, separate EIAs shall be prepared and submitted to the Environment Protection Department for approval prior to commencement of quarry activity.

3.3 MANAGEMENT POLICIES FOR IMPLEMENTATION

The following sections describe the policies that will be adopted by the Project Proponent throughout the Project life cycle. Ideally, these policies shall be included in the Environmental Management and Monitoring Program (EMMP) and in all contractual documents with the appointed contractors.

3.3.1 EFFICIENT USE OF ENERGY

The current design level has not yet considered energy production and consumption during the construction stage. This is thus dealt with in the environmental management plan, **Chapter 7**.

3.3.2 PROCUREMENT POLICY

The Project Proponent will implement and impose upon contractors to employ strategies for green and sustainable procurement. Natural resources such as timber, sand, gravel, and rock must be verifiably legal. As stated in the Terms of Reference (TOR), separate EIAs shall be carried out for quarries, earth borrows and earth disposal areas. These EIAs shall be submitted to the Environment Protection Department for approval.

Sourcing of labour shall as far as possible favour local residents but shall otherwise not consider race, religion or similar non-qualifying attributes. Sourcing of labour must strictly follow state policies and regulations concerning the employment of foreign labour.

3.3.3 WASTE AND HAZARDOUS MATERIALS

The policies regarding handling of waste and hazardous materials are defined through federal and state legislation, i.e. Environmental Quality (Scheduled Wastes) Regulations 2005. The Project Proponent will ensure all relevant staff and contractors are aware of this legislation and that remoteness is no excuse for deviation from the regulations. The Project Proponent will also impress upon contractors that they have responsibility for the actions of sub contractors.

In particular, efforts will be made to protect local communities from coming into contact with hazardous materials such as chemical agents or explosives.

3.3.4 BIOMASS REMOVAL

In principle biomass removal shall optimise the use of available resources and technical innovations to the benefit of the environment. The Project Proponent recognises the dangers associated with submerging large amounts of biomass for mainly anaerobic decomposition and the possibility of heavy metals such as mercury being accumulated in the food chain. A guideline on the biomass removal plan and the subsequent reservoir management is described in **Chapter 7** and **Appendix 1-13: Biomass Removall**

3.3.5 LAND ACQUISITION

The present Project area concerning the dam, reservoir and transmission- lines will affect mainly State Land, which may be alienated for such development. The powerhouse and access roads may also include private lands which will require some form of compensation.

The Project Proponent will, where livelihoods are negatively affected, pursue a policy of negotiated land acquisition, where amicable and voluntary terms for the acquisition are mutually agreed with the affected communities or their representatives. The compensation and other terms for the acquisition will ensure a continuum of the communities' livelihoods and social values that are at the same or better level than what is presently available to them.

3.3.6 RELOCATION OF COMMUNITIES

Whenever there is a risk that the Project will endanger the health or livelihoods of individuals, households or communities, optimal solutions for their safety must be sought by mutual agreement giving priority to the people's welfare. When relocation becomes necessary, the Company will ensure livelihoods can be fully re-established at the new site for settlement.

The Project is not expected to require relocation of entire communities. There will be no relocation at the dam, reservoir or powerhouse. The establishment of the transmission- lines may, but is not expected to, require some minor adjustments of individual dwellings in order not to expose the dwellers to health hazards from electromagnetic radiation.

3.3.7 CONSULTATIONS AND DISCLOSURE

The Project Proponent is bound to follow a policy ensuring free, prior and informed consultations take place between the Project Proponent and the communities affected by the Project.

The Equator Principles state:

> *Consultation should be "free" (free of external manipulation, interference or coercion, and intimidation), "prior" (timely disclosure of information) and "informed" (relevant, understandable and accessible information), and apply to the entire project process and not to the early stages of the project alone. The borrower [Project proponent] will tailor its consultation process to the language preferences of the affected communities, their decision-making processes, and the needs of disadvantaged or vulnerable groups. Consultation with Indigenous Peoples must conform to specific and detailed requirements as found in Performance Standard 7. Furthermore,*

the special rights of Indigenous Peoples as recognised by host-country legislation will need to be addressed.

The Project Proponent will follow a policy of transparency and ensure relevant information about the Project, its purpose and progress is made available to the public using most appropriate means of disclosure (media, internet etc). In particular, the Project Proponent will ensure the Special Environmental Impact Assessment for this particular Project is disclosed to the public and in particular to the affected communities and that public views are taken into account.

3.3.8 DECOMMISSIONING

No decommissioning plan has been made as part of the Project design. Decommissioning and abandonment is thus included in the environmental management plan, **Chapter 7**.

3.4 PROJECT OPTIONS

The proposed Project has considered the following options for optimization and finalization:

- Site selection;
- Hydropower generation options;
- Dam layout options;
- Transmission lines Options;
- Alternative Road haulage routes; and
- “No Project” Options.

Except for transmission lines and haulage routes options, the Feasibility Study has looked into the available options mentioned above for its optimisation study.

3.4.1 SITE OPTIONS

Prior to the Feasibility Study, Sabah Electricity Sdn. Bhd. commissioned SWECO International, a Swedish firm to carry out a Pre-feasibility Study of the Hydropower Resources in the Upper Padas River basin. One of the objectives of this Study was to select potential hydropower sites within the Padas River from 4 km below the Telekosang confluence to above the Maligan confluence, and Telekosang River from its confluence with Padas River to above the Binalun confluence and based on power demand, regulation requirement, economic and financial criteria. The potential site evaluation also included the impact on the downstream region of Padas River, in particular at the existing Tenom Pangi Hydropower Plant.

Based on the criteria above, SWECO International has chosen the two most promising sites which are clearly superior to other sites. The two sites are in Sg. Padas and Sg. Telekosang. Further comparison between the two sites showed that a power development at Sg. Padas would be most favourable of the two in respect of power output and economy.

Further to that, SWECO International strongly recommended to pursue investigations and studies for the Padas River and to bring the development to feasibility level.

3.4.2 POWER GENERATION OPTIONS

The use of fuel oil in Sabah power generation is expected to decline in parallel with the Government's emphasis to reduce oil usage in the energy sector under the four-fuel diversification strategy. The decline of oil usage in Sabah's generation mix is expected to be from 47.3% in 2000 to 17.8% in 2020[7].

The hydro potential in Sabah has been studied since 1984. Several mini hydros with capacity of 250 KW to 1 MW have been suggested to replace oil-based plants currently serving as isolated stations. This is also an effort to reduce oil consumption in power generation. Two bigger hydro projects identified for implementation are the Upper Padas Hydroelectric Project and the Liwagu Hydro Project which would be able to produce 1,3000 GWh in total per year. In addition, there is also the possibility of getting power from Bakun Hydro in Sarawak to be injected to the Sabah Grid; the whole Bakun Hydro Scheme is currently being studied by Tenaga Nasional Berhad.

Alternative sources of energy as input to power generation such as photovoltaic and Diesel Battery Hybrid electricity generation systems were already studied and implemented under the Rural Electrification Programme. Currently, there are eight villages benefiting from this programme with power generation rating from 10 kW to 100 kW. Several major generation development plans have been identified for the medium and long term. Generally, these projects concentrated on expanding the Sabah Grid and increasing utilization on hydro resources. Below are the expected changes in the medium to long term time frame:-

- Establishment of a total of 1,050 MW gas-fired plants at Kota Kinabalu to inject power to the Grid System.
- Development of the Liwagu Hydropower (approx. 165 MW) at the centre of Sabah and Upper Padas (150-210 MW) at the southern part of Sabah. In conjunction with this hydro Project, an extra high voltage (EHV) transmission network will also be constructed to link to the East Coast load centres.
- Bakun Hydropower could be extended into Sabah Grid and maintain interconnection with Brunei and Sarawak.
- New diesel generating capacity will continue to be installed at power stations supplying isolated power system, which are not economical to be supplied by the grid.

3.4.3 HYDROPOWER GENERATION OPTIONS

With the Sg. Padas selected as the potential site for hydropower generation, the Feasibility Study was then carried out to establish the potential firm capacity and energy production the Project and its corresponding increases at the existing Tenom Pangi Hydropower Plant.

[7] http://www.aseanenergy.org/energy_sector/electricity/malaysia/sesb/generation_devt_plan.htm

The concept of firm capacity is used to express the minimum capacity that can be generated in a hydropower scheme during a given period of time, at a certain probability. The shortest time used in the Feasibility Study was one week. Using optimisation software operating on hourly basis with weekly basis of output, the probability for firm capacity has been set to 95% which is common in hydropower development. The firm capacity was analysed based on several scenarios, namely:

- Upper Padas with an infinite reservoir
- Upper Padas as a run-of the-river scheme
- Upper Padas as a standalone project
- Upper Padas as an integrated project in future generation system

3.4.3.1 UPPER PADAS WITH AN INFINITE RESERVOIR

The maximum discharge capacity of the Project would be 70.0 m^3/s or 42.3 Mm^3 per week. The weekly average inflow of water to the Upper Padas Reservoir is 75.1 m^3/s (45.4 Mm^3) which means that the Project with an infinite reservoir would be able to generate the full capacity at all times, i.e.:

- Firm capacity: 150 MW
- Average energy: 1314 GWh/year
- Max energy: 1314 GWh/year
- Min energy: 1314 GWh/year

The Feasibility Study has indicated the values above are hypothetical case, but sets the upper physical limits of the Project.

3.4.3.2 UPPER PADAS WITHOUT RESERVOIR

Hydroelectric generation can also work without reservoir, in a process known as diversion or run-of-the-river. Portions of the water from fast flowing rivers can be diverted through a penstock to a turbine set in the river or off to the side. Another run-of-the-river design uses a traditional water wheel on a floating platform to capture kinetic force of the moving river. While this approach is inexpensive and easy to implement, it does not produce as much power as shown in the values below:

- Firm capacity: 34 MW
- Average energy: 985 GWh/year
- Max energy: 1200 GWh/year
- Min energy: 712 GWh/year

3.4.3.3 UPPER PADAS AS A STAND ALONE PROJECT

The Project was also studied as a stand-alone project with the following important consequences:

- The efficiency of the Project cannot be optimized since the head (reservoir level) cannot be increased by generation in the alternative plants.

- Even though the generation is optimized, the market for the generated energy is unknown.

The second item above is of great importance for the analysis and understanding of the generation system in Sabah. The Feasibility Study projected a load situation for 2005 (initial plan to commission the Upper Padas Hydroelectric Project) as an example.

The study forecasted the yearly peak load for 2005 was 534 MW (actual yearly peak load is 572 MW). Based on the Feasibility Study assessment, it is evident that the full capacity of the Project scheme cannot be utilized during long periods of the year and water must thus be spilled. Should the output from the scheme be optimized as a stand-alone Project in a system with infinite load, the weekly output will be as shown below:

- Firm capacity: 57.8 MW
- Average energy: 1188 GWh/year
- Max energy: 1310 GWh/year
- Min energy: 816 GWh/year

3.4.3.4 UPPER PADAS AS A SYSTEM COMPONENT

The Feasibility Study also looked into a more realistic approach of the Project as an integrated unit in the generation system. The individual firm capacities are in this study of lesser importance, with emphasis given on the total system firm capacity, and in this study, how much the system's firm capacity will increase as a result of the commissioning of the Upper Padas Hydroelectric Project. The calculations were carried out in the following three steps:

- Using the load demand forecast, the exact peak load when the existing and committed generation system cannot fulfil the design criteria is established. This simulation will give the first breakpoint P1 for the firm capacity.
- The Upper Padas Hydroelectric Project is added to the generation system and the system is simulated with increasing load until the design criteria once again are violated. This simulation will give the second breakpoint P2 for the firm capacity.
- The firm capacity of the Upper Padas Hydroelectric Project can then be calculated as: Pfirm = P2 – P1

The corresponding energy production values are presented below:

- Firm capacity: 115 MW
- Average energy: 1188 GWh/year
- Max energy: 1310 GWh/year
- Min energy: 816 GWh/year

3.4.3.5 SUMMARY OF OPTIONS FOR ENERGY SIMULATIONS

Table 3.4-1 below summarizes the different calculations that have been made in the above sections.

Table 3.4-1 Summary of Energy Simulation

Case	Firm Capacity (MW)	Average Energy (GWh/year)	Maximum Energy (GWh/year)	Minimum Energy (GWh/year)
1. Infinite Reservoir	150	1314	1314	1314
2. No Reservoir	34.0	985	1200	712
3. Upper Padas optimized as an isolated Project	57.8	1188	1310	816
4. System Benefit	115.0	1096	1252	791

The first two cases set the boundaries of what can be achieved with a 150 MW installation at the Upper Padas Reservoir. The opposite of an infinite reservoir is to operate the Project as a run-of-the-river Project and to use the dam to increase the head. The firm capacity of this Project would in this case decrease drastically as the runoff fluctuates heavily and there are several dry sequences in the hydrological series. A comparison of Case 2 and Case 3 shows benefit of the storage capacity of the reservoir, with increase of 23.8 MW in firm capacity.

Case 4 presents the results from a system approach of hydropower simulations and shows how much the firm capacity of the integrated generation system is increased after the commissioning of the Upper Padas Hydroelectric Project. As seen in **Table 3.4-1**, the system benefit in Case 4 is almost doubled compared to Case 3.

3.4.4 DAM LAYOUT OPTIONS

3.4.4.1 DAM AND SPILLWAY

The Feasibility Study has analysed three different options for the dam and spillway arrangements, as follows:

- Dam Alternative 1: Concrete Faced Rockfill Dam with two spillway chutes located at each of the dam abutments.
- Dam Alternative 2: Roller Compacted Concrete Dam with the spillway integrated in the central part of the dam body.
- Dam Alternative 3: Arch-dam with the spillway at the dam crest integrated in the central part of the dam body.

In the pre-Feasibility report from October 1990 as well as in the Interim Reports, a Concrete Faced Rockfill Dam was proposed as the main alternative and the appropriate dam layout. However, since then technical design as well as the construction methods for the Roller Compacted Concrete dams has developed rapidly, and today Roller Compacted Concrete dams have become more viable compared to other dam types. For the final selection of dam type, a cost comparison for the Concrete Faced Rockfill Dam and Roller Compacted Concrete dam has been performed in the Feasibility Study. Based on the comparison, it is obvious that the Roller Compacted Concrete dam is the most favourable. A Roller Compacted Concrete dam has also other advantages:

- The dam type is superior to a rockfill dam in case overtopping of the dam crest if extreme floods should occur.
- The construction time is shorter and less attention needs to be considered concerning wet periods.
- Better to withstand earthquake displacements.
- The spillway can be incorporated into the dam body and will consequently need less construction work.
- Using Roller Compacted Concrete facilitates the construction of a small hydro unit installed in the dam body. The minimum discharge from the reservoir for environmental reasons then can be used for power generation.

3.4.5 TRANSMISSION LINES ROUTE OPTIONS

Basically, the selection of line is mainly based on consideration of its effect on land parcels, terrain and development of the surrounding area and ensuring the minimal impact on environment as well as weighing the technical and engineering requirements.

There shall also be consideration to balance between construction requirement, risk in design and completion time to match that of the Upper Padas Hydroelectric Project powerhouse.

The engineering consultant, Upper Padas Hydropower Consultants has recommended that power from the Upper Padas Hydroelectric Project shall be evacuated via transmission lines to be connected to the Sabah Electricity Sdn. Bhd. Grid at the following injection points:

- At Tenom via a 132 kV double circuit line, and
- At Sipitang via a 275 kV double circuit line.

During the submission of TOR, the Proponent and their engineering consultant, UPHC initially proposed three alignment options for the transmission lines to Sipitang and one option to Tenom without indicating where the new substations shall be located. However, in November 2009, UPHC has come out with an approximate alignment for Sipitang and Tenom. Still in its planning stage, the alignment was configured based on the wayleave consideration which is the first stage as mentioned in the following paragraph.

There are three stages involved in determining the exact locations for new substations and routes of the transmission lines:

- Wayleave issues, including land matters, compensation, etc. and any special permitting that may be necessary.
- Engineering requirements based on sound engineering judgement. This embraces the technology/economic aspects of line routing and substation locations, including considerations related to topography and ground conditions and provisions for access during operation and maintenance stage.
- Environmental impacts.

Like highways and roads, electric power transmission lines are linear facilities that will affect natural and socio-cultural resources. Long transmission lines are to be avoided as it can have regional effects. The other reason to selecting the shortest route is to minimize power loss in the transmission.

The proposed route alignment will require further finalization with the aim to minimize the potential contact with people and their property. The most significant property considerations were houses and built-up areas. Hence, the proposed route should traverse into areas with the least number of landowners. Selection of the route alignment of the transmission line should avoid densely populated areas, developed areas and potential prime lands. This is to reduce cost for compensation payment and avoid affecting future land use.

The key environmental criteria generally include matters such as pollution, reduction in biodiversity due to habitat removal, safety, aesthetics and social acceptability. Wherever possible, the route alignment of the transmission line will traverse the least number of critical obstacles, i.e. major rivers, road crossings, mountainous terrain, forests and least wayleave obstruction, besides safety issues such as critical flight path for aircrafts and avoidance of populated and residential areas.

3.4.6 ALTERNATIVE HAULAGE ROUTES AND JETTIES

At present, there is no access to the dam site and there is no direct linkage between the powerhouse and the dam site. The nearest access to the powerhouse would be via Jalan Tomani-Tenom up to Kuala Tomani which lies along the southern side of the upper Sg. Padas.

There are two options for regional access to Jalan Tomani-Tenom:

- Kota Kinabalu-Sipitang-Tenom Highway - traverses across mountainous areas and steep gradients with climbing lanes provided. The Sipitang-Tenom section is frequented by logging trucks transporting logs to the Sabah Forest Industries pulp and paper mill. Total length is approximately 200 km.
- Kota Kinabalu-Keningau-Tenom Highway – there are two options for the Kota Kinabalu-Keningau route; (i) Kota Kinabalu-Tambunan-Keningau; and (ii) Kota Kinabalu-Kimanis-Keningau route which is a shorter route albeit having more mountainous areas and steeper gradients than the former route. The Keningau-Tenom route traverses across undulating terrains. The total length is approximately 150 km.

In terms of transportation of construction materials and equipments, the shorter route is usually preferred, i.e. the Kota Kinabalu-Keningau-Tenom route. Furthermore based on the Public Works Department (JKR) Traffic Census (See **Map 4.3- 3 State Trunk Road Network and JKR Traffic Census Stations**) the recorded traffic volume at the existing stations along this route is lower than the volume recorded at the Beaufort-Sindumin station which is located along the Kota Kinabalu-Sipitang route.

Another route option that can be considered is the Kota Kinabalu-Tenom Railway which is under the management of Sabah State Railway (SSR). The railway consists of a single 134 km line from Tanjung Aru, near Kota Kinabalu, to the town of Tenom. Operating speeds on the line are low, due to the nature of the terrain and the use of relatively low powered equipment. Passenger and freight services take 4 hours to complete a journey from Tanjung Aru to Tenom, allowing for stops on the way. However, the line can be hazardous, with mudslides in rainy weather a real threat which can lead to the service being disrupted or suspended for brief periods.

The train service has not been in operation since 2007, due to the short and medium term works on the railway to ensure continued operation, improve operational safety and to modernise the system. This included rehabilitating the track and signalling and also overhaul of the rolling stock in order to ensure continuation of service.

Sea transportation can also be considered to transport materials and equipment from Kota Kinabalu to Sipitang as there is a jetty within the Sabah Forest Industries area. However, this is a private owned jetty and the port facility is only used for shipment of the Company's products as well as for the delivery of chemicals and other necessities for their mill.

3.4.7 NO PROJECT OPTION

The "No Project" option would mean that the proposed Project will not be implemented at the designated area, thus would deprive Sabah of electricity supply to cater for the growing demand. Should this option be taken into consideration, the immediate party that would be suffering the most in terms of financial loss and also loss in time and effort is the Project Proponent, Sabah Electricity Sdn. Bhd. for having conducted various studies since back in 1994.

As mentioned in **Section 1.3, Statement of Need**, the proposed Project complements the transmission network to link up with the south and south-eastern parts of the State, and hence improving the state-wide transmission system. It would therefore be considered a substantial loss to Sabah's need for more reliable and clean electricity supply to cater for the ever-growing need of electrical power by the industrial sector as well as the general daily consumers, business and commercial owners and retailers.

3.4.7.1 ENERGY PRODUCTION BENEFIT

Based on the preferred hydropower generation option Case 4, the total firm system capacity due to implementation of the Upper Padas Hydroelectric Project was estimated at 115 MW, including the increase at Tenom Pangi Hydroelectric Plant. The characteristic of Tenom Pangi Hydro is shown in the following section.

3.4.7.2 TENOM PANGI HYDRO

- Year commissioned: 1984
- Catchment area: 7,715 km^2
- Type of scheme: Run-of-river
- Headworks: Weir and intake (crest elevation 174 m)
- Silt control works: trash boom, strainer and sand separator
- Gross generating head: 74 m

- Power tunnel: 5 km long
- Length of river channel between the weir and the power station (i.e. bypassed): 5 km
- Installed generating capacity: 66 MW (3 x 22 MW)

It is notable that, the Sg. Padas flooded as the result of heavy rains throughout September 1988 (250 mm of rain was recorded for the month) causing damage to the water intake gate and other facilities (trash protection, vertical gates, etc). It subsequently underwent a rehabilitation programme, but problems remain in managing siltation and debris. The following prospective beneficial effects of Upper Padas on Tenom Pangi are noteworthy:

- Additional hydro output (kWh) would be achieved by the river regulating effect of Upper Padas dam (i.e. reduced spill at Tenom Pangi).
- Hydro generation down-time due to debris and sediment blocking would be reduced slightly.
- The magnitude of the sediment problems affecting Tenom Pangi will be reduced slightly by the sediment capture occurring in the Upper Padas reservoir (i.e. this has a positive effect on the ease-of-operation at Tenom Pangi).

Based on the simulations in Case 4, the energy production attributed to the Upper Padas Hydroelectric Project will be as shown in **Table 3.4-2**.

Table 3.4-2 Energy Production

	UPHEP (GWh/year)	TPHP (GWh/year)	Total (GWh/year)
Average Energy	1,096	22	1,118
Maximum Energy	1,252	5	1,257
Minimum Energy	791	25	816

The benefits in terms of power generation have been studied in the Feasibility Study. The benefits are assumed to consist of the firm system capacity of the Upper Padas Hydroelectric Project and the increased firm system capacity of Tenom Pangi Hydropower Plant together with the energy generation from the Project.

The Upper Padas Hydroelectric Project is located upstream of the existing Tenom Pangi Hydroelectric Plant and will regulate some of the inflow to the Tenom Pangi Hydroelectric Project. The regulation will increase the energy generation and the firm capacity at Tenom Pangi Hydroelectric Project and since the increase is a direct result of the regulation capacity of the Upper Padas Hydroelectric Project, these values shall be added to values of the Upper Padas Hydroelectric Project.

3.5 PROJECT ACTIVITIES

There are four (4) main activities to the UPHEP, i.e. pre-construction or site preparation; construction; operation or maintenance and abandonment.

3.5.1 PRE-CONSTRUCTION ACTIVITIES / SITE PREPARATION

Pre-construction includes geological and other site investigation surveys: topographical surveys, environmental and engineering studies. Subsequently this is followed by the mobilisation stage of the Project, which includes construction of infrastructure, arranging human resources, procuring construction equipment and materials, construction of access roads, establishment of quarries, batching plants, borrow areas and land acquisition. **Table 3.5-1** lists major investigation and preparation activities.

Table 3.5-1 Preparation and Investigation Activities

Investigation and Preparation Stage: Dam and Power house
- Invasive site investigations: Geology
- Disclosure and communication
- Land Use Planning (Catchment area management, Right of Way)
- Resettlement
- Land acquisition
- Temporary access
Investigation and Preparation Stage: Transmission-line
- Selection of options
- Topographic, geological and soil investigations
- Disclosure and communication

3.5.2 CONSTRUCTION ACTIVITIES

The following sections describe work methodologies during the construction stage which includes access roads, dam construction and associated infrastructure (power station, transmission lines, etc). It also includes impoundment of the reservoir upon completion of dam construction.

The Project will comprise work on a number of different work sites, which can proceed independently of each other. In principle, the sequence of activities would be as follows:

- Construction of access roads (temporary and permanent roads);
- Construction of diversion tunnel, abutment excavation and aggregate stockpiling;
- River closure after approximately 9 months;
- River channel and foundation works until end of second year;
- Construction of a RCC dam to spillway sill elevation during the third year;
- Completion of dam and hydromechanical installations during the first half of the fourth year;
- Construction of transmission lines;
- Filling of the reservoir in the middle of fourth year;
- Testing and commissioning; and
- Decommissioning of site infrastructures.

Due to its easier accessibility, the construction of the main powerhouse can proceed independently. The basic construction criteria such as construction works proceeding continuously without interruptions and the design and manufacture of the electromechanical equipment to be finalised on time can thus be achieved to ensure timely completion and a short construction time.

Still in its planning stage, the final locations for the alignments of transmission lines and the location of substations would be in accordance to several factors such as:

- Wayleave issues, including land matters, compensation, etc. and any special permissions that may be necessary.
- Engineering requirements concerning the technology/economic aspects of line routing and substation locations, including considerations related to topography and ground conditions and provisions for access during operation and maintenance stage.
- Environmental impacts.

There shall also be consideration to balance between construction requirement, risk in design and completion time to match that of the Upper Padas Hydroelectric Project powerhouse.

3.5.3 CONSTRUCTION METHODOLOGY

The following section describes the construction works of the main components. The methodology is tentative and may be refined at later stages at the commencement of the construction.

3.5.3.1 DIVERSION ARRANGEMENT

A final decision has not yet been made as to whether there will be a need for diversion arrangements or whether the dam can be built ‘on the river’. In such case, there will be no need for diversion tunnels or for coffer dams.

However, for the most likely method of constructing the dam and appurtenant works in the river bed, the river flows will need to be diverted away from the work area. In planning and designing diversion arrangement/works, the following construction activities shall be adopted:

- One diversion tunnel with a final cross sectional area of 115 m^2 and a concrete lining of 500 mm. The tunnel is situated on the left bank and will have a length of approximately 650 m.
- Inlet and outlet for the tunnel with provision for a gate at the inlet for plugging the tunnel after completion of the works.
- Upstream cofferdam with a crest elevation of 395 m asl.
- Downstream cofferdam with crest elevation of 375 m asl.

The excavation of the diversion tunnel, its lining and construction of inlet and outlet will be started immediately after gaining access to the site. The abutment excavation for the foundation of the dam shall commence approaching the finalisation of the diversion tunnel. Following the completion of the diversion tunnel, the two cofferdams shall be constructed and thereafter the river flow will be diverted into the tunnel. It will then be possible to excavate the river channel and perform the required foundation works and start the construction of the dam structure. Upon completion of the dam and spillway, the inlet gates of the diversion tunnel will be lowered, the tunnel will be plugged and the cofferdams may be removed.

The excavation of the diversion tunnel will produce about 90,000-100,000 m^3 soil and rock material calculated in its natural, solid stage. There are currently no decisions as to where to deposit this material.

3.5.3.2 DAM, SPILLWAY AND INTAKE STRUCTURE

Due to the time of transport between the powerhouse and dam site, a batching plant will be required at the dam site itself. In order to allow the dam construction to proceed smoothly, at least 3 months requirement of aggregates is needed to be stockpiled on site. Construction materials will most likely be transported from Kota Kinabalu via land transport.

Excavations will be carried out to achieve suitable foundation rock for the dam, plunge pool and abutment. Following that, dam foundation works and the permanent foundation slab of reinforced concrete for the dam will be carried out followed by construction of the Roller Compacted Concrete.

The body of the dam will be constructed as a single unit in layers of around 0.3 m in thickness. Movement joints may be established by driving metal sheets into the last placed layer. The joints will traverse the dam body at spacing of around 20-25 m to accommodate spillway gate installations. The drainage and inspection galleries incorporated in the dam structure will be constructed using prefabricated concrete elements to facilitate the rapid erection during the continuous placement of Roller Compacted Concrete.

Construction focus is on completion without any unnecessary delays. Possibly the main dam body can be completed in approximately one year after the placement of Roller Compacted Concrete.

The reinforced concrete works for the main spillway chutes and the lower parts of the piers will be completed approximately 4-5 months after finalisation of the Roller Compacted Concrete placing.

Based on the earlier Feasibility Study, during the middle of the fourth year of construction, the river will be passed over the spillways and the remaining spillway radial gate installation could be performed with one gate at a time, behind stop logs or maintenance gate.

Adjacent to the intake structure at the eastern dam abutment, a steel penstock structure for the secondary power station will be constructed. The penstock and power station with outlet channel will be constructed of conventional concrete with the foundation at the rock slope before the Roller Compacted Concrete construction reached this level.

3.5.3.3 DIVERSION TUNNEL AND HEADRACE TUNNEL

The excavation for diversion tunnel is planned from both ends, enabling a two face approach. Due to the size of the tunnel, it is foreseen that the heading and benching method will be adopted. The upper half portion will be drilled and blasted full face in the first stage. In the second stage, the lower half portion will also be drilled and blasted.

The headrace tunnel will have four fronts since an adit[8] is proposed to be constructed approximately midway of the tunnel. The excavated cross section of the tunnel will be approximately 30 m^2 and thus is suited for full face driving with a multi-drill Jumbo machine. The full section will be excavated in single pulls of 2-4 m depending on geological conditions.

The excavation works of the headrace tunnel is planned to be completed over a period of two years. Surplus rock from the headrace tunnel together with excavated materials from the dam site will be placed on a spoil dump which shall be identified during the soil and geotechnical investigation works. Suitable levels and foundations for temporary facilities such as stock piles for aggregates, crushing and screening plant, batching plant, offices, stores, workshops, etc. will be set-up as the work progresses.

For rock strengthening, roof stabilisation will be carried out. Mucking will be by wheel loader into dump trucks. Suitable machines will perform rock bolting, grouting, rib and arch work, shotcreting and floor trimming as necessary.

Ventilation in the tunnels will be forced induction, using flexible ductings and electrically powered axial fans, which shall be mounted immediately outside the adit portals. Booster fans will be placed at suitable required intervals along the tunnel sections to relieve congestion.

Concrete lining will be carried out using steel panelled collapsible formwork with 5-6 m length and carried forward on carriers mounted either on rails or on dump truck chassis. The lining is assumed to have a minimum thickness of 0.5 m for diversion tunnel and 0.25 m for the headrace tunnel.

3.5.3.4 SURGE SHAFT

The proposed surge shaft will have an upper part with a final diameter of 30 m for high surge levels and a surge gallery in the lower part for downward surges. The upper and lower parts will be connected through a 14-m diameter shaft. The upper part of the surge shaft will be excavated in the weathered surface rock layer and lined with concrete. The top of the shaft will be at ground level.

The intermediate part of the surge shaft is proposed to be excavated by raise boring and stoping (performed from a drilling platform), thereafter precise profile drilling for the final diameter. The shaft is proposed to be lined with concrete using a steel shutter and employing the slipform method.

[8] *Tunnel entrance*

3.5.3.5 PENSTOCK

The uppermost part of the penstock, downstream of the surge shaft will be a continuation of the headrace tunnel for approximately 190 m until it reaches the ground surface. The diameter of the penstock along this part will be around 5.0 m.

Where the penstock reaches the open, it will bend and follow the natural hillside for a length of some 720 m down the power station site. Some 90 m of the lower part of the penstock will be buried deep down in the weathered rock and fixed with concrete and thus forming and anchor block. The manifold part of the penstock upstream of the power house will be horizontal.

The excavated trench for the penstock will have slopes 1V:2H in the overburden soil and 1V:1H in the weathered rock layer. The trench will be excavated in a straight line, thus giving different depths between 2-8 m, in order not to increase the number of extra anchor blocks due to forces from penstock bends. The weathered rock walls in the trench will be strengthened by sprayed concrete with steel fibres. As the excavation of the penstock trench proceeds, the concrete foundations for the penstock will be constructed. The penstock pipes will be fabricated in a workshop and transported to the construction area in sections to be welded together at the site and the erection of concrete supports around it will be made using appropriate construction methods.

Along the penstock, a drainage gutter will be constructed, which at the anchor blocks will be cut off and the drainage water diverted to drainage canals constructed along the approach road for the construction works of anchor blocks.

3.5.3.6 COFFER DAMS FOR THE MAIN DAM SITE

At the time of this assessment, no final decision or design has been made concerning coffer dams and thereby diversion for the main dam construction site.

A decision may be taken to build the dam ‘on the river’, i.e. having the river passing through the construction site during construction. It is, however, more likely that diversion tunnels will be made and the river diverted through these tunnels by a coffer dam between the dam site and the tunnel entry. Such cofferdam is likely to be a simple earth and rock dam of about 35 metres height but could also be a small RCC dam.

To avoid back-flow from the outlet of the tunnels, a smaller cofferdam will be necessary between the construction site and the outlet.

The upstream cofferdam will just be left in the reservoir when this gets inundated while the downstream cofferdam may be removed.

3.5.3.7 POWER HOUSE

Upon mobilisation of machineries and construction materials, common excavation and rock excavation (drill and blast) for the power house will be performed. Deep excavation of the power house adjacent to the steep southern slopes of the river channel will require temporary rock support of the slopes. Tentatively, the walls will be strengthened by sprayed concrete with steel fibres in addition to extensive rock bolting.

On the upstream side of the power house, the deposit area for the rock from excavation of the penstock trench and power house will form a cofferdam with crest level of 230 m asl, and thus a relatively dry working area for the construction of power house. At the downstream part, no cofferdam is required since most of the excavation of the tailrace canal can be carried out in dry conditions behind the upstream cofferdam.

Ideally, a batching and mixing plant will be placed near the power house to allow for direct pumping or crane transport of the concrete to the place of casting. The concreting of the power house sub-structure is estimated to be virtually completed in less than two years after commencement. Blockouts will be left for generating units, drafts tubes and other parts which will be gradually filled with concrete as this equipment is installed. The concreting of the super-structure will thereafter commence and first priority will be the columns for the Electric Overhead Travelling (EOT) crane. The next priority will be the installation of the roof of the power house and auxiliaries units. The gates and hoists include intake spillway gates, trash racks, intake gates, draft tube gates and valves. It is anticipated that the gates and hoists will be fabricated in the workshops and thereafter brought to the site. All gates and hoists will be erected before testing of the first power house unit.

3.5.3.8 TAILRACE CANAL

The tailrace canal will bend slightly to the north and cut through a smaller waterfall with an estimated head of 2-3 m just before joining the main river channel. The tailrace canal will mainly be excavated in weathered rock. The excavated slopes are assumed at 1V:1H. Those parts of the canal which are excavated in overburden soil will have a slope of 1V:2H.

The excavation depth for the tailrace canal is assumed to be 6-10 m except for the part just downstream of the draft tubes where the excavation depths will be up to 20-25 m since the bottom of the draft tubes and the canal is assumed to be with a bottom inclination of 1V:10H.

It is essential to commence the excavation of the upper part of the tailrace canal as soon as possible in order to establish an access to the foundation of the power house.

3.5.3.9 SWITCHYARD

Levelling of the terrace for the substation will be carried out using machineries. The excavation for the foundations of various structures and ducts is anticipated to be done manually. For concreting of the foundations and ducts, it is foreseen that the same batching plant for the power house will be used due to its close proximity. As an alternative, portable concrete mixers may also be used. The mixers would be placed near the work site and aggregates and cement would be brought there.

3.5.3.10 LANDSCAPING

The large excavation works will represent changes in the present topography and in order to avoid landslides and washing out of slopes during wet season, landscaping works will be carried out concurrently during construction stage.

3.5.3.11 CONSTRUCTION OF TRANSMISSION LINES

The construction and operation of the proposed transmission lines will involve a series of activities. The site development will be staged as follows:

Pre-construction

- Procurement of Right-of-Way.
- Activities involved include cutting through vegetation to provide line of sight, site investigation which may require some drilling and digging of the topsoil and construction of camp / workers quarters areas.

Construction

- Temporary occupation – Construction of temporary buildings, water supply, solid waste disposal and temporary sewage disposal.
- Site stripping – Demolition and removal of structures and vegetations along the Right-of-Way.
- Earthworks – Construction of access roads, transporting soil and waste.
- Transmission Tower Erection – General operating equipment, i.e. piling, excavators and cranes will be needed.
- Cables – Transporting, laying and stringing of the cables.

Operation and Maintenance

- Consequential activities including clearing of swathe, horticulture and occasional line repair and maintenance. After construction, the ownership and maintenance of the transmission line will be handed over to the Sabah Electricity Sdn. Bhd.

For ease of reference, the main activities involved in the development of the Project and the relevant sub-activities that would take place are outlined in **Table 3.5-2** below.

Table 3.5-2 Project Activities of Transmission Line Construction

Project Activity	Description
Preliminary Planning Stage	
Identification of Route Alignment	Ground survey, identification of land owners, serving of notices and negotiation of compensation.
Transmission Tower Design	Preparation of tower design details – foundation footings and legs, lattice steel legs and body and lattice cross arms for phase conductors and earth wires.
Procurement of Accessories	Procurement of equipment and materials for foundation towers, cables, etc.

Project Activity	Description
Site Preparation	
Survey and Soil Investigation	Topographical survey of route to mark out the Right-of-Way.
	Soil investigation along Right-of-Way to assess foundation needs for the construction of towers.
Clearing of ROW	Clearing of vegetation and building or structures along the corridor of the Right-of-Way.
	Demolish and removal of structures directly affected.
Construction & Installation	
Foundation work	Pre-cast concrete cylinder pile foundation to be employed.
	In mangrove areas, tower islands will be constructed. Ground level at tower areas will be raised using fill materials from cut activity along the ROW.
Tower erection	Galvanised steel tower legs are embedded into piled concrete foundations.
	Section method and helicopter erection will be used, depending on terrain, sensitivity and accessibility of site.
Stringing work	Cables (275 kV and 132 kV) are strung across the towers.
Transportation	Most machinery, equipment and construction materials will be transported by trucks to the ROW. From here, the materials will be delivered to the ROW by hoist from the main access or by helicopter chute.
Solid and scheduled wastes	Disposal of scheduled wastes such as engine oils. Other wastes include pile and concrete material, aluminium conductor and multicore cable and wastages during assembly of the power transformers. The disposal of these materials should be carried out regularly depending on the amount generated.
Clean-up	Removal of work materials and equipment from work sites along ROW.

3.5.4 OPERATION/MAINTENANCE ACTIVITY

The Project will be operated by the Proponent with an estimated up to 40 people to be employed to operate and maintain the dam and powerhouse structures.

After construction, the ownership and maintenance of the transmission line will be handed over to the Proponent. Subsequent activities will include clearing of swathe, horticulture and occasional line repair and maintenance.

Operation activities include

- Information activities.
- Spillway operation, i.e. management of water level in the reservoir
- Release of water through the turbines
- Monitoring and reporting activities.

Maintenance activities include:

- Catchment management for protection against sedimentation.
- Clearing of the reservoir of debris.
- Right-of-way maintenance to avoid vegetation or structures to reach the transmission lines.
- Inspection and repair of dam, powerhouse and associated facilities to ensure technical integrity.
- Transmission line inspection and repair to ensure technical integrity.
- Operation of offices and other support facilities.

3.5.5 DECOMMISSIONING OF SITE INSTALLATIONS

During this stage, temporary structures such as batching plants, construction camps, stockpile areas and other construction related structures will be removed. Hence proper management shall be proposed to ensure proper rehabilitation on these areas.

CHAPTER 4 EXISTING ENVIRONMENT

4.1 INTRODUCTION

This section describes the Project location and potential Project impact areas. The impact area of this Project may be divided into three distinct main parts: The Catchment area and river above the dam; and the transmission line right of way. To this may be added general regional or state issues and some specific issues pertaining to river water quality and civil works sites. The study area has therefore been divided into six zones:

Zone 1: Sabah and the region

Zone 2: Catchment area

Zone 3: Construction sites for dam, powerhouse and penstock

Zone 4: Reservoir area for the reservoir

Zone 5: Transmission-line ‘Right of Way’

Zone 6: The Padas, Maligan Ketanum and Mengalong rivers

With the exception of parts of the transmission- lines and transport corridors, the impact area is all within the Padas river Basin as may be seen in **Figure 4.1.1**.

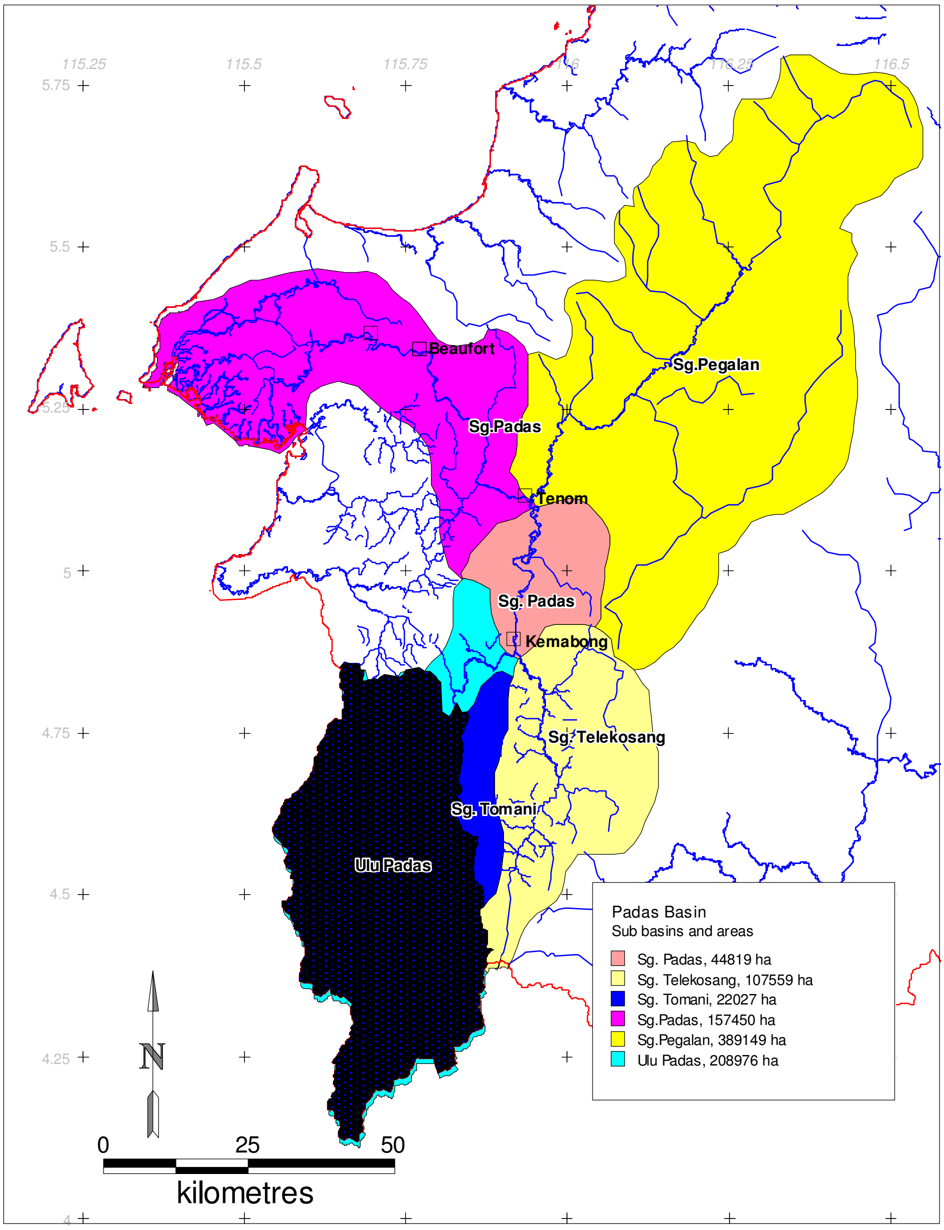


Figure 4.1.1 The Padas Basin and Sub-Catchments. Reservoir Catchment Hatched

In principle, the study area extends 5 km to all sites from Project installations as seen in **Figure 4.1.2**.

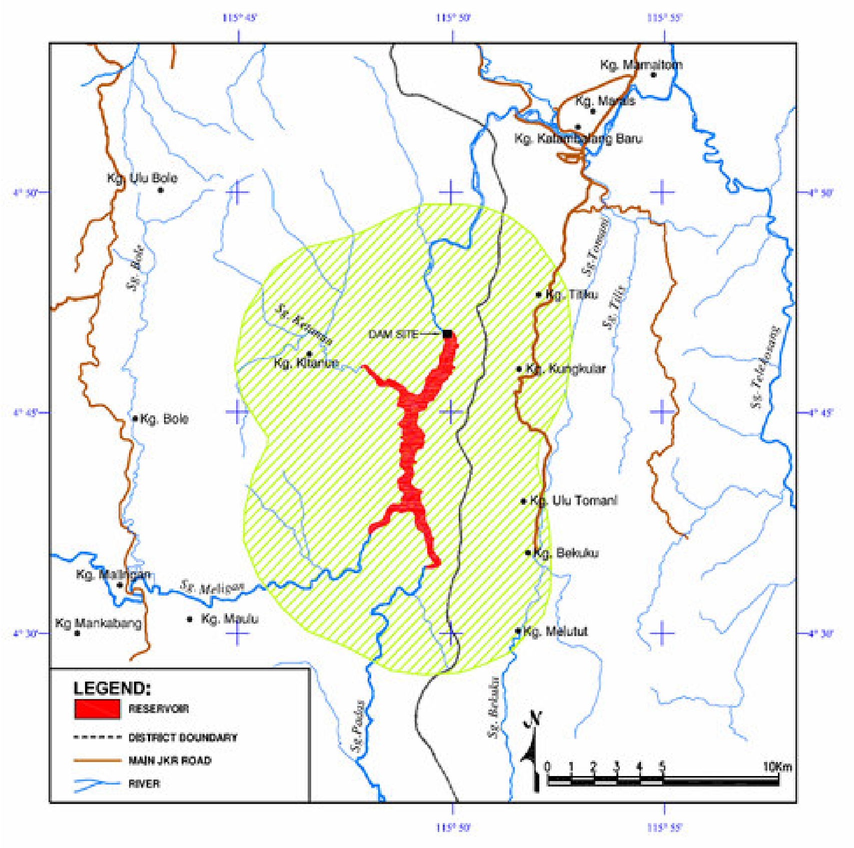


Figure 4.1.2 Study Area for the Dam and Reservoir Sites

However, the eastern side with the villages Titiku, Kungkular, Kekuku, Ulu Tomani and Melutut are sheltered from any impacts by a mountain ridge and has thus been excluded.

Demographic and socio economic issues are included in **Chapter 6**. This includes issues pertaining to the transmission-line alignment, issues related to the two enclaves of human settlements on state land: Kampong Bole and Kampong Melingan to the west of the proposed reservoir and Long Mio and Long Pasia to the south (See **Figure 4.3.9**) and issues pertaining to the management implication for the Sabah Forest Industries (SFI), whose concession cover most of the catchment area.

The present assessment does not cover engineering aspects of the Project, i.e. specific geotechnical surveys or specific hydrographic modelling useful for dam and reservoir planning.

The Project Proponent has appointed Jurukur Sabah to carry out topographical survey works to supplement the existing survey work done previously during the Feasibility Study stage at the dam, surge chamber, penstock and powerhouse sites. Jurukur Sabah has also been commissioned to carry out new survey works along the proposed access track (which is intended to become part of the permanent access road to the dam site) and corridor patch surveys at areas of low rock head along the proposed alignment of the headrace tunnel. In addition, hydrographic surveys have been carried out over reaches of the Padas River at the dam and powerhouse sites. These comprise plans and river cross sections. The survey works were completed during mid 2009.

No detailed topographical survey has been carried out for the transmission- lines as alignment has not been finalized yet during the preparation of this SEIA report.

4.2 THE PADAS RIVER BASIN

The Padas River. The Padas River rises near the border with Indonesia and Sarawak at an altitude of about +1,600 m. From the watershed, it flows in a northerly direction. The area is mountainous, heavily folded and intersected by numerous rivers and brooks. The mountain ranges on both sides of the river rise to about +2,000 m. The river plunges over a series of rapids between steep-sided hills and occasionally interrupted by flood plains. See overall Padas River System in **Figure 4.2.1**.

The tributaries joining the Padas River are equally rapid and flow over boulder races and waterfalls and between precipitous rocky banks and slippery shale slopes. The main tributary to the Upper Padas River is the Maligan River.

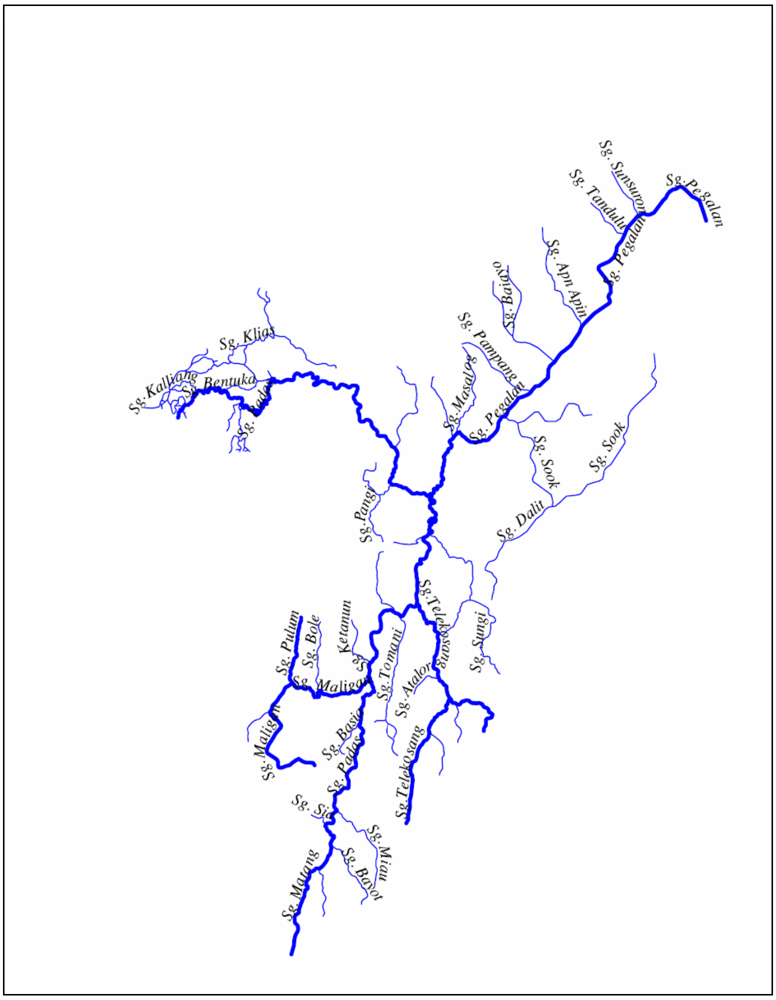


Figure 4.2.1 Padas River System

About 1,250 km^2 of the Padas drainage area are situated at an altitude above + 1,200 m asl with several mountain ranges with ridge altitudes between +1,500 m asl to +2,000 m asl. From the confluence of Maligan and Padas Rivers, the river then falls 50 m over a distance of 8.7 km. The river flows between banks of alluvium forming flood plains 100 to 300 m wide. The sides of the valley are steep and covered by primary rainforest. Further downstream, the river flows over a series of rapids and short stretches of river alluvium between steep sided hills and falls from an altitude of +370 m at the dam site down to +240 m over a stretch of 10.8 km. The width of the riverbed varies between 30 and 80 m. Downstream, the river flows more calmly down to a small island upstream of Kuala Tomani, and falls from an altitude of +240 m to +220 m over a stretch of 3.8 km. Further 6.3 km downstream at the confluence with the Telekosang River, the level is about +194 m. Over the next 1.7 km, the river flows between hills, some 150 to 200 m in height and thereafter through an open landscape down to Kemabong. The overall length of the river from the Padas/Maligan confluence to Kemabong is about 26 km.

Table 4.2-1 shows the areas associated with the drainage areas of Padas River and its tributaries.

Table 4.2-1 Sub-Catchments and Their Areas

Sub catchment	Area (Ha)	Per cent of total basin area	Accumulated sub catchment areas (Ha)
Ulu Padas	208,976	22.5	208,976
Sg. Tomani	22,027	2.4	231,003
Sg. Telekosang	107,559	11.6	At Kemabong: 338,562
Sg. Padas (Middle)	44,819	4.8	383,381
Sg. Pegalan	389,149	41.8	At Tenom: 772,530
Sg. Padas (Below Tenom)	157,450	16.9	929,980

From Kemabong the river continues to Tenom where it is joined by the Pegalan River 170 meters asl. Here about 3,800 km^2 is drained by the Padas River itself and 3,900 km^2 by the Pegalan River. The river then turns northwest and cuts through the Crocker Range via the Tenom Gorge to Beaufort. Further west of Beaufort, the river meanders across the Klias Peninsula and eventually enters the South China Sea through the mangroves at Padas Bay.

The Study Zones

4.3 ZONE 1: SABAH AND THE REGION

Zone 1 incorporates regional information such as meteorology, seismic concerns, traffic, public administration and regional land use planning.

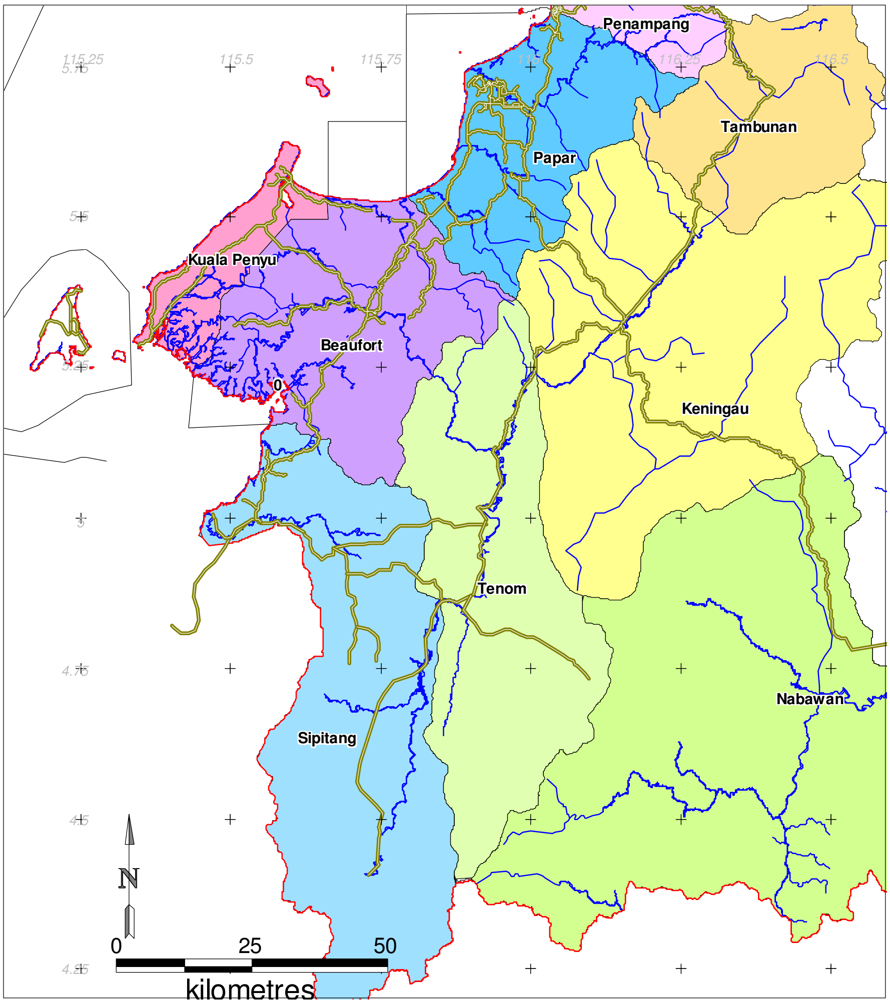


Figure 4.3.1 Interior Division with Districts and Major Roads

Source: ICZM/DANCED and Kofod GIS

4.3.1 CLIMATE

The climate in Sabah and Padas basin is characterized by uniform temperature, high humidity and high rainfall, typical of equatorial regions. Winds are generally light. Even though the area is outside the true monsoon area, there are still two monsoon related regimes; the south-west monsoon (May to September) and the north-east monsoon (November to March). The north-east monsoon brings heavy rainfall and the south-west monsoon normally signifies relatively drier weather. As East Malaysia is not directly exposed to the genuine monsoon, it enjoys little seasonal variation compared to other south-east Asian regions.

The recurrent El Niño phenomena, which is linked to the conditions of the Pacific Ocean currents, can result in drier than normal climatic conditions in the region whereas La Niña has the opposite effect, causing more rainfall. The two strongest El Niño of the last century occurred in 1982-83 and 1997-98, when East Malaysia experienced very dry periods which caused several forest and bush fires. The frequency of La Niña is much less than that of El Niño, with La Niña events from the past 20 years occurring in 1988-89 and 1998-2000.

Typhoons are normally only occurring north of 7^0 latitude in the South China Sea region. Due to weaker Coriolis forces closer to the equator they are less frequent and comparatively weaker here. Nevertheless, through interaction with monsoon winds, low latitude typhoons or 'tail winds' from typhoons can generate extreme wind and wave conditions in coastal waters and heavy rainfall on land. In 1996 Storm Greg, which was a Typhoon tail wind, passed across the northern part of Sabah. This resulted in severe wind and wave conditions off Kota Kinabalu and flooding that led to the loss of lives around the Padas River near Beaufort. Typhoon Hilda in 1999 also caused flooding in Sabah.

Rainfall. There are no government rainfall gauging stations in the Project catchment area. The annual average rainfall measured elsewhere in Sabah ranges from 1,318 (Keningau) to 5,095 mm (Ulu Moyog in the North of the Pegalan catchment). The stations closest to the catchment area are in Sarawak which show variations from 2,438 mm per year to 2,652 mm per year. Indicative of monsoonal patterns, average monthly rainfalls vary from 136 mm in February up to 237 mm in October. A complete listing of rainfall records and a map of stations are included in **Appendix 1-1: Climate and Air. Table 4.3-1** shows the readings from the closest stations.

There are other – unregistered – gauging stations in the area, notably those belonging to the Sabah Forest Industries. Data from these stations have not been available to the consultant during this assessment.

Table 4.3-1 Average Annual Rainfall

Station	Elevation	Average Annual Rainfall
Long Semado (Sarawak)	730	2438
Long Merarap (Sarawak)		2652 mm
Long Sukang (Sarawak)	350 m	2484 mm
Kemabong	228 m	1621 mm

Source: Malaysian Meteorological Department.

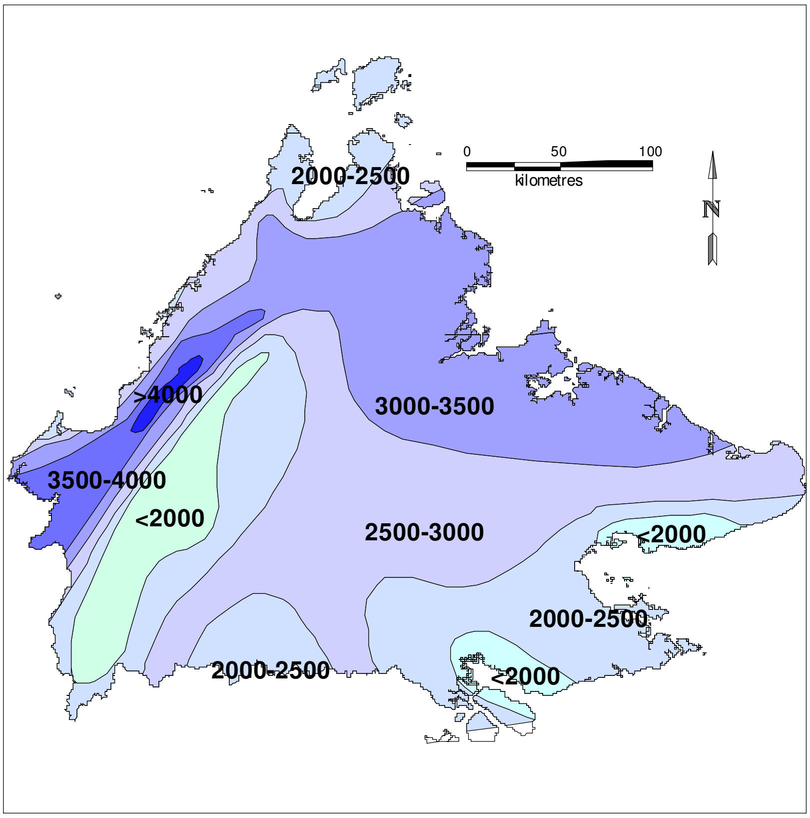


Figure 4.3.2 **Mean Annual Rainfall (mm per year)**

Source: ICZM, DANCED. GIS: Singhai Management

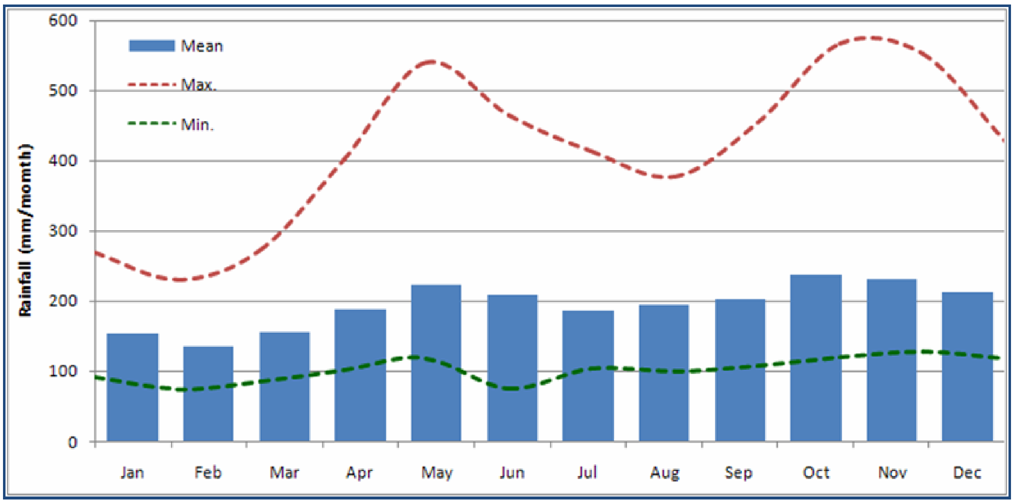


Figure 4.3.3 **Mean Monthly Rainfall**

Figure 4.3.3 Shows the mean monthly rainfall (blue bar chart), minimum (green dot line) and maximum (red dot line) derived on the basis of the rainfall records available at the stations listed in **Appendix 1-1: Climate and Air**. The chart shows an even distribution of the mean and minimum precipitation over the months of the year but with two clear seasons for extreme maxima coinciding with the monsoon seasons.

4.3.2 AIR QUALITY

To assess the existing air quality of the overall Project area, air sampling was carried out at twenty-seven (27) locations which comprise the sensitive receptors surrounding the proposed sites for powerhouse, access roads, and particularly along the earlier three transmission lines options[9] (see **Map 4.3- 1 Air and Noise Sampling Points**). The sampled parameters were[10]:

- Total Suspended Particulates (TSP);
- SO_2;
- CO; and
- NO_2

Table 4.3-2 describes the air monitoring points (A1-A27). The results of baseline air monitoring are summarised in **Table 4.3-3** (see **Appendix 1-1: Climate and Air** for test results and **Appendix 5-1: Malaysian Recommended Air Quality Guideline** for Guidelines).

Table 4.3-2 Description of Air Monitoring Points and Results

Point	GPS Reading	Location	TSP[11] (µg/m^3)
Malaysian Recommended Guidelines for Gaseous Pollutants			***260***
A1	E 115°51'30.5" N 04°51'48.5'	Bridge near powerhouse site, Tomani	16.4
A2	E 115°52'05.9" N 04°51'32.9'	Kg Katambalang Baru, Tomani	22.5
A3	E 115°52'40.5" N 04°51'04.6'	Kg Kaliwata Lama, Tomani	13.3
A4	E 115°53'20.6" N 04°51'00.6"	SK Tomani, Tomani	15.1
A5	E 115°51'19.3" N 04°49'56.7"	Lembaga Industri Getah Tomani	13.7
A6	E 115°42'38.0" N 04°41'00.5"	Kg. Kungkular	9.5
A7	E 115°42'38.0" N 04°41'00.5"	Kg. Maligan	35.6
A8	E 115°44'13.6" N 04°34'08.8"	SFI camp	30.7
A9	E 115°52'21.2" N 04°50'16.5"	Lembaga Industri Getah Tomani	28.5
A10	E 115°41'21.7" N 04°56'56.6"	Kg Mendolong	17.7

[9] *The sampling points were established based on the initial three transmission line options. See **Section 3.4.5: Transmission Line Route Options**.*

[10] *NO_2, CO and SO_2 parameters were only measured at A1-A3 locations due to its close proximity with to the main power house so as to determine the baseline levels.*

[11] *Averaging time: 24 hour*

Point	GPS Reading	Location	TSP[11] ($\mu g/m^3$)
A11	E 115°53’48.5” N 04°51’45.0”	Kg. Kalibatang	32.5
A12	E 115°54’30.7” N 04°52’54.8”	Kg. Mamaitom	24.0
A13	E 115°55’25.9” N 04°55’31.3”	Kg. Kalamatoi Ulu	24.5
A14	E 115°55’11.3” N 04°57’50.4”	SJK (C) Yuk Hwa, Kemabong	22.4
A15	E 115°55’21.5” N 05°00’18.2”	Klinik Desa Kg. Paal	22.5
A16	E 115°57’01.7” N 05°03’42.7”	Kg. Sapong @ SK Ladang Sapong	22.2
A17	E 115°56’45.8” N 05°05’19.2”	SK Chinta Mata	23.1
A18	E 115°56’25.7” N 05°06’37.5”	Housing Area. Tenom	20.1
A19	E 115°41’23.7” N 04°57’52.6”	Lembaga Industri Getah, Sipitang	26.6
A20	E 115°40’28.9” N 04°57’37.8”	Kg. Muaya	16.7
A21	E 115°37’56.6” N 04°58’27.1”	Kg. Marau	25.4
A22	E 115°36’39.2” N 04°59’23.5”	Kg. Melamam	26.7
A23	E 115°35’58.5” N 04°59’41.3”	Kg. Kaban	22.5
A24	E 115°34’49.0” N 04°59’38.4”	SK Lubang Buaya	25.5
A25	E 115°33’59.9” N 04°59’42.6”	Kg. Bangsal	25.2
A26	E 115°31’50.0” N 05°00’56.0	SK Padang Berampah	25.0
A27	E 115°32’55 N 05°03’35.0”	SIB Church	23.2

Table 4.3-3 NO_2 CO and SO_2 Results

Point	Additional Parameters at Powerhouse Area		
	NO_2[12], $\mu g/m^3$	CO[13], ppm	SO_2, $\mu g/m^3$
MRGGP	***320***	***9***	***105***
A1	21.7	< 2.0	124
A2	9.4	< 2.0	65
A3	8.5	< 2.0	105

Generally, the air quality was good with all parameter levels well below the stipulated value except for SO_2 level at A1 and A3. The major source of pollutants especially SO_2 are from vehicles emission and open burning for disposal of domestic and vegetative waste by the villagers.

4.3.3 NOISE LEVEL

Noise measurements were measured at thirty-three (33) locations within the strict Project area as well as outside. The measuring points included the proposed areas for power house, access roads and along the initial three proposed transmission lines options[9] covering both Sipitang and Tenom areas. Noise level was measured during day time (15 hours) and night time (9 hours) at each location. The results and description of sampling points are shown in **Table 4.3-4** below.

Table 4.3-4 Noise Level Measurement Results

Points	GPS Reading	Description	Results (L_{eq}, dB)	
			Day time[14]	Night time
N1	E 115°51'30.5" N 04°51'48.5"	Bridge near powerhouse site, Tomani	56.7	52.5
N2	E 115°52'05.9" N 04°51'32.9"	Residential area, Kg Katambalang Baru, Tomani	54.4	50.8
N3	E 115°52'40.5" N 04°51'04.6"	Residential area, Kg Kaliwata Lama, Tomani	54.7	56.2
N4	E 115°52'40.0" N 04°51'46.9"	Residential area, Kg Marrais, Tomani	58.4	53.8
N5	E 115°53'20.6" N 04°51'00.6"	School area, SK Tomani, Tomani	59.5	55.0
N6	E 115°51'19.3" N 04°49'56.7"	Proposed access road area, Lembaga Industri Getah Tomani	55.3	55.3
N7	E 115°42'38.0" N 04°41'00.5"	Residential area, Kg. Kungkular	59.6	52.3

[12] *Averaging time: 1 hour*
[13] *Averaging time: 8 hour*
[14] *Average value for day time sampling results.*

Points	GPS Reading	Description	Results (L_{eq}, dB)	
			Day time[14]	Night time
N8	E 115°42’38.0” N 04°41’00.5”	Residential area, Kg. Maligan	59.0	41.2
N9	E 115°44’13.6” N 04°34’08.8”	Logging camp, SFI camp	50.3	46.6
N10	E 115°52’21.2” N 04°50’16.5”	Proposed access road area, Lembaga Industri Getah Tomani	58.4	53.4
N11	E 115°41’21.7” N 04°56’56.6”	Residential area, Kg Mendolong	54.9	53.5
N12	E 115°53’48.5” N 04°51’45.0”	Residential area, Kg Kalibatang	56.3	54.6
N13	E 115°54’30.7” N 04°52’54.8”	Residential area, Kg. Mamaitom	55.5	53.8
N14	E 115°55’11.1” N 04°54’43.1”	Commercial and residential area, Kemabong Town	57.9	57.7
N15	E 115°55’25.9” N 04°55’31.3”	Residential area, Kg. Kalamatoi Ulu	56.6	54.3
N16	E 115°55’00.5” N 04°56’40.1”	Health centre, Klinik Desa Baru Jumpa	56.2	57.8
N17	E 115°55’11.3” N 04°57’50.4”	School area, SJK (C) Yuk Hwa Kemabong	57.3	56.5
N18	E 115°55’21.5” N 05°00’18.2”	Health centre, Klinik Desa Kg. Paal	63.9	59.1
N19	E 115°57’01.7” N 05°03’42.7”	School area, SK Ladang Sapong	58.4	52.9
N20	E 115°57’04.2” N 05°03’53.3”	Health centre, Klinik Desa Sapong	62.8	59.7
N21	E 115°56’45.8” N 05°05’19.2”	School area, SK Chinta Mata	59.5	54.5
N22	E 115°56’25.7” N 05°06’37.5”	Housing Area	55.3	50.4
N23	E 115°41’23.7” N 04°57’52.6”	Residential area, Lembaga Industri Getah, Sipitang	60.4	53.6
N24	E 115°40’28.9” N 04°57’37.8”	Residential area, Kg. Muaya	56.0	57.3
N25	E 115°37’56.6” N 04°58’27.1”	Residential area, Kg. Marau	57.0	50.8
N26	E 115°36’39.2” N 04°59’23.5”	Residential area, Kg. Melamam	69.0	59.8

Points	GPS Reading	Description	Results (L_{eq}, dB)	
			Day time[14]	Night time
N27	E 115°35’58.8” N 04°59’41.3”	Residential area, Kg. Kaban	57.7	66.8
N28	E 115°34’49.0” N 04°59’38.4”	School area, SK. Lubang Buaya	61.0	57.3
N29	E 115°33’59.9” N 04°59’42.6”	Residential area, Kg. Bangsal	55.8	54.8
N30	E 115°31’46.0” N 05°01’7.0”	Religious building, Masjid Pantai	60.4	59.6
N31	E 115°31’50.0” N 05°00’56.0”	School area, SK Padang Berampah	57.5	57.6
N32	E 115°32’52.0” N 05°02’44.0”	School area, SK Merintaman	59.2	58.2
N33	E 115°32’55.0” N 05°03’35.0”	SIB Church	56.4	57.6

The measured noise levels[15] are compared against DOE limits[16] of 55 dB (A) for daytime and 45 dB(A) for night time respectively under suburban or rural setting. Based on the results above, more than 85 % of daytime and night time levels have exceeded the DOE limits (see **Appendix 5-3: Schedule of Permissible Sound Levels, Department of Environment, 2004** for DOE Schedule and **Appendix 1-2: Noise Level** for test results). Human activities and vehicle movement were the significant sources of noise for most of the sampling.

[15] *Other noise level parameters such as L_{90}, L_{10}, L_{max} and L_{min} were also taken for each sampling points and appended in the environmental noise measurement report in* ***Appendix 1.2***.

[16] *Sampling points are located in suburban areas. For this reason, Schedule 1 of Annex A, The Planning Guidelines for Environmental Noise Limits and Control is deemed most appropriate for the proposed Project. The category chosen is “Suburban Residential (Medium Density) Areas, Public Spaces, Parks, and Recreational Areas”.*

Plate 4.3-1 TSP measurement

Plate 4.3-2 SO_2 measurement

Plate 4.3-3 NO_2 measurement

Plate 4.3-4 Noise measurement

4.3.4 REGIONAL GEOLOGY

The Padas Valley area is underlain with sedimentary rocks of the Crocker and Temburong Formations. The formations are part of a thick sedimentary sequence that forms the Northwest Borneo Geosynclinal Structure. This structure extends from Central North Sarawak and West Kalimantan in the southwest to West and North Sabah. (**Map 4.3- 2 Geological Formation of the Project Area**).

Sedimentation in the Padas Valley continued throughout the Oligocene to late Miocene, forming two distinct facies. The dominant facies, which is the Crocker Formation, is dominantly arenaceous, and is a flysch-type deposit that contains monotonous alternating beds of turbiditic sandstone, siltstone and mudstone. It is believed to be over 5,800 m thick. The other facies is the Temburong Formation, which is dominantly shale, and occurs in the flatter valley areas.

Both the Crocker and Temburong Formations are strongly folded and interfingers in some parts. The dominant fold axes are in a north-south direction, forming parallel N-S strike ridges and valleys. The upper part of the Padas stream valley being one of the valleys.

According to the tectonic framework for northern Borneo, compiled by Yan et. al., the region is part of a very broad Crocker Fold-Thrust Belt. Within this belt, the newly named Crocker fault zone is deemed to be potentially active. The chosen dam site is at the southern edge of the Tenom Graben, which is part of this fault zone. However, there is no known seismicity recorded in this zone. The so called Tenom Graben is not deemed an active tectonic structure.

Aerial photograph interpretations have delineated two north-south lineaments that are attributed to the fault zone, and they are deemed to be potentially active. An interpreted fault on the East of the fault zone is not active.

4.3.5 Seismicity

The seismicity of the region is regarded as intra-plate seismicity, with the Philippine Tectonic Plate boundary approximately 1000 km away. The sketch shown below shows earthquakes with magnitudes $m_b \geq 4$ within a radius of 500 km using USGS earthquake data. It is noted here that there was an outbreak of seismic energy in the Ranau earthquake swarm in May to July 1991. The epicentres of the swarm were around 140 km from the Project area. The maximum magnitude of $m_b = 5.1$ was recorded twice during the swarm. In February 2010 a new earthquake hit Ranau. This time, the magnitude was measured to be 2.6.[17]

Probable active faults and older inactive faults are plotted in the sketch map (see **Figure 4.3.4**) in order to show a relationship with the earthquake centres. Of significance is the probable active fault zone known as the Crocker Fault Zone, and the Tenom fault zone.

[17] *Media reports: New Strates Times, Brunei Times and others*

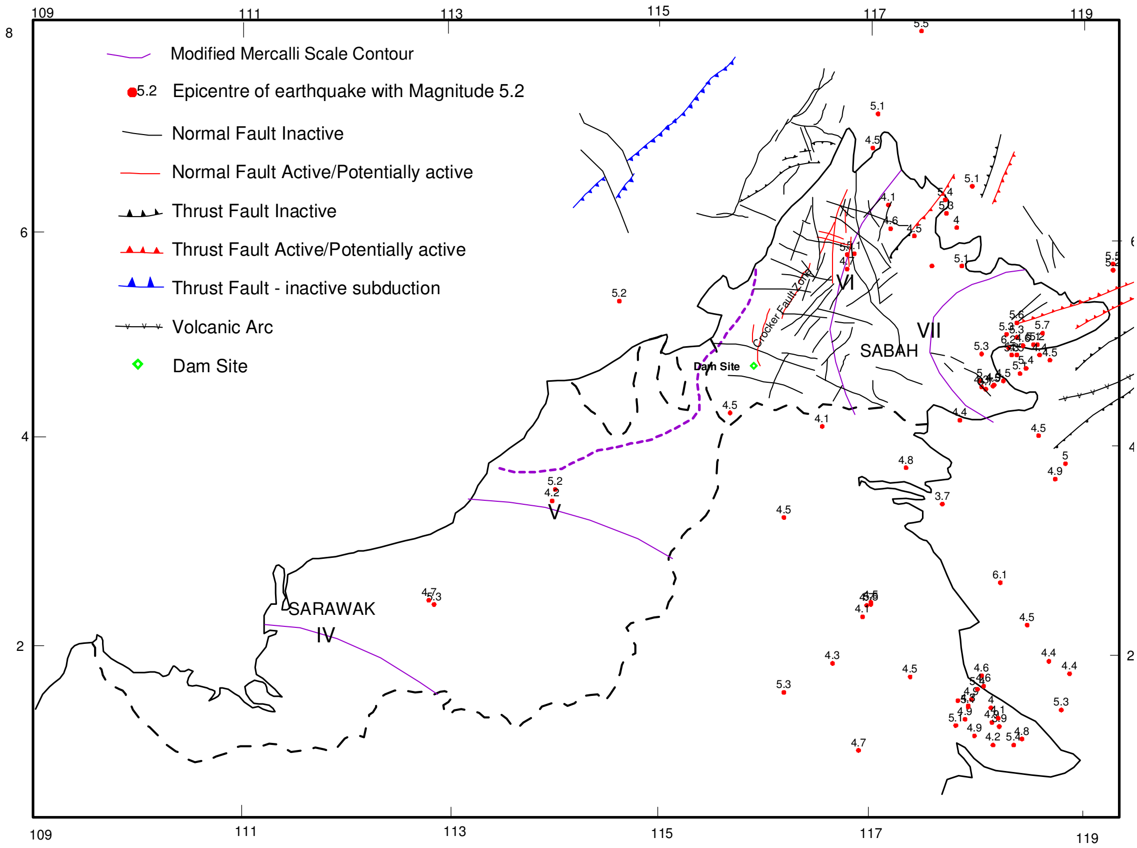


Figure 4.3.4 Earthquakes and Faults

Various probability tests have been conducted on the risk of earthquakes(see **Appendix 2-1: Soils and Geology**) It was concluded in the feasibility study that for a return period of 1000 years, the peak ground acceleration (PGA) of 0.082g was obtained for a homogenous earthquake source.

A new study conducted by Universiti Sains Malaysia Sabah (USMS) in 2009 used two approaches to assess the seismicity of the region. The first approach, the Probabilistic method (PSHA), and the second approach, the Deterministic method (DSHA). In the latter method, the earthquake source is assumed to be from specified areas such as the seismically active fault zones in Ranau.

USMS estimated the peak ground acceleration (PGA) for a return period of 10,000 years using the probability method for the homogenous source at 0.099 g. For the DSHA approach, the PGA largest value obtained was 0.026 g.

Practically 99% of all earthquakes occur along plate boundaries. Other causes could be reactivation of faults not connected to plate boundaries and dam reservoir induced seismicity (RIS). The magnitude of the shock due to activation of a fault will depend on the size of the fault and its distance from the site. There are no very large active faults near the site. West of the site, there is an inferred fault with a strike length of over 15 km. This fault can be considered as potentially active due to their relationship with the Tenom Graben and the Crocker Fault zone in the north. However, there are no records of seismicity related to the Tenom Graben or the fault.

4.3.6 PUBLIC ADMINISTRATION

Sabah is administratively divided into 5 divisions (Bahagian) and each division into a number of districts. This Project falls within the Interior Division. The construction of the dam will take place at Upper Padas River in Sipitang district while the powerhouse will be constructed in Kemabong sub-district within the Tenom district, and the proposed alignments for transmission- lines will cut across both these districts. Further downstream is Beaufort District, which includes the Klias Peninsula, where the Padas river meets the South China Sea.

Tenom District covers an area of about 2,238 km^2 including the sub-district of Kemabong. It is bordered by Keningau, Nabawan, Pensiangan, Beaufort, Papar districts and the Indonesian East Kalimantan province. The sub-district Kemabong in Tenom covers an area of about 1812 k m^2. The Padas River, with the proposed dam site and the existing Pangi Hydroelectric Power Station, mainly runs through this sub-district.

Sipitang District covers an area of about 2,732 k m^2 and is bordered by Beaufort, Tenom, Sarawak State and East Kalimantan.

Beaufort District covers an area of 1,715 km^2 and has a population of almost 70,000. The district covers the most of the Klias peninsula and the western slopes of the Crocker Range.

Table 4.3-5 shows population development of these three districts since 1980 as presented in the general census statistic of Malaysia.

Table 4.3-5 Urban and Rural Population in Tenom and Sipitang District (1980-2000)

District	Total Population		
	1980	1991	2000
Sipitang	12,076	24,349	29,256
Tenom	26,353	37,954	46,106
Beaufort	36,403	48,742	61,698

Source: 1980, 1991 and 2000 Census from Statistics Department, Sabah

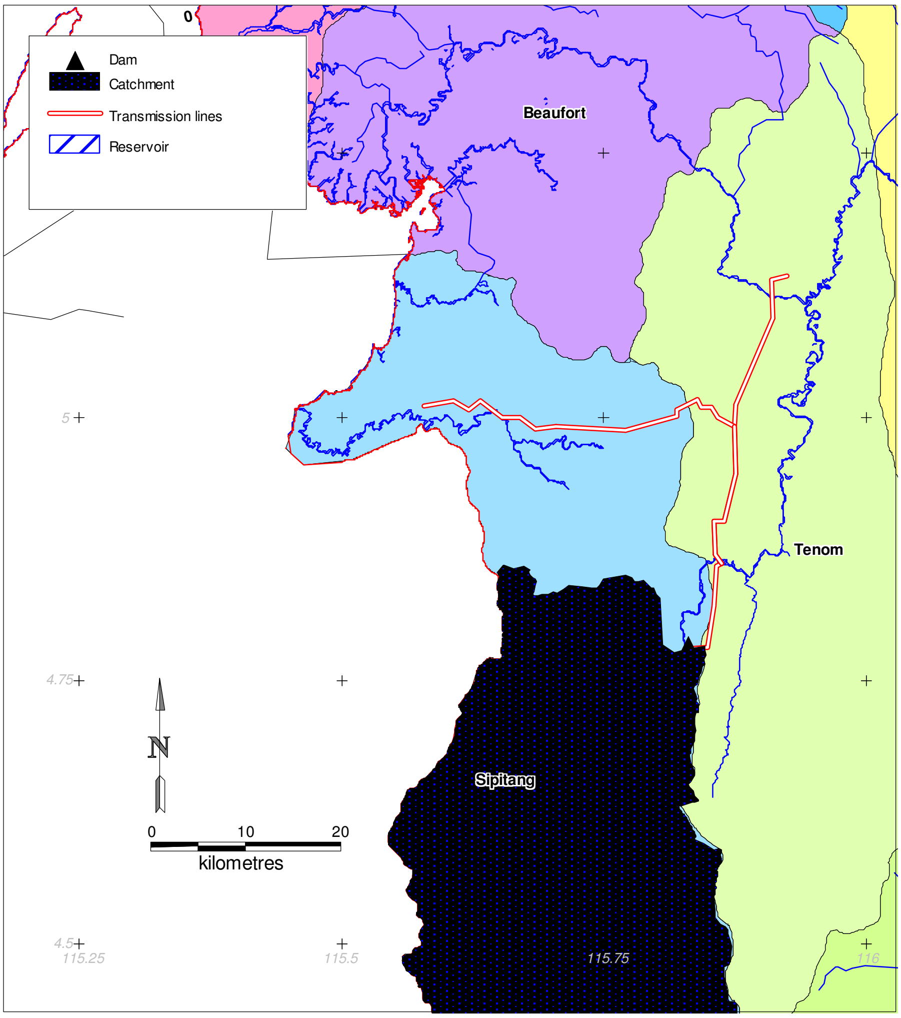


Figure 4.3.5 Administrative Districts and Main Project Components

4.3.7 ROAD TRAFFIC

Existing Road Network. Access to the Project site is by a two-lane single-carriageway that traverses in the north-south direction from Keningau to Tenom continuing to Tomani (See **Map 4.3- 3 State Trunk Road Network and JKR Traffic Census Stations**). The power house is accessible by an existing rubber estate road (**Plate 4.3-6**) from Kuala Tomani which lies along the southern side of upper Padas River. Presently, the only access to the dam site is via a rough and undulating logging road with very steep gradients especially the last section of the road. There is no direct linkage between the powerhouse and the dam site.

As shown in **Map 4.3- 3 State Trunk Road Network and JKR Traffic Census Stations**, regional access to the Tomani-Tenom road is by Sipitang-Tenom Highway (**Plate 4.3-7**) or Kimanis-Keningau Highway. These two roads traverse across mountainous areas and steep gradients where climbing lanes are provided. The former road (Sipitang-Tenom Highway) has a total length of about 50 km and traverses westwards from the Tomani-Tenom road till Kota Kinabalu - Sindumin Highway. The latter one (Kimanis-Keningau Highway) traverses through rugged terrain and is connecting from Kota Kinabalu - Sindumin (near Bongawan)

Highway to Keningau on the east, a total length of approximately 60 km. **Table 4.3-6** below lists the approximate haulage distances for the main highways and roads from Kota Kinabalu to Tenom.

Table 4.3-6 Road Haulage Distance

Road	Distance (km)
Kota Kinabalu – Sindumin Highway *(From Kota Kinabalu via Beaufort to Sindumin)*	160
Kota Kinabalu – Tenom Highway *(From Kota Kinabalu via Tambunan-Keningau to Tenom)*	165
Sipitang-Tenom Highway	50
Kimanis-Keningau Highway	60

The Tomani-Tenom road and the Sipitang-Tenom Highway intersect to form a three-legged mini-sized roundabout. For ease of reference, this roundabout is referred to as Tomani-Tenom Roundabout hereinafter in this report.

Existing Traffic Conditions.

Traffic Survey Conducted by the Public Works Department (JKR). Traffic volumes at relevant traffic census (refer to **Map 4.3- 4 Existing Peak Hour Traffic in Year 2008**) have been obtained from Road Traffic Volume Malaysia (RTVM) 2007 (compiled by Ministry of Works Malaysia, Highway Planning Unit) to determine the daily traffic along the haulage routes. **Table 4.3-7** below presents the average 16-hour traffic volumes and compositions at the traffic census locations.

Among all, Beaufort-Sindumin Highway (HR101) has recorded the highest 16-hour volume of 10,772 vehicles per day (vpd) in Year 2007, followed by Kota Kinabalu -Sindumin Highway (HR106) which has daily volume of 5,240 vehicles per day (vpd). Along the highways from Kota Kinabalu to Beaufort (HR201, HR209) and Donggongon-Tambunan (HR202), the daily volume is slightly less than 5,000 vpd. While the road section from Tambunan to Keningau (HR103 – Kota Kinabalu - Sapulut Road) has about 2,300 vpd the section from Keningau to Tomani (HR104 - Tenom-Tomani Road) has about 3,900 vpd. The percentage of truck composition ranges from 12% to 35%.

As shown in **Table 4.3-7** peak hour traffic generally ranges from 210 to 900 vph. The highest peak hour traffic volume is at HR101, which has nearly 900 vph. The nearest station to the site is HR104, which has peak hour traffic volume of 311 vph. With the exception of HR209, generally the peak hour traffic constituted about 8%-12% of the 16-hour traffic volume.

Table 4.3-8 below tabulates the average annual growth rate at each station over the last ten years from Year 1998 to 2007. While HR101 (Beaufort-Sindumin Highway) has the highest average growth rate of 14.62%, HR103 (Jalan Kota Kinabalu-Sapulut) and HR202 (Donggongon-Tambunan Highway) has the lowest growth rate of 2.98%. At HR104 (Jalan Tomani-Tenom), the average traffic growth rate is about 4.60%.

Table 4.3-7 Recorded Traffic Volumes at JKR Traffic Census (Year 2007)

Station	Location	16-Hour Traffic (vpd)	% of Vehicle Composition						Peak Hour Traffic Volume (vph)	vph / vpd (%)
			Cars	Van	Medium Truck	Heavy Truck	Bus	Motorcycle		
HR101	Beaufort-Sindumin	10,772	36.4%	27.6%	18.0%	13.7%	0.3%	4.0%	892	8.3%
HR103	Kota Kinabalu -Sapulut	2,282	38.0%	28.8%	13.0%	11.7%	1.5%	6.8%	209	9.2%
HR104	Tenom-Tomani	3,879	26.3%	25.7%	20.0%	1.7%	3.0%	22.8%	311	8.0%
HR106	Kota Kinabalu-Sindumin	5,240	57.9%	21.0%	9.0%	3.1%	0.2%	9.0%	510	9.7%
HR201	Kota Kinabalu-Papar	4,932	53.5%	22.5%	11.8%	4.8%	0.9%	6.5%	580	11.8%
HR202	Donggongon-Tambunan	4,685	32.3%	26.9%	17.0%	13.0%	4.7%	6.0%	416	8.9%
HR209	Kota Kinabalu-Sindumin (near Bongawan)	4,638	56.1%	23.3%	10.0%	2.6%	1.2%	6.2%	795	17.1%

Source: RTVM 2007

Table 4.3-8 Average Annual Growth Rate and 16-Hour Traffic Volumes

Station	Location	16-Hour Traffic Volumes (vpd)										Normal Growth (%)
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	
HR101	Beaufort-Sindumin	3,240	3,058	2,608	2,689	3,856	4,077	4,902	5,805	7,042	10773	14.62
HR103	Kota Kinabalu-Sapulut	2,197	2,102	2,163	2,308	2,202	2,360	2,727	2,839	3,039	2,282	2.98
HR104	Tenom-Tomani	2,327	2,743	2,545	2,963	3,081	2,501	2,796	2,662	4,196	3,879	4.60
HR106	Kota Kinabalu-Sindumin	2,664	2,887	2,939	3,622	3,738	4,320	4,507	4,412	4,565	5,240	7.63
HR201	Kota Kinabalu-Papar	2,599	1,861	2,261	2,831	2,800	3,029	3,124	3,416	3,541	4,932	8.01
HR202	Donggongon-Tambunan	3,732	3,726	3,668	4,006	3,189	3,836	4,123	4,326	4,751	4,685	2.98
HR209	Kota Kinabalu-Sindumin (near Bongawan)	3,863	3,486	4,115	4,246	4,532	6,368	6,876	6,609	8,757	4,639	7.71

Source: RTVM 2007

Traffic Survey Conducted by Chemsain.

The consultant conducted existing traffic survey on the 17th and 18th July 2008 during the morning and afternoon peak hour periods at Tomani-Tenom Roundabout (**Plate 4.3-8**). The traffic was recorded at 15-minute intervals under six different vehicle categories: passenger car/4-wheel drive, motorcycle, van/utility, light truck, heavy truck, and bus. The directional peak hour traffic volumes in vehicles per hour (vph) was computed and the directional traffic flows at the roundabout are presented in **Map 4.3- 4 Existing Peak Hour Traffic in Year 2008**.

The numbers of various classes of vehicles have also been converted to passenger car unit (PCU) based upon the conversion factors as recommended in REAM – GL 2/2002 or Arahan Teknik (Jalan) 8/86 of Jabatan Kerja Raya – “A Guide on Geometric Design of Roads”. These conversion factors are presented in **Table 4.3-9** below and the traffic volumes in vph have been converted to passenger cars per hour (pcph) as also presented in **Map 4.3- 4 Existing Peak Hour Traffic in Year 2008**.

Table 4.3-9 Conversion Factors to Passenger Car Unit (PCU)

Type of Vehicle	Road(1)
Passenger Car/4-Wheel Drive	1.00
Motorcycle	1.00
Van/Utility	2.00
Light Truck	2.50
Heavy Truck	3.00
Bus	3.00

Source: REAM – GL 2/2002 or Arahan Teknik (Jalan) 8/86 of Jabatan Kerja Raya.

The total peak hour traffic volume at the roundabout was very low, only 228 vph (325 pcph) during the morning peak hour, and 177 vph (262 pcph) during the afternoon peak hour.

During the morning peak hour, it was recorded that the northbound/southbound traffic contained about 9% heavy vehicles (light trucks, heavy trucks, buses) and the eastbound traffic had about 13% heavy vehicles. During the afternoon peak hour, the percentage of heavy vehicles increased to 17% on the northbound direction (from Tomani towards roundabout), and to 10% on the southbound direction (from Tenom towards roundabout). Sipitang-Tenom Highway (eastbound) recorded as high as 29% of heavy vehicles during the afternoon peak hour.

4.3.8 SOCIAL SURVEY ON WATER TRANSPORTATION

The river system within the Project area is not used extensively as a means of transport over longer distances.

Table 4.3-10 below tabulates the results of social survey on the current riverine activities. Out of the 274 individuals interviewed, only 60 persons. (22%) stated that they are using the river for transportation. Half of them are using sampans and about 20% of them own more than one type of boat. The boats are used mainly for carrying passengers, transporting goods and agricultural products as well as for fishing purposes.

The boats are used mainly for crossing the river between villages and villages/schools (27%). About 45% of the boat trips are to orchards along the river and for fishing purposes. Some of the boats are used only when needed, such as when there is flooding around the kampong areas. Only about 50% of the persons that stated they were using the river, i.e. 11% of the total sample, can be considered as regular users of the river.

It is expected that these river users will continue to be using the rivers for their transportation activities, where most of them will be plying across the river between villages and schools, and along the river to orchards or for fishing.

Table 4.3-10 Summary of Social Survey on Riverine Activities

Item	No.
Use of River for Transportation:	
1. Yes	60
2. No	214
Total	274
Type of Boat used:	
1. Sampan	30
2. Sampan (engine)	9
3. Others	9
4. Sampan / Sampan (engine)	7
5. Sampan / Others	3
6. Sampan (engine) / Others	2
Total	60
Usage of Boat:	
1. Carrying Passengers	12
2. Transporting Goods/Agricultural Products	6
3. Fishing	13
4. Transporting Goods/Agricultural Products/Fishing	10
5. Carrying Passengers/Fishing	5
6. Others	14
Total	60
Purpose:	
1. To Kampongs/School	16
2. To River/Fishing	13
3. To Orchard	14
4. Flooding	5
5. Others	12
Total	60
No. of Boat Trips / Week:	
1. <1 time	14
2. 1-2 times	15
3. 3-4 times	10
4. 5-6 times	5
5. 7-8 times	7
6. 9-10 times	0
7. >10 times	5
8. Depends	4
Total	60

Plate 4.3-5 Tomani-Tenom

Plate 4.3-6 Rubber estate road to project site

Plate 4.3-7 Jalan Sipitang-Tenom

Plate 4.3-8 Tomani-Tenom Roundabout

4.3.9 FORESTRY

Sabah has one of the highest species diversity in the world[18]. The natural vegetation is tropical rain forest with lowland mixed Dipterocarp forest and montane rain forest[19]. Of the total land mass of 7.3 million hectares in Sabah, about 3.49 million hectares (60%) have been constituted as forested areas and about 48% is gazette as Permanent Forest Reserve or State or National Parks[20]. Logging or clear felling should not be allowed to take place at any time within the forest reserves which is in line with the National Physical Plan (NPP). According to the National Physical Plan, all catchment forests of existing and proposed dams are considered as Environmentally Sensitive Area Rank 1, therefore logging, development and agricultural activities are not permitted in these areas[21].

Ulu Padas region is one of the last areas of extensive old growth forest remaining in Sabah. With its unusual forest types, high floral diversity rich in Sarawak elements, and high species endemism, Ulu Padas forms a distinct floristic region within Sabah's forest

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[18] *Whitmore, T.C. 1984 A vegetation map of Malesia at scale 1:5 million. Journal of Biogeography, 11:461–471.*
[19] *Field Site Description. Sook Plain, Sook Sub-District, Sabah. http://www.sabah.gov.my/pdks/fieldsite.html*
[20] *Lee Ying Fah. Management of The Tree Flora in Sabah : Status, Issues and Chanllenges. Forest Research Centre Forestry Department Sabah.*
[21] *Proposed logging in catchment forest threatens rhinos, tigers. http://www.wwf.org.my/about_wwf/what_we_do/species_main/species_news/?uNewsID=7480.*

estate. Ulu Padas is an outstanding site of botanical diversity and can be considered second only to Mt. Kinabalu, as a hotspot for biodiversity in Borneo. Most of the Ulu Padas area is Commercial Forest Reserve and is available for commercial timber extraction[22].

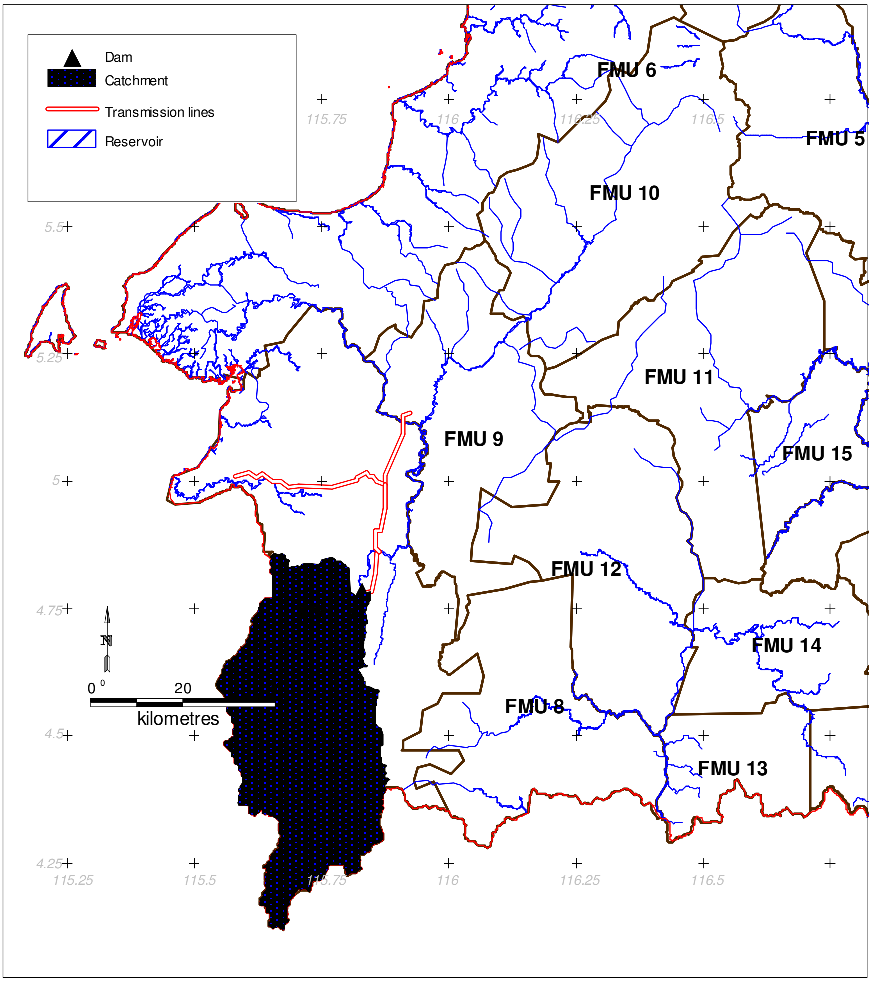

Figure 4.3.6 Forest Management Units

Source: Adapted from Forestry Dpartment

The Sabah Forestry department has divided the entire state area into 27 'Forest Management Units' or FMUs. The Padas Basin cuts, as may be seen in **Figure 4.3.6**, into FMUs 6, 7 8 and 9. This Project is entirely within Forest Management Unit number 7.

Each forest management unit comprises one forestry 'district', where all forestry related administration and enforcement is dealt with locally. FMU 7 is also known as Sipitang Forestry District.

The gazetted forest area in Sabah have been classified into seven forest classes as detailed in **Table 4.3-11** and **Figure 4.3.7**.

[22] *Dr. Junaidi Payne & Mis. Justine Vaz. Indentification of Petential Protected Areas Ulu Padas Final Report. November 1998.*

Table 4.3-11 Forecasted Permanent Forest Estate (PFE) in Sabah, 2008

		Area (Ha)
Class I	Protection Forest	364,766.000
Class II	Commercial Forest	2,665,886.000
Class III	Domestic Forest	7,355.000
Class IV	Amenity Forest	21,284.246
Class V	Mangrove Forest	320,521.560
Class VI	Virgin Jungle Forest	92,400.700
Class VII	Wildlife Reserves	132,653.000
Total		**3,604,866.506**

Source: Sabah Forestry Department.

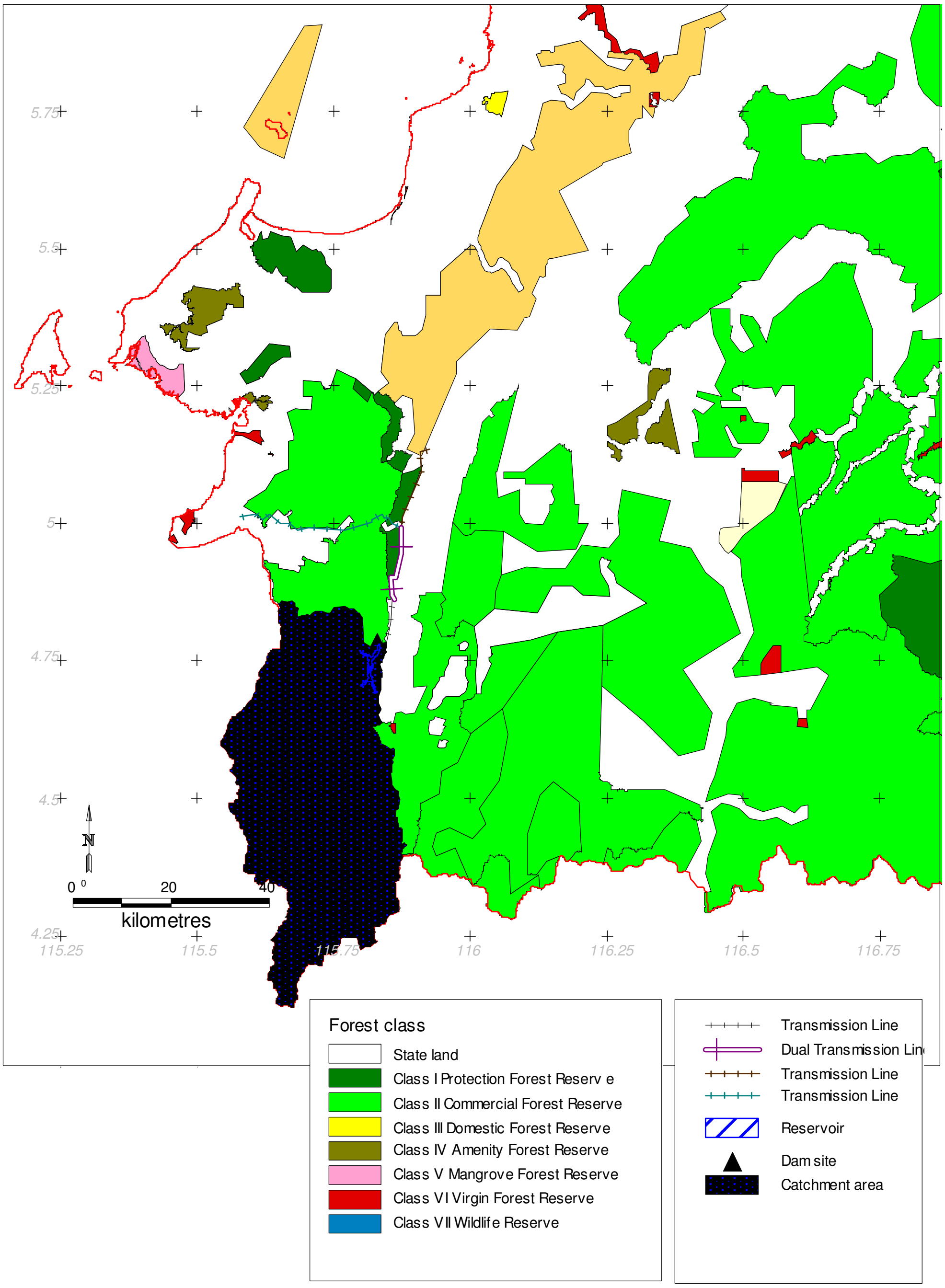

Figure 4.3.7 Forest Classification

Source: Sabah Forestry Department

Most of the catchment area is in the commercial Sipitang Forest Reserve but includes also the virgin Jungle Reserves Maligan and Sg. Basio. In addition, there are two enclaves of state-land (the white areas in **Figure 4.3.7**).

The Forestry department defines the catchment area forest classes as:

Class II - Commercial Forest. Forest allocated for logging to supply timber and other produce, contributing to the State's economy. Logging is carried out according to

Sustainable Forest Management (SFM) principles. Collectively there are 2,665,886 hectares of Commercial Forest Reserves in 32 locations throughout Sabah.

Class VI - Virgin Jungle Forest. Forest conserved intact strictly for forestry research purposes. Logging is strictly prohibited in this forest reserve. The Sepilok Virgin Jungle Reserve in Sandakan covers 4,000 hectares and is one of the largest tracts of undisturbed lowland dipterocarp forests in Sabah. Collectively, there are 92,400.700 hectares of Virgin Forest Reserves in 52 locations throughout Sabah.

In the vicinity, there is an additional small Virgin Jungle Reserve on the Tomani River: the Agathis Virgin Jungle Reserve. Further north, the slopes of the Padas River are protected on the NE side by the Gunung Lumaku Protection Forest Reserve.

On the way through the Crocker Range the Padas River passes along the Crocker National park and on the Klias through an amenity forest, the Padas Damit reserve before it reaches the dendritic delta passing through the Menumbok Mangrove Forest Reserve.

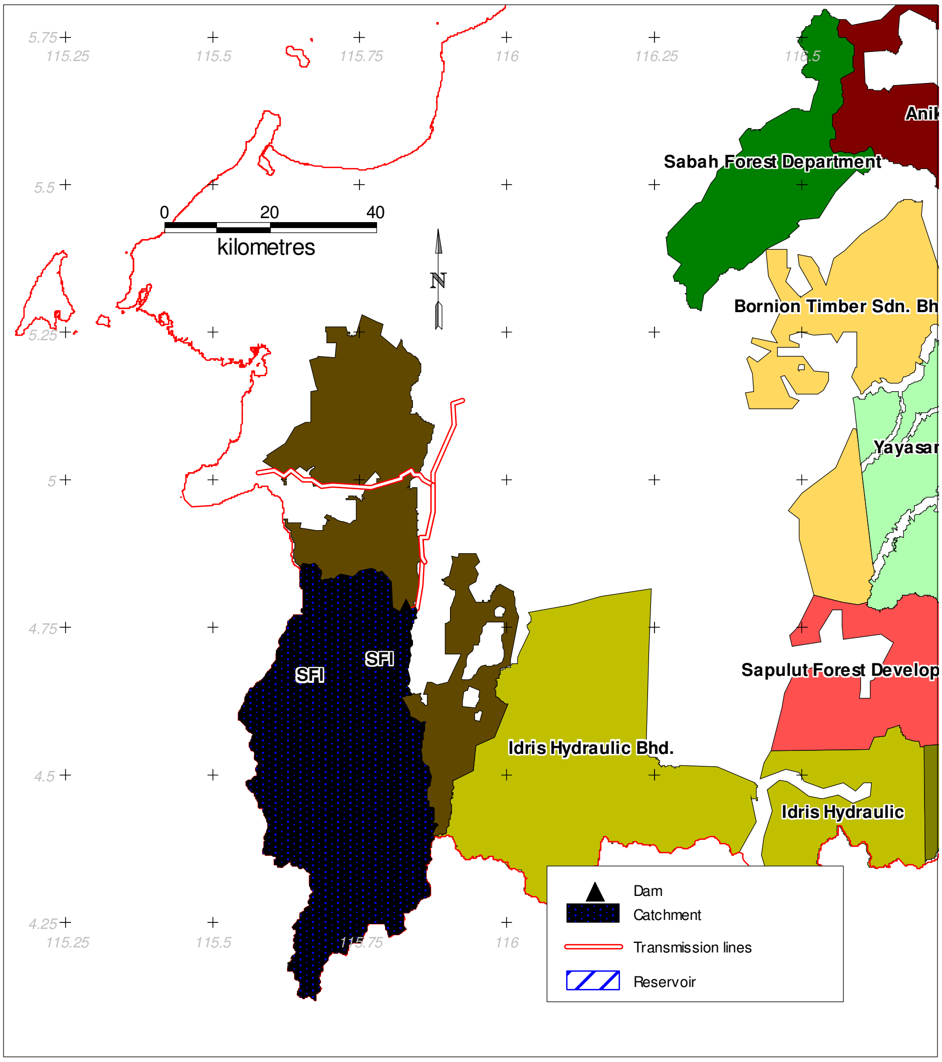

Figure 4.3.8 Forestry Concessions

Source: Forestry Department

The commercial forest in each FMU is licensed to a forest management company, which may be a private company but which may also be a government owned entity. The forests in Sipitang District or FMU 7 are thus licensed to Sabah Forest Industries, who own a pulp and paper factory in Sipitang and who has license to convert suitable parts of the licence area into industrial tree plantations. (**Map 4.3-5 Plantation Area**).

The Ulu Padas Forest Reserve, an area of almost 30 000 hectares proposed as a new Protected Area in the Sabah Conservation Strategy, has been incorporated into a binding 99-year lease agreement (1996–2094) with the Sabah Forest Industries. Sabah Forest Industries' concession is divided into two categories: (1) Industrial Tree Plantation areas, where natural forest is cleared for pulp and paper and replaced with fast-growing species; and (2) areas under Natural Forest Management, which are meant to be managed for the sustainable harvest of timber according to the state's Forestry Guidelines. Sabah Forest Industries' integrated timber complex is the major industry in the nearby town of Sipitang, employing over 2000 people and linked with numerous other contractors and businesses[23].

The soils of this part of Sabah are not well suited for agricultural purposes that may sustain local settlements. The few villages in the area (**Figure 4.3.9**) are there are concentrated in the two state land enclaves or at Tomani, near the power station. These communities use their land for traditional subsistence agriculture or increasingly as small holder rubber and oil palm plantations.

[23] *See Footnote no.11*

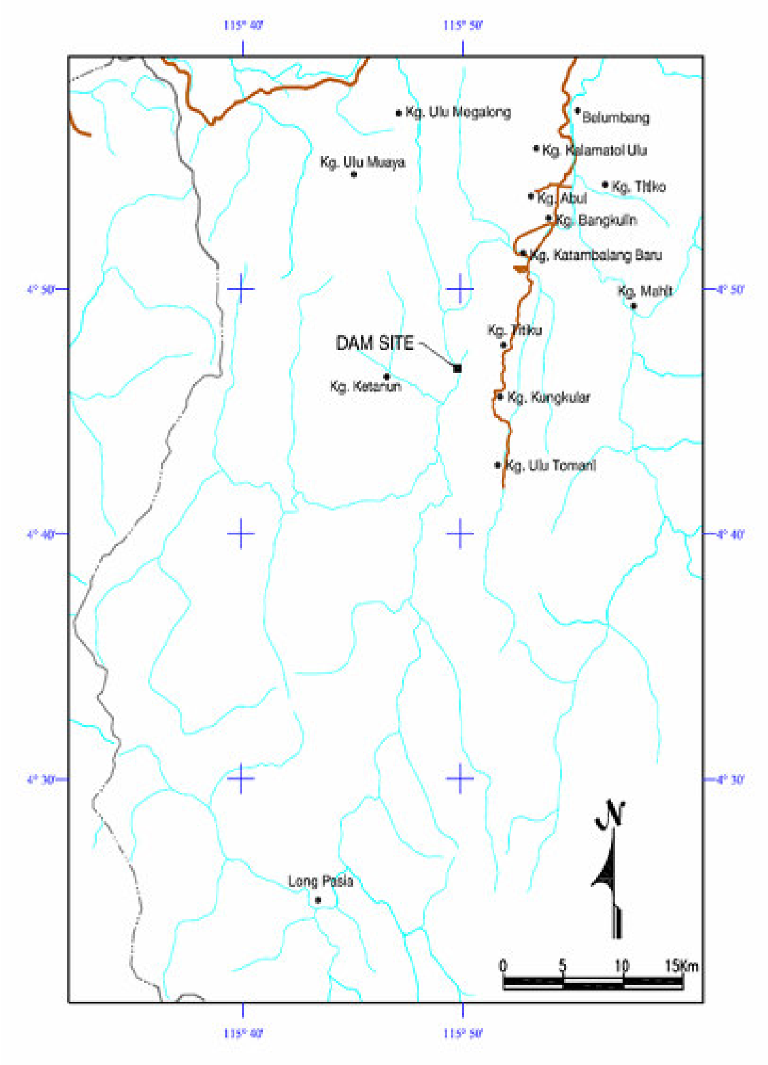

Figure 4.3.9 Settlements

Note: Kg=Kampong=Village. Source ICZM/Danced

4.4 ZONE 2: CATCHMENT AREA FOR THE RESERVOIR

The catchment area upstream the reservoir covers the entire south western corner of Sabah to the borders to Indonesia and Sarawak. These 18,885 km^2 are deeply intersected low hills with two relatively flat areas of state land, the rest being part of Forest Management Unit number 7, which is licensed to Sabah Forest Industries (SFI).

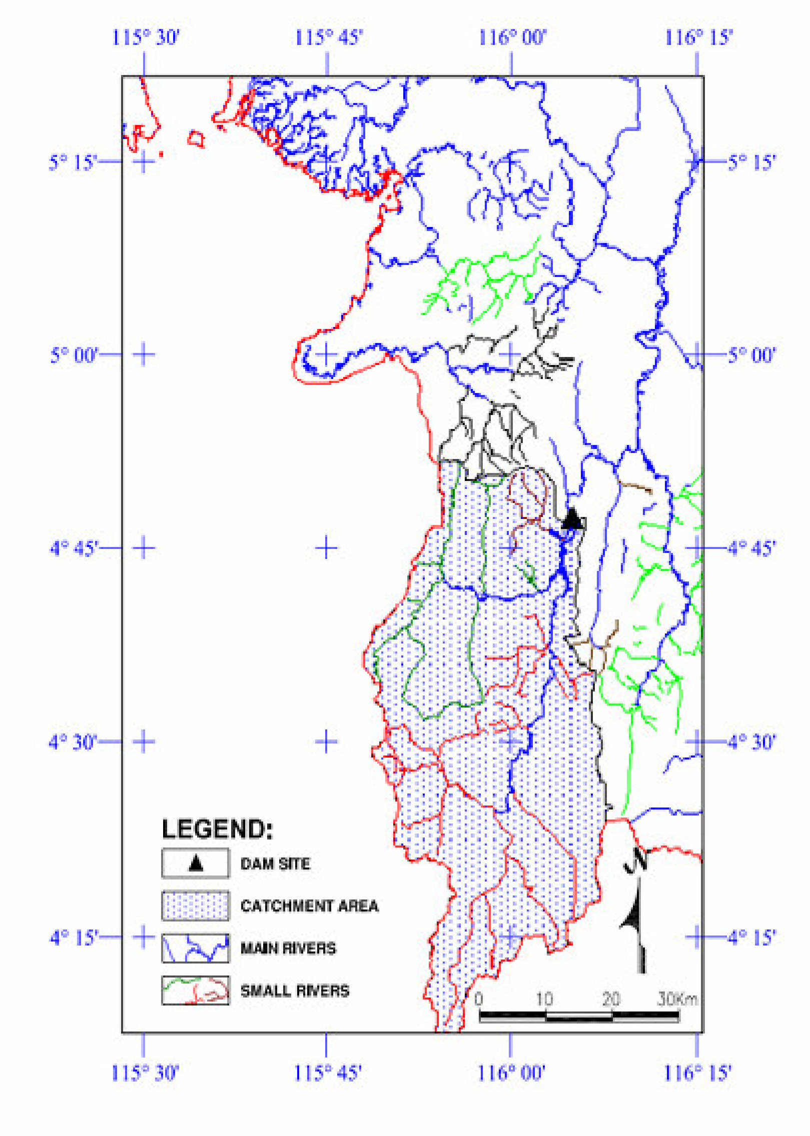

Figure 4.4.1 Catchment Area and Drainage Pattern

4.4.1 CLIMATE

The climatic characteristics of the Upper Sg Padas catchment are within the scope as listed for Sabah and the Region. However, as **Figure 4.3.2** shows, there is a marked rain shadow behind the Crocker Range. The Isohyets show a fall in the annual average rainfall from 3500 mm per year north west of the range to less than 2000 mm per year immediately behind the mountains as the winds from the sea have delivered all their moisture contents crossing over the mountain range.

Compared to the coastal zone, the rainfall inland is generally more evenly distributed throughout the year as they are sheltered from the influence of the monsoon. Humidity is high all year round: Mean monthly relative humidity is 86% on average so the evaporation is essentially also uniform throughout the year, with an average of 4.1 mm/day.

Being equatorial, the temperature in the catchment area is uniform and winds light throughout the year (average daily temperature 27°C), although influences from the monsoonal seasons can be noted despite the rainfall is evenly distributed due to sheltering effect.

As for wind speed, air pressure is generally consistent throughout the year, although influences from the monsoonal seasons can be seen - greater variations in air pressures will occur on shorter timescales (for example, during local tropical thunderstorms).

4.4.2 GEOLOGY AND SOILS

Minerals. There are, according to the Department of Minerals and Geoscience, no known mineral deposits of interest in the catchment area.

Soils[24]. The Project area is dominated by the Maliau and the Crocker soil associations: Maliau south of the reservoir site and Crocker in the northern part (See **Figure 4.4.2**) The Crocker Associations occur on high mountains and is dominated by Acrisols and Cambisols. It is the most extensive soil association in Sabah. The Maliau Association also contains many soils common to the Crocker Association, but it is formed on distinctive cuesta-form mountains with well defined dip slopes on which Podzols sometimes occur.

Some patches of the Brantian association occur on terraces of old alluvium at in the Maligan valley. The terraces are, in general, flat to slightly undulating with short steep slopes in dissected parts. The alluvium is mainly medium- to fine-textured but is occasionally coarse-textured and stony.

The Binkor Association can be found in a small area in the upper reaches of Padas. This association occurs mainly on river terraces with flat to gentle slopes and only minor dissection. Soil parent materials consist of medium- to coarse-textures alluvium, which is often stony.

Of conservation interest are the mountain peat areas of the Sipitang association in the hills near the Sarawak border. These soils consist of poorly drained depressions of peat and coarse-textured alluvium.

[24] *Description of soil associations adapted from Sabah Forestry website.*

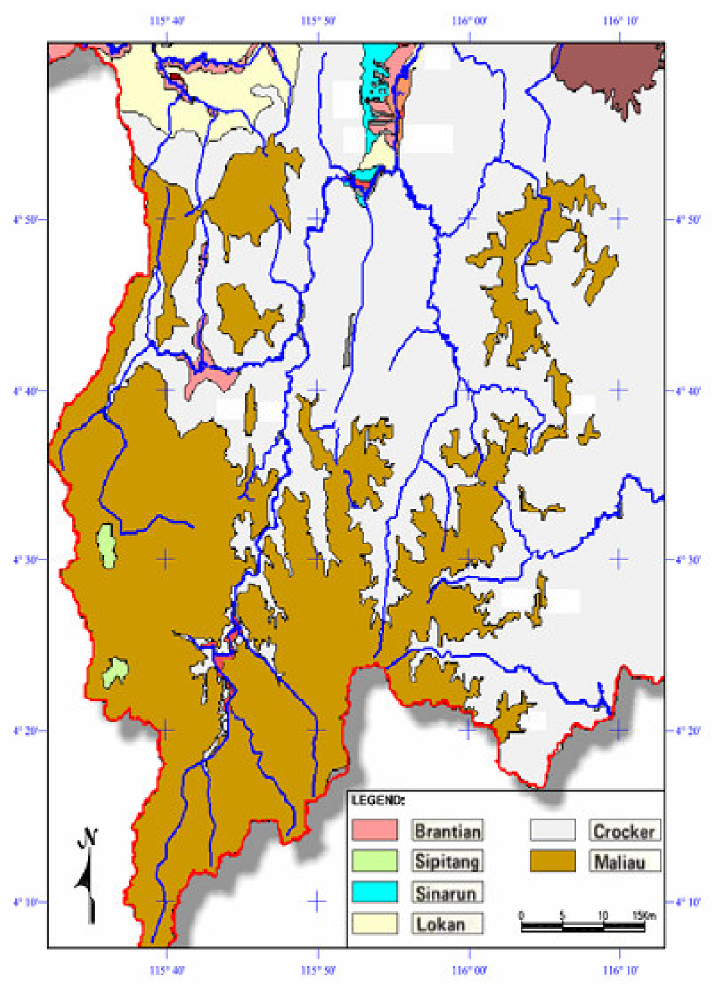

Figure 4.4.2 Soil Associations in the Catchment Area

Grey: Crocker; Brown: Maliau soil association; Green: Sipitang; Purple: Binkor

Source: ICZM/DANCED

Crocker. The Crocker Association is the most extensive association in Sabah and it is almost continuous from the Kudat and Bengkoka Peninsulas in the northeast to the Kalimantan boundary in the south.

Amplitudes are in excess of 300 m and slopes are normally greater than 25°. Ridge crest and valley bottoms are narrow and landslips are common. The mountains are formed of interbedded sandstone and mudstone.

Much of the association is under lowland dipterocarp forest. The association is quite unsuitable for agricultural development largely because of the steepness of the majority of slopes.

Maliau. The Maliau Association is extensive in the south of the Sipitang and Tenom Districts.

Sandstones which vary in colour from white, through yellowish red and which are mainly omposed of fine sand are the dominant parent materials. Interbedded mudstone is less common but it occurs notably in the low concentrically arranged troughs within the basin structures. The primary, natural vegetation comprises dipterocarp forest on scarp slopes and dissected dip slopes with heath forest on long plane dip slopes. The association is not suitable for agricultural development.

Sipitang. The Sipitang Association occurs above 1,200 m in the Maligan Range near the border to Sarawak. It consists of poorly-drained depressions of peat and coarse-textured alluvium.

Brantian. While this association occurs extensively elsewhere in Sabah, it only occurs in the catchment area as a small pocket on part of the Sg. Maligan and along the Padas River from the Powerhouse to Tenum. The association occurs on terraces of old alluvium. These terraces are, in general, flat to slightly undulating with short steep slopes in dissected parts. The alluvium is mainly medium, rarely fine, in texture and in places contains variable amounts of pebbles. Deep pebble deposits also occur. The pebbles are mainly of quartz.

Lokan. While the Lokan Association is the second most extensive association in the state it is only present near the Project site on slopes of the east banks of Padas between the powerhouse and Tenom.

It occurs on very high hills with amplitudes up to 300 m and slopes often greater than 25°. Hill crests are often very narrow. The hills are formed of interbedded sandstone and mudstone.

Sinarum. The Sinarum Association occurs in the Tenom, Keningau, Tambunan and Penawan Plains, and does thus form the main valley bottom for the Padas River from the powerhouse to Tenom.

Parent materials comprise medium- to fine-textured, sometimes pebbly, alluvium overlying sandstone and mudstone. The alluvium often forms cappings on the hills with sandstone and mudstone outcrops on lower slopes. It forms on strongly dissected terrace remnants of formerly extensive inland plain at heights of about 450 m. These high level terraces are mainly surrounded by mountains rising to about 1,050 m.

Erosion. The Padas River is turbid due to forestry and agricultural land use activities in the catchment. Dinor et al (2007)[25] estimated the deforested area (or large scale agriculture) in the Padas catchment down to Kemabong over the period 1984 to 1995 at 23%, resulting in an increase in the peak flood discharge and in runoff volume. Annual sediment load entering the river system was estimated using DHI's Soil Erosion Assessment module, SEAGIS. SEAGIS is a GIS based application for the assessment of soil erosion risk (full details on the SEAGIS setup and calibration can be found in the Appendix document). From SEAGIS, the sediment yield at the upper Padas dam site was estimated at 320,000 t/year (**Figure 4.4.3**), which correspond to a sediment yield at 170 t/km^2/year. In

[25] *"Deforestation Effect to the Runoff Hydrograph at Sungai Padas Catchment", Dinor et al, Paper to Rivers 07 Conference, June 2007, Kucking, Sarawak, Malaysia (http://redac.eng.usm.my/html/publish/2007_18.pdf).*

comparison, the SWECO study put the figure at 300,000 t/year which correspond to sediment yield at 160 t/km^2/year. It is noted that this prediction is in line with estimates given by Malmer, A.[26] which range from 90 to 390 t/km^2/year.

This prediction is in line with estimates from previous studies. A feasibility study for the Murum Hydroelectric Project (1994) calculated the sediment yield at 390,000 t/year (205 t/km^2/year). In contrast, the SWECO study put the figure at 300,000 t/year.

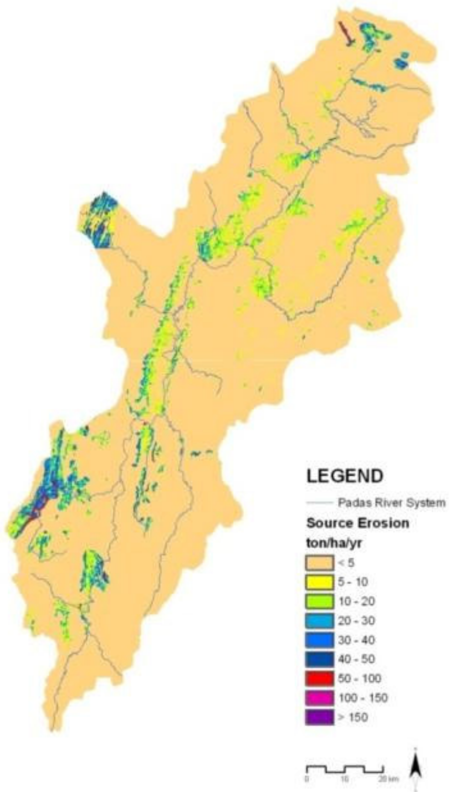

Figure 4.4.3 Source Erosion (t/ha/yr), with Lumped Source Erosion and Sediment Yield Per Sub-Catchment (t/year)

4.4.3 TOPOGRAPHY AND RIVERS

Based on the Horton-Strahler's Method (Horton, 1945; Strahler, 1957), streams and rivers within the area and the immediate vicinity of the Upper Padas Hydroelectric Project fall within the 1st - 4th order[27]. The stream drainage is a dendritic pattern before discharging into the main Padas River. Padas River (4th order) is the main river system fed by one major tributary, that is the Maligan River (3rd order) which is a left bank tributary of Padas.

[26] *Malmer, A., 1990: "Stream Suspended Sediment Load After Clear-Felling and Different Forestry Treatments In Tropical Rainforest, Sabah, Malaysia".*

[27] *Springs, water sources and other 'beginnings' are of 1st order. Where they join other water courses, they become 2nd order streams, joining other streams again to become 3rd and 4th order rivers etc.*

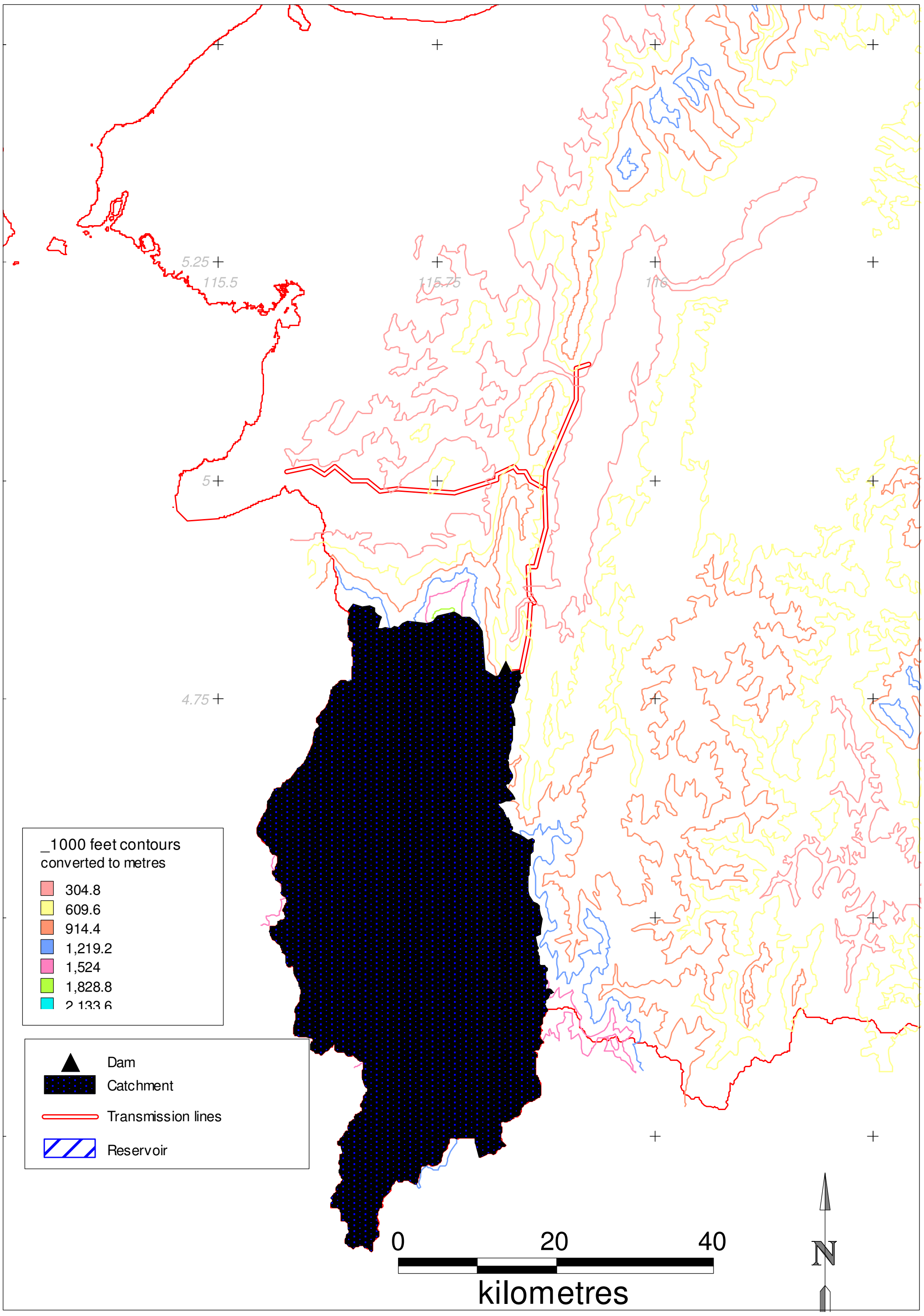

Figure 4.4.4 1000 ft Contours (shown in metres)

Source: Adapted from ICZM/Danced

The river has dug its path through a highland with several peaks exceeding the 2000 metres (**Figure 4.4.4**). The valleys are steep and narrow making the slopes prone to failure and land use constrained.

4.4.4 VEGETATION

The vegetation of the catchment area is mainly under the management of Sabah Forest Industries, who converts the areas that are suitable (slope, soils) from (disturbed) natural dipterocarp forest to industrial tree plantations of mainly Eucalyptus and Acacia mixed with other exotic as well as local species. For this assessment, vegetation investigations have been concentrated in the areas within and surrounding the future reservoir. For further information on sampling data see **Appendix 1-5: Terrestrial Flora** and methodology in **Appendix 2-6: Terrestrial Flora**.

Representing the catchment area outside the reservoir, one station, Station 5, was selected for flora inventory within area logged-over dipterocarp forest on Padas River above the reservoir and one station, station 7, was selected in the area, Compartment P27, that has been converted to Eucalyptus plantation.

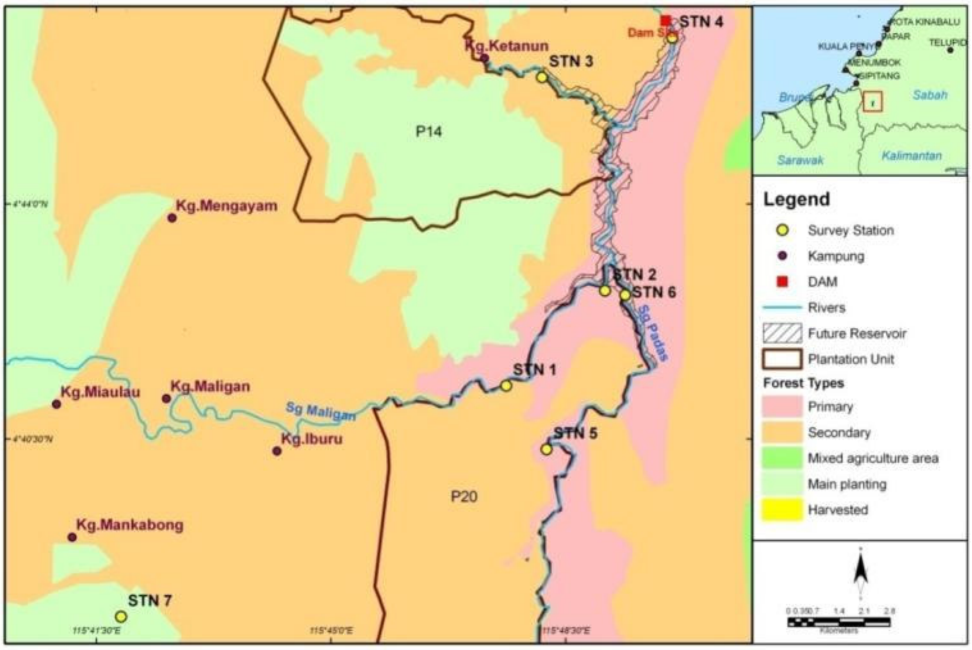

Figure 4.4.5 Flora Inventory Stations

<u>Logged over forest: Station 5 –Padas River above the reservoir.</u> The forest at this site has been logged 10-20 years ago. The skidding trails can be observed and some forest area has been colonised by the secondary species such as *Macaranga* Rattan and other climbers and lianas.

The area of this forest is steep with slopes of around 19° in general. However, at the survey station a more than 25° slope was recorded in all survey plots.

The under-storey layer near the river was dense with lots of seedlings and *Zingiberaceae spp*. such as *kantan* growing beside the river. However, on the steep hilly slopes there is little under-storey vegetation and some areas are almost clear. Steep and rocky slopes at the banks of the Padas River render these areas unsuitable for logging activities. As such, mature *Dipterocarp* trees such as *Seraya (Shorea curtisii)* and *Oba-Suluk (Shorea* *pauciflora)* were found within the survey area mixed with other fruit trees, and DBH was generally more than 19 centimetres (60 cm Girth at breast height).

One protected species of palm (*Arenga undulatifolia*) was observed in the area but was out of the survey plots. The much sought after source of incense *Aquilaria malaccensis*, locally known as *Gaharu*, was recorded in Station 5. This species is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora[28]. *Aquilaria malaccensis* is the major source of agar wood, a resinous heartwood, used for perfume and incense[29].

The combined analysis of all stations within the logged over forest is compiled in the section of this report describing Zone 4: Reservoir Area.

Plantation Area. Station 7: Compartment P27: This survey site is located within SFI's plantation of *Eucalyptus* species (P27) from 2005. Besides the eucalyptus trees, under-storey plants such as climbers, lalang (*Imperata cylindrica*), pokok kapal terbang, (*Eupatorium odoratum*) and grasses are growing well with at least half a meter height of the under-storey vegetation. This is due to the sparse canopy cover of the young eucalypt trees, allowing rapid colonisation and growth of the under-storey vegetation, which is good for the prevention of soil erosion.

Management regimes and seed supplies have changed since 2005 and new plantations are expected to close canopy much earlier than those from under the old regimes.

Community Composition

Species composition. A total of five tree species were found at Station 7 (**Table 4.4-1**). The most common species within the study site was *Eucalyptus grandis* with a total of 34 individuals sampled. Other species were all below 10 individuals found. The rarest species found within site survey is *Eupatorium odoratum* with only 2 individuals found within the survey plot.

Based on the data from all three plots, the relative density, dominance (based on estimated basal area) and frequency have been calculated for each species as shown in **Figure 4.4.6** below. *Eucalyptus grandis* clearly dominates in terms of number of individuals (relative density) as well as biomass (relative dominance).

Table 4.4-1 Summary of Tree Species Found Within the Plantation Area

Species	Local Name
Eucalyptus grandis	Grandis
Musa spp.	Pisang Hutan
Eupatorium odoratum	Pokok Kapal Terbang
Trema orientalis	Menarong
Melastoma malabathricum	Senduduk

[28] *From Wikipedia, the free encyclopedia – Agarwood: http://en.wikipedia.org/wiki/Agarwood*
[29] *From Wikipedia, the free encyclopedia – Aquilaria malaccensis: http://en.wikipedia.org/wiki/Aquilaria_malaccensis*

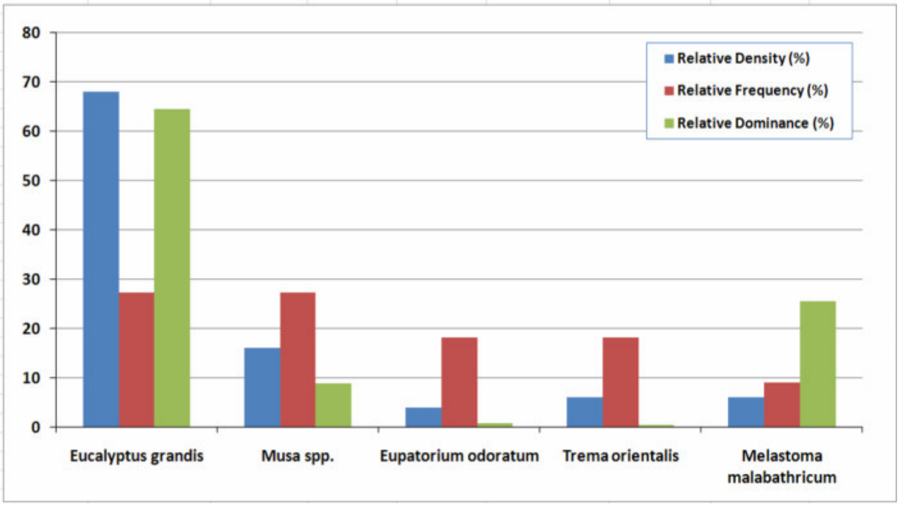

Figure 4.4.6 Relative Density, Dominance and Frequency of All Species Found At Station 7

Trees. On average, 3.7 species were found per 100 m^2 plot in the plantation area with a density of 1670 trees/ha, *Eucalyptus grandis* being the most dominant species.

Under-storey. A total of four under-storey species were found in the plantation station community type. Therefore, species diversity is 4 species per 75 m^2 sub plot. Only *Lianas spp*. was present in the three height classes. Coverage in the station is 62 individual counted per 75 m^2 sub plot. See **Figure 4.4.7** below.

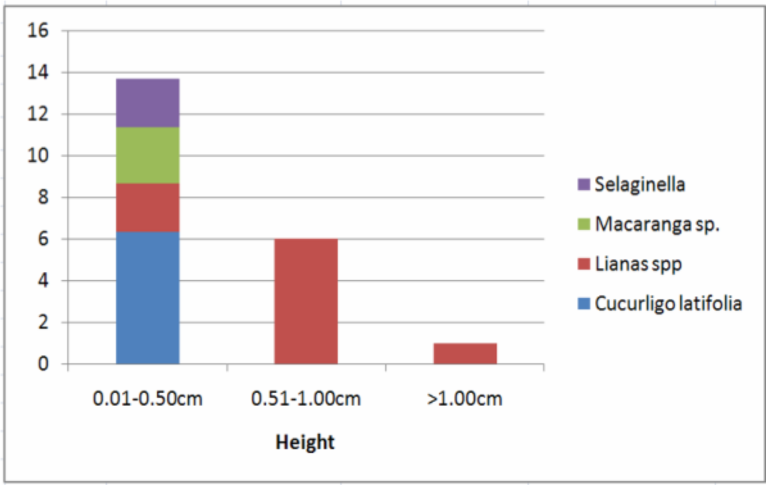

Figure 4.4.7 Number of Under-storey Species per Plot Found Within Station 7

Community Structure

Species attributes Most trees are thin with a mean diameter at breast height (DBH) between 4 and 9 cm (**Figure 4.4.8**). There are significant differences between species. As the basal area (BA = stem cross section) is calculated from DBH, a similar pattern between species can be observed for BA. The average height of the plantation area is low with mean tree height (TH) varying between 3 m to 7 m. The lowest values were for *Eupatorium odoratum* and the highest for *Eucalyptus grandis* (**Figure 4.4.8** and **Figure 4.4.9**).

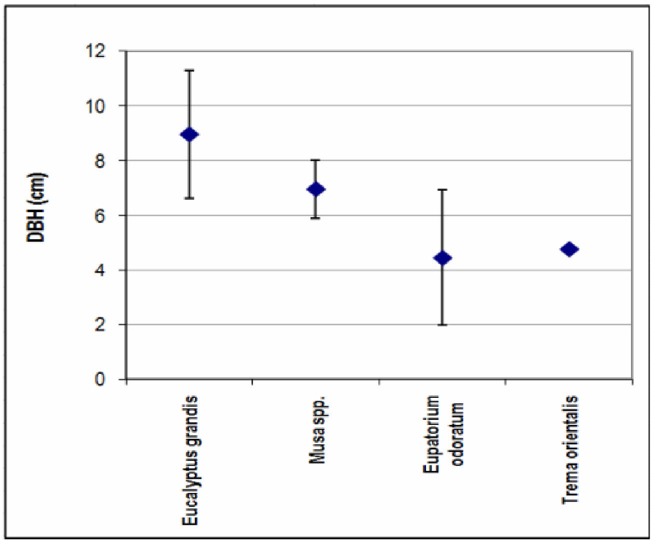

Figure 4.4.8 Mean DBH (Diameter At Breast Height) of the Species Encountered At Station 7

Legend: Bars Indicate the Standard Deviation of the Mean

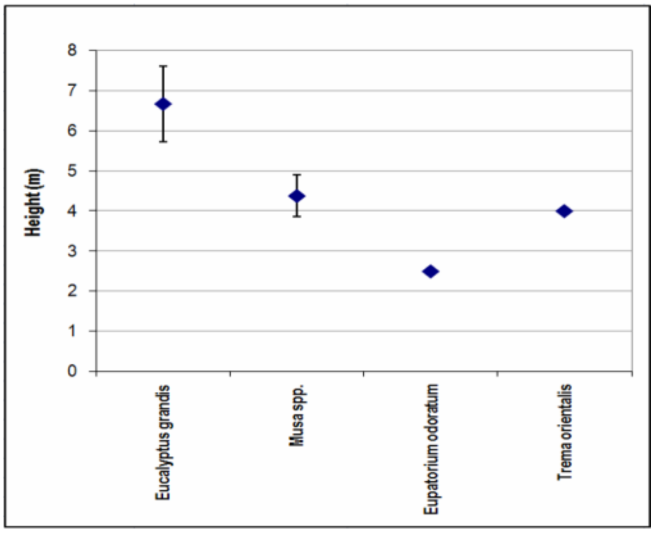

Figure 4.4.9 Mean Height of the Species Encountered At Station 7

Legend: Bars Indicate the Standard Deviation of the Mean

<u>*Stand attributes.*</u>

Tree density. The average density is 1670 trees/ha, which indicates a complete stand planted at a spacing of 3 x 2 metres.

Basal Area. The mean basal area per hectare for the plantation station was 8.4 m^2/ha ±0.49 cm^2. There were no significant differences between the plots. The basal area ranges from 7.9 m^2/ha to 8.8 m^2/ha.

Biomass. The estimated biomass found in the plantation area station is 3.65 tonne/ha for the trees and 0.72 tonne dry weight/ha for the under-storey.

Canopy Closure. The plantation area was uneven and had at the sampling site very large gaps in canopy cover (88.5%) and high light penetration to the forest floor which stimulated thick under-storey vegetation growth biomass of 0.72 t/ha). The plot was selected in an area dominated by gaps due to earlier poor weed management. Other parts of the plantation compartment had achieved canopy closure already.

The areas in P27 would have been planted at 1250 trees per ha. The early maintenance of these stands was poor and survival and subsequent growth was therefore poor. Current practice is to plant at 1600 trees/ha and Sabah Forest Industries has achieved much better weed control. Consequently, new plantations should have canopy closure within one year.

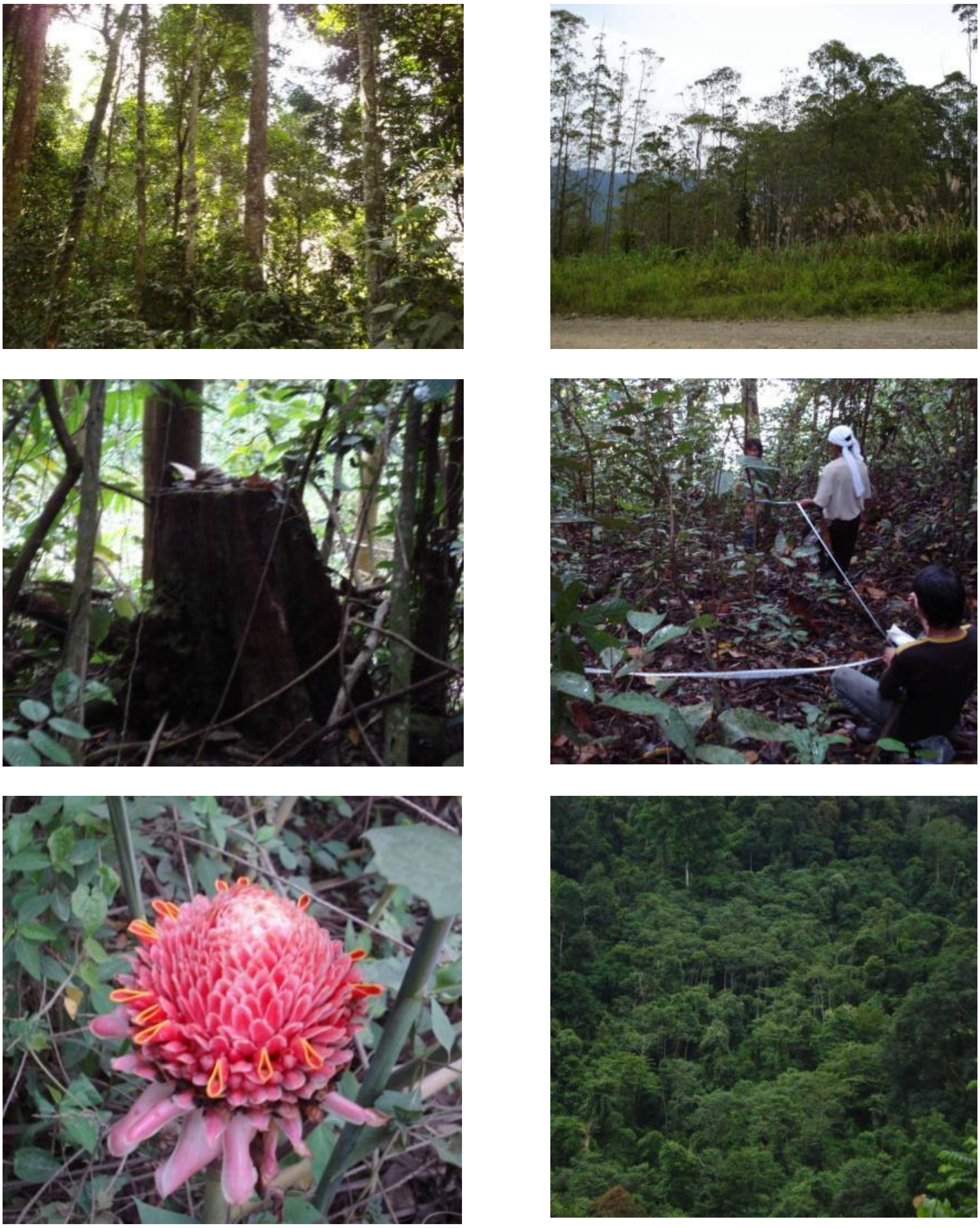

Plate 4.4-1 Flora Sampling

4.4.5 AQUATIC FLORA

Phytoplankton is planktonic algae that live suspended in the water column with little swimming ability. Their distribution is considered to be controlled by physical processes of waters such as current and water mixing. Periphyton is benthic algae that grow attached to surfaces of rocks or larger plants. Both phytoplankton and periphyton are mostly autotrophic that depends on light and chlorophyll to fix carbon dioxide into organic molecules hence they play an important role in the carbon sink. They are also an important component in food web of the aquatic ecosystem.

Sampling was done at twelve stations (**Map 4.4- 1 Aquatic Flora and Fish Fauna Sampling Stations**: Sungai Ulu Padas and Sg. Maligan upstream of the reservoir (stations 9-12). These sites are not expected to be affected by the Project but will be important as a gene pool from which new material will flow downstream. Other sampling stations were selected to represent points or areas, where the proposed Project will change river flow and water levels both upstream and downstream of the dam. The three stations 6-8 at the reservoir area were selected in order to assess the potential impact to phytoplankton and periphyton in this area due to reduced flow and increased water depth. Stations 1-5 at Sg. Paal, Marais and Tomani – all downstream of the powerhouse – were sampled as they are expected to experience some reduction of river water level due to the control of outflow from the dam. The sampling and analysis methodologies are included in **Appendix 2-8: Aquatic Flora**.

<u>Phytoplankton Composition, Epilithic Periphyton Composition & Chlorophyll *a*.</u> Sampling stations were categorized into excellent, good, fair and poor based on the natural state of the stream/river and surrounding environments.

Five stations (Station 1 Menaung areas, Station 2 hunting camp, Station 3 Padas River at the proposed dam site, Station 6 Marais River, and Station 9 high elevation site at Padas River were categorized as good to excellent (site in nature or virtually natural condition; excellent condition), with primary mixed dipterocarp forest on the banks. The river areas were shaded by riparian forest vegetation.

Three stations (Station 4 Katambalang area, Station 7 Sg Paal, and Station 10 Upper Maligan River) were categorized as poor, with significant alteration of natural habitat, with reduced habitat value and experiencing erosion and sedimentation problems, due to agricultural activities, sand mining and/or settlements. River canopy at the sampling area was open with riparian vegetation consisting of grasses and shrubs. This is in line with general observations throughout this multidiscipline assessment that the Padas River and its tributaries is a multi-habitat system with good and less good patches evenly distributed throughout the system. A detailed habitat description of these sampling stations is included in **Appendix 1-7: Aquatic Flora**.

The common phytoplankton and periphyton of streams and rivers include members from diatoms (Bacillariophyceae), green algae (Chlorophyceae) and blue green algae (cyanophyceae). A total of thirty-four taxa of phytoplankton were found in Sg. Padas, Sg. Maligan and their tributaries during this assessment (**Table 4.4-2**), with fourteen taxa of diatom, thirteen taxa of green algae and seven taxa of blue green algae. The common phytoplankton genera were diatoms, *Navicula*, *Pinnularia*, *Denticula*.

Nineteen of epilithic periphyton from three taxonomic algae group were identified in this study (**Table 4.4-3**). The number of epilithic periphyton diatoms found was comparable to those recorded in Batang Balui, Sg Muram, Sg. Linau, Sg. Bahau (6-9 genera) (DOE, 1995), Pinang River Basin (Maznah & Manshor, 2002), but lower than at the tributaries of Batang Rajang Basin (38 genera, Sg Nyimoh & Sibau near Kapit) (DOE, 2005). Seven taxa of green algae were also recorded with density estimates (cell cm^{-2}) varying in the range of 1 to more than 50 cell/filaments cm^{-2}. Green algae *Microspora* were found in abundance in the periphyton samples collected from Sg. Paal.

Some diatom species found are useful as indicator species for habitat assessment. Diatom *Achnanthes oblongella, Cocconeis placentula, Fragilaria capucina and Psammothidium bioretii* were suggested as indicators species for clean water quality in Penang River Basin while several other diatom species *Achnanthes exigua, Gomphonema, Nitzschia palea*, *Pinnularia bicepts* & *P. microstauron* were found in abundance in polluted stations (Maznah & Mansor, 2002).

Chlorophyll-*a* concentration measurements were in the range of 0.49 to 2.30 μg/L (equivalent to mg/m^{-3}) (**Table 4.4-4**). Low chlorophyll-*a levels* in these river ecosystems indicates oligotrophic, i.e. very low, nutrient conditions. This is found to be consistent with the water quality analysis at these sampling locations, which also showed low nutrient level in most of the samples collected. This is well below the Class **I** and **II** of National Water Quality Standard Malaysia (NWQSM) (Frachisse et al. 2009. (See **Table 4.4-4**)

Table 4.4-2 Summary of Phytoplankton Composition (cell L^{-1})

Stations	Below Dam					Above Dam						
						Reservoir			Above Reservoir			
	1	2	3	4	5	6	7	8	9	10	11	12
Locations	Sg. Paal	Sg. Tomani	P. Simon	Sg. Marais	Upper power house	Lower dam	Dam	Upper dam	Sg. Maligan	Maligan bridge	Sg. Ulu Padas	Ulu Padas bridge
Chlorophyceae	0	0	1	6	12	60	80	18	216	20	17	17
Cyanobacteria	0	0	0	6	0	100	0	18	101	30	67	0
Bacillariophyceae	200	266	0	54	12	0	0	0	300	460	818	268

Table 4.4-3 Periphyton Composition (cell or filaments cm-2)

Stations	Below Dam					Above Dam						
						Inundated			Above Reservoir			
	1	2	3	4	5	6	7	8	9	10	11	12
Locations	Sg. Paal	Sg. Tomani	P. Simon	Sg. Marais	Upper power house	Lower dam	Dam	Upper dam	Sg. Maligan	Maligan bridge	Sg. Ulu Padas	Ulu Padas bridge
Chlorophyceae	>50	4	3	1	3	6	8	0	0	0	0	0
Cyanobacteria	0	0	0	1	0	0	0	0	0	0	0	0
Bacillariophyceae	0	7	1	13	3	0	0	0	7	5	10	7

Table 4.4-4 Chlorophyll a Concentration (µg L-1)

Stations	Below Dam					Above Dam						
						Inundated			Above Reservoir			
	1	2	3	4	5	6	7	8	9	10	11	12
Locations	Sg. Paal	Sg. Tomani	P. Simon	Sg. Marais	Upper power house	Lower dam	Dam	Upper dam	Sg. Maligan	Maligan bridge	Sg. Ulu Padas	Ulu Padas bridge
Chlorophyll a	2.30	0.79	1.42	0.77	0.49	1.19	1.78	0.9	0.99	1.7	1.90	1.11

Plate 4.4-2 Aquatic Flora Sampling

4.4.6 WILDLIFE

There has seemingly been little scientific interest in wildlife in the Upper Padas area. No specific literature has been available for this area. Stray notes on wildlife can be found in field reports from e.g. the Danced Sabah Biodiversity Conservation Project and WWF Malaysia in connection with proposals for landscape conservation of the Long Pa Sia area. The notes indicate a very low level of wildlife presence in the area.

Wildlife studies have been concentrated on four areas in connection with the reservoir. These areas – see **Figure 4.4.10** have covered the main vegetation and land use types surrounding the reservoir including the protected area on the East bank. During these studies, direct sightings, sounds, tracks marks or other indicators along tracks and cut survey lines were used to get a measure of the diversity of the fauna. Estimation of population densities or distribution was not attempted.

Generally, although the area have been logged and some areas have been cleared and developed as tree plantations, the major part of the area can still be considered as good habitat for wildlife. This is especially true in areas where selective logging has been practiced in the past and where some good timber stands have been retained. In some areas, forest regeneration has taken place for a longer period and this has allowed the forest to return to almost its original, primary state. Most wildlife can still thrive in such areas provided that there is no further disturbance after logging. This is however not the case for some of the study areas where hunters have gained easy access through the network of logging roads that are still passable to 4-WD vehicles. This has clearly been seen during this survey as some species or signs and tracks from them, notably bearded pig and deer species, were rarely encountered.

Mammals. Generally, most mammal species seem to occur at very low density as very few direct sightings were made during the surveys. Even indirect evidence of their presence was found to be very low throughout the surveyed areas. This was confirmed by the Director of Wildlife Department during an interview on March 2nd, 2010 and with the WWF on March 17, 2010.

Forty six species of mammals were recorded throughout the surveyed areas. These included the Sun Bear, clouded leopard, Leopard cats, otters, martens, bear cat, civets various deer, bearded pig, monkeys, squirrels, rats and bats. Of the forty six species, twenty five (54%) are protected species under the Sabah Wildlife Conservation Enactment 1997.

Of particular interest is the presence of the Malayan Sun Bear and Clouded Leopard, which are priority species to Sabah as they are listed as ‘Totally Protected Species’ under the Wildlife Conservation Enactment and they are also classified as ‘Vulnerable’ on the IUCN Red List. The Project area and its surrounding probably now represents the southwest record of the presence of these species within Sabah.

Large ungulates (Hoofed animals) that were recorded include sambar deer, red muntjac and bearded pig. However, their abundance appeared to be very low in the surveyed area presumably due to heavy hunting pressure in the past. This is indicated by the presence of many recently abandoned hunting huts inside the forest. Hard evidence of hunting activities was found in one of them as the butt of a home made firearm was left at the hut.

The primate community is fairly diverse. Five species were recorded in the area. The Bornean gibbon can frequently be heard in the morning suggesting that there is a healthy population of this species in the area. Other species that were recorded include maroon langur, Hose’s langur, pig-tailed macaque and long-tailed macaque.

The squirrel community is also very diverse with a total of nine species being recorded. These include the Bornean black-banded squirrel, Prevost’s squirrel, Low’s squirrel, tufted ground squirrel and plantain squirrel.

However, there is no evidence of the presence of Borneo Pygmy Elephants or the highly endangered orang-utan, or rhinoceros.

Earlier reports from particularly the WWF that there should be some Tembadaus (Banteng, *Bos javanicus*) in the Ketanun area cannot be confirmed from field observations. Workers and villagers in the area do, however, report that Tembedau occasionally is seen. The Wildlife Department has confirmed this but is of the opinion that it may be a few roaming individuals rather than an actual population.

On the overall, the area is still fairly rich in terms of the diversity of mammal species. The density may be questioned.

A complete species list of mammals that were recorded in the survey area within survey area is presented in **Appendix 1-6: Terrestrial Fauna.**

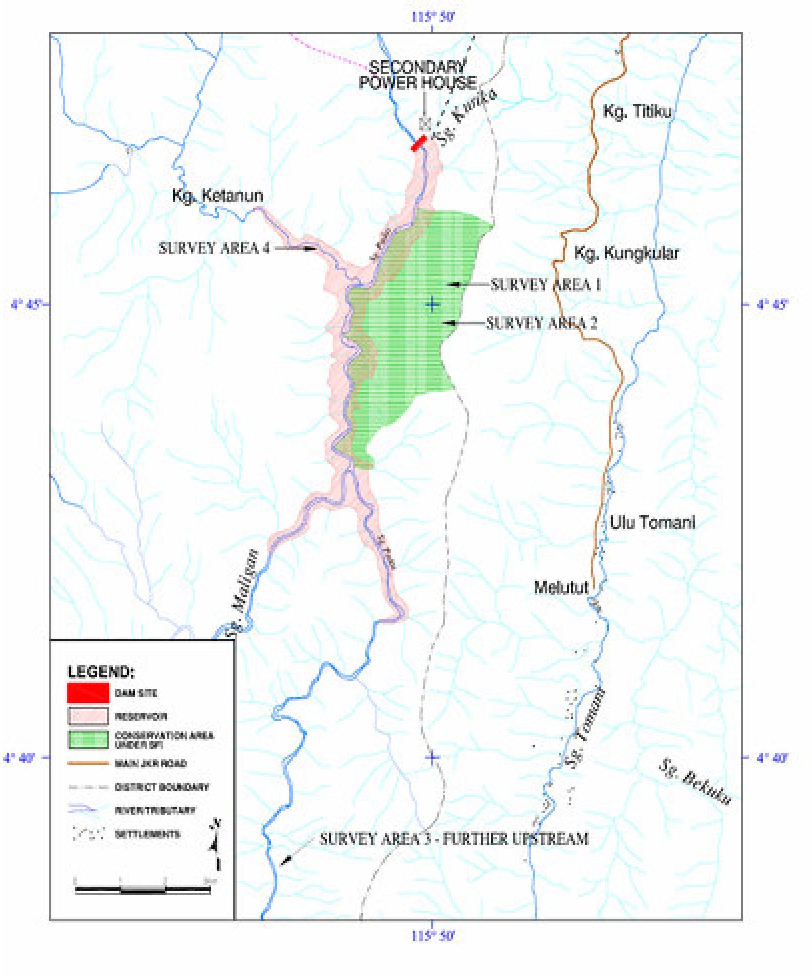

Figure 4.4.10 Wildlife Survey Areas

Birds. All bird species recorded - except for larger birds such as the hornbills and pheasant - were found to be fairly common throughout the surveyed areas. Estimates of their density or distribution were not attempted but there appeared to be a healthy population of most species based on encounter rate.

A total of two hundred thirty eight species of birds from 43 families (see **Table 4.4-5**) were recorded[30] in the survey area of which fifty species (18%) are listed as protected species under the Wildlife Conservation Enactment 1997. Notable species of birds include Bulwer's pheasant, Argus pheasant, crested fireback, crested partridge, crimson-headed partridge and six species of hornbill: The helmeted hornbill, rhinoceros hornbill, wreathed hornbill, bushy-crested hornbill, pied hornbill and white-crowned hornbill. Bulwer's pheasant is classified as 'Vulnerable' on the IUCN Red List while crested fireback, crested partridge,

[30] *Some species were recorded during this survey, some by earlier authors. See **Appendix 1-6** for details.*

helmeted hornbill, rhinoceros hornbill and white crowned hornbill are classified as 'Near Threatened' on the IUCN Red List.

Table 4.4-5 Species Diversity Per Bird Family

FAMILY	Number of species	FAMILY	Number of species	FAMILY	Number of species
Accipiteridae	8	Dicruridae	5	Ploceidae	3
Alcedinidae	7	Eurylaimidae	1	Podargidae	1
Apodidae	4	Falconidae	2	Psittacidae	3
Ardeidae	2	Hemiprocnidae	1	Pycnonotidae	18
Bucerotidae	6	Hirundinidae	2	Ralidae	1
Campephagidae	8	Laniidae	2	Sittidae	1
Capitonidae	8	Meropidae	2	Strigidae	2
Caprimulgidae	2	Motacillidae	19	Sturnidae	2
Chloropseidae	4	Muscicapidae	10	Sylviidae	8
Columbidae	4	Nectariniidae	2	Timaliidae	28
Coraciidae	1	Oriolidae	1	Trogonidae	4
Corvidae	4	Phalaropidae	6	Turdidae	8
Cuculidae	11	Phasianidae	15	Tytonidae	1
Dicaeidae	10	Picidae	4	Zosteropidae	3
		Pittidae	5		

A complete species list of birds that were recorded in the survey area within the surveyed area is presented in **Appendix 1-6: Terrestrial Fauna**.

Plate 4.4-3 A white-lipped Frog on a tree branch overlooking Ketanun River

Plate 4.4-4 Carcass of a Blood Python on the road into the Project area.

Plate 4.4-5 A fresh foot print of a Sambar deer on the bank of Ketanun River.

Plate 4.4-6 A fresh foot print of a Bearded pig on the bank of Ketanun River

Reptiles and Amphibians.

Records of reptiles for the area obtained from the environmental impact assessment for the Sabah Forest Industries area encompass 17 snakes including a viper, a cobra and three pythons; three skinks and the monitor lizard. No crocodiles have been recorded in these earlier studies.

In the present survey only two species were recorded. One carcass of blood python was found lying on the road as a result of road kill. The other was a striped bronze-back which was found on a boulder at Ketanun river. Although no other species were recorded during the survey, it is considered that the other species recorded in previous studies are still present in the area.

The pythons and the monitor lizard are protected under the Wildlife Conservation Enactment. However, none of these are found in the IUCN Redlist.

A total of twenty one species of anuran (Frogs and toads) were recorded in the survey area. Most of the species were found along rivers and smaller stream during night and daytime surveys. Most of the species found in the survey area are widely distributed and generally common in Sabah both in primary and secondary forests with similar habitat types.

The IUCN Redlist has 11 of these species listed as ‘Least Concern’ while Dring's Slender Litter Frog, Hose's Bush Frog, and Short-nosed Tree Frog are listed as ‘Near Threatened. No frogs are locally protected.

A complete species list of herpetofauna (amphibians and reptiles) assumed to be resident within the surveyed area is presented in **Appendix 1-6: Terrestrial Fauna**.

4.4.7 AQUATIC FAUNA

Padas River is within the Project area a multi-habitat River. The benthic substrate varies from cobble (hard substrate), snags (woody debris), vegetated banks, and sand associated with the type of river flow, which is riffles, pools and glides[31]. As an example, the flow classification of the river reach and substrate type at the sampling stations for macro-invertebrates is shown in **Table 4.4-6**.

Table 4.4-6 Description of Macro-benthos Survey Stations in Padas River

Station	Sampled Habitat Type	Substrate Type	Sampled Reach Length (m)
MB 1	Riffle and pool	Boulders, gravel and sand	300
MB 2	Riffle and pool	Boulders, gravel and sand	315
MB 3	Riffle and pool	Boulders, gravel and sand	240
MB 4	Glide	Sand and snags	500
MB 5	Glide	Sand and snags	500

Fishes. Studies on the diversity of the freshwater fishes on the island of Borneo have been carried out by Inger and Chin (2002), Roberts (1989) and Kottelat et al. (1993). A total of 340 species belonging to 25 families are reported to be present in Borneo by Kottelat et al. (1993). In terms of the number of the major families present, 41% is represented by the family Cyprinidae, 14% by the family Balitoridae, 8% by Siluridae and Belontiidae, and 19% by the family Cobitidae.

Fish fauna were sampled at study stations at the dam site, power station, and Tomani Bridge and Marais River reported 7 families and 15 species of fish. The assessment was further supplemented by a preliminary EIA carried out by UMS in 1999. At the dam site, one family comprising 9 species were caught. At the power station and Tomani Bridge, seven families comprising 16 species were caught and at Marais River, 3 families comprising 7 species were caught.

A total of 15 sampling stations were selected as shown in **Map 4.4- 1 Aquatic Flora and Fish Fauna Sampling Stations**.

[31] *David V. P., James M. L., and Donal J. K. 2001. Environmental monitoring and assessment program surface waters: Western Pilot Study Field Operation Manual For Wadeable Stream. National Health and Environmental Effects Research Laboratory Office of research and Development U.S Envrionmental Protection Agency Research Triangle Park. NC 27711.*

The location of the sampling stations in relation to the proposed dam were: 4 stations were located at the area to be inundated for the reservoir, 5 stations below the proposed dam site, 4 stations at an area above the reservoir, i.e. an area above the dam that will not be inundated, and 2 stations below Pangi Dam. Assessment of habitat quality within approximately 100 m stretch of sampling area was conducted following the method of the Water Quality Monitoring Program by Lincoln University of Australia (2002). The physical characteristics of the stations are summarized in **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**.

A total of 1,005 fish samples were collected from the 15 sampling stations (see **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**). A summary of the diversity, i.e. number of families and species per station is included in **Table 4.4-7**. The number and species of fish caught from each of the study station is influenced by the type of habitat present at that particular station.

Table 4.4-7 Number of Fish Families and Species Represented Per Zone and Station

	Zone 4: Reservoir					Zone 6: Downstream				Zone 2: Catchment Area			Zone 6: Pangi, Downstream		
Family / Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bagridae	1			1	1					1				1	1
Balitoridae	3	1	5				5	7	2	4	1		4		
Channidae													1		
Clariidae	1									1					
Cyprinidae	10	2	4	4	5	6	7	4	6	8	1		7	8	7
Mastacembelidae									1				1	1	
Siluridae				1	1									1	
Sisoridae							1	1	3	1			1		
Synbrachidae														1	1
Total per station	**15**	**3**	**9**	**6**	**7**	**6**	**13**	**12**	**12**	**15**	**2**	**0**	**14**	**12**	**9**
Total per zone	**21**					**16**				**27**			**14**		

At Station 1, 193 fishes were caught comprising 4 families and 15 species. Cyprinidae is the dominant family caught making up 94 percent of all the total number of individuals caught. In terms of the number of individuals caught, the three dominant species are *Tor tambra* (45 percent), *Puntius binotatus* (20 percent) and *Paracrossochilus acerus* (14 percent).

Only six individuals from two families and three species were caught from Station 2. Puntius binotatus is the dominant species comprising 67 percent of the total number of individuals caught.

At Station 3, 109 fishes were caught comprising 2 families and 9 species. Balitoridae is the dominant family caught making up 67 percent of all the total number of individuals caught. In terms of the number of individuals caught, the three dominant species are Tor tambroides (28 percent), *Glaniopsis multiradiata* (27 percent) and *Glaniopsis hanitschi* (17 percent).

Twenty-three individuals were caught from Station 4 comprising 3 families and 6 species. The dominant species is *Mystus baramensis* comprising 48 percent of all the total number of individuals caught.

At Station 5, eighteen individuals were caught comprising 3 families and 7 species. Cyprinidae is the dominant family comprising 61 percent of the total number of individuals caught. The two dominant species are *Mystus baramensis* and *Barbonymus sp.* comprising 28 percent and 22 percent respectively.

Twenty-eight individuals were caught from Station 6 from one family (cyprinidae) and 6 species. The dominant species is Lobocheilos bo comprising 61 percent of the total number of individuals caught.

At Station 7, one hundred and fifteen individuals were caught comprising 3 families and 13 species. Cyprinidae is the dominant family comprising 78 percent of the total number of individuals caught. The three dominant species are *Lobocheilos bo* (41 percent), *Paracrossochilus acerus* (24 percent) and *Homoloptera bebulosa* (12 percent).

At Station 8, eighty-eight individuals were caught comprising 3 families and 12 species. Balitoridae is the dominant family comprising 65 percent of the total number of individuals caught. The three dominant species are *Gastromyzon borneensis* (30 percent), *Paracrossochilus acerus* (22 percent) and *Gastromyzon lepidogaster* (16 percent).

At Station 9, one hundred and twenty-nine individuals were caught comprising 4 families and 12 species. Cyprinidae is the dominant family comprising 74 percent of the total number of individuals caught. The three dominant species are Lobocheilos bo (46 percent), Osteochilus chini (15 percent) and Homoloptera bebulosa (13 percent).

At Station 10, one hundred and seventy-nine individuals were caught comprising 5 families and 15 species. Balitoridae is the dominant family comprising 44 percent of the total number of individuals caught. The three dominant species are Nematabramis everetti (15 percent), Gastromyzon lepidogaster (15 percent) and Gastromyzon borneensis (13 percent).

Only two individuals were caught from Station 11 and no fish were caught from Station 12.

At Station 13, seventy-three individuals were caught comprising 5 families and 14 species. Cyprinidae and Balitoridae are the dominant families comprising 56 percent and 40 percent of the total number of individuals caught respectively. The four dominant species are Paracrossochilus acerus (33 percent), Gastromyzon lepidogaster (14 percent), Gastromyzon borneensis (11 percent) and Gastromyzon monticola (11 percent).

Twenty-one individuals from 5 families and 12 species were caught from Station 14. Cyprinidae is the dominant family comprising 71 percent of the total number of individuals caught. The dominant species is Lobocheilos bo making up 24 percent of the total number of individuals caught.

At Station 15, twenty-one individuals were caught comprising 3 families and 9 species. Cyprinidae is the dominant family comprising 91 percent of the total number of individuals caught. The dominant species is Osteochilus chini making up 19 percent of the total number of individuals caught.

Species such as those from the families Balitoridae, Mastacembelidae and Sisoridae are well adapted to clear and fast flowing. However, species from the family Cyprinidae are normally found in both smaller tributaries and larger rivers. Larger sized individual of the commercially important species such as Tor spp. are mainly found in the larger rivers such as Padas River and Maligan River.

A total of 9 fish families represented by 22 genera and 35 species were present in the study area (**Table 4.4-8**). There is a significant increase in the number of family, genera and species caught from the present study when compared to the preliminary EIA study mainly due to the wider area sampled during this study period and an increase in the methods of fishing employed.

Table 4.4-8 Fish Families and the Number of Their Related Genera and Species Caught From All the Study Stations

Family	Genera		Species		Individual	
	No.	%	No.	%	No.	%
Bagridae	1	4.5	1	2.9	23	2.3
Balitoridae	5	22.7	11	31.4	288	28.7
Channidae	1	4.5	1	2.9	1	0.1
Clariidae	1	4.5	1	2.9	8	0.8
Cyprinidae	10	45.5	13	37.1	648	64.5
Mastacembelidae	1	4.5	2	5.7	3	0.3
Siluridae	1	4.5	2	5.7	5	0.5
Sisoridae	1	4.5	3	8.6	26	2.6
Synbranchidae	1	4.5	1	2.9	3	0.3
Total per station	22	100	35	100	1005	100

Cyrinidae and Balitoridae are the most dominant families in the area (**Table 4.4-8**). In terms of the number of fish genera present in the study area, 46% is represented by the family Cyprinidae and 23% by the family Balitoridae. In terms of the number of species caught, 37% is represented by the family Cyprinidae and 31% by the family Balitoridae. In terms of the number of individuals caught by family, 65 percent is represented by the family Cyprinidae and 29% by the family Balitoridae. The dominance of Cyprinidae in the study area is typical of the freshwater rivers in the whole of South East Asia (Lowe-McConnell, 1975). In Western Borneo, about one-third of all freshwater fishes belong to the family Cyprinidae (Roberts, 1989).

There are 16 species recorded from the area below the dam, 21 species recorded from the area to be inundated, 27 species from the area that will not be flooded and 12 species caught from sampling stations at Kampung Pangi area (See **Table 4.4-7**). More species is present in the area that will not be flooded compared to the area to be inundated.

In terms of the species that are only caught from one of the survey areas, three species *Chela* sp., *Kryptopterus macrocephalus* and *Monopterus albus* were only found in Kampung Pangi, five species, *Gastromyzon fasciatus*, *Channa striata*, *Paracrossochilus vittatus*, *Mastacembelus maculatus and Glyptothorax platypogonoides* were only found at the catchment area above the planned reservoir, one species (*Glaniopsis denudate*) found at planned reservoir site area, and no species were reported present at area below the dam (see **Table 4.4-9**).

Therefore, assuming that all the species present in the study area have been caught, then only one species, *Glaniopsis denudata* may be lost as a result of the proposed dam. However, since this species prefer relative fast flowing water, it is likely that they are present in the upper catchment but were not caught due to relative inaccessibility of the area. *Glaniopsis denudate* is not listed as threatened in the 2008 IUCN Red List of Threatened Species (IUCN, 2008). This species is commonly found elsewhere in fast flowing and shallow waters in Sabah (Inger and Chin, 2002) and north Borneo (Kottelat *et al.*, 1993).

Table 4.4-9 List of Fish Species that are only Found in one of the Study Areas

Study Area	Family	Species
Below the Dam	*None*	*None*
Reservoir Area	Balitoridae	*Glaniopsis denudata*
Upper Catchment	Balitoridae	*Gastromyzon fasciatus*
	Channidae	*Channa striata*
	Cyprinidae	*Paracrossochilus vittatus*
	Mastacembelidae	*Mastacembelus maculatus*
	Sisoridae	*Glyptothorax platypogonoides*
Kampung Pangi	Cyprinidae	*Chela* sp.
	Siluridae	*Kryptopterus macrocephalus*
	Synbranchidae	*Monopterus albus*

Indicator and Threatened Species. The types of habitat determine fish species present at a particular area. Species from the families *Balitoridae, Mastacembelidae* and *Sisoridae* are normally found in clear and fast flowing waters and prefer stony or rocky bottom where they would stay on rock surfaces and crevices. In this aspect, *Gastromyzon spp.* is a good indicator as they are sensitive to changes in water current and increase in suspended solids. This species stays on rock surfaces and feed on algae growing on the. This species is present in eight of the study stations.

Altogether, 35 species were reported from the study area. Although *Glaniopsis denudate* is only caught from the area to be inundated, this species is also found in other small and fast flowing rivers in Sabah. As mentioned before, this species is not listed as threatened in the 2008 IUCN Red List of Threatened Species (IUCN, 2008). Similarly, none of the other 34 fish species are listed as threatened in the 2008 IUCN Red List of Threatened Species.

Fish Movement. The Tenom Pangi diversion weir is the only structure on the Padas River that obstructs movement of fish upstream.

Movement of fish In Padas River has been reported by the local people and the species involved include *Tor spp., Osteochilus sp.* and *Rasbora sp.* This movement is usually associated with the spawning season where spawners start to form schools. It is postulated that this is just a localized movement to the spawning grounds. Similar observations were also reported to occur in major rivers in Sarawak such as the Batang Rajang (Nyanti, 1995) and Tutoh River (Nyanti and Jongkar, 2007).

Diversity Indices. The values of species diversity index (H') ranges from 0 in Station 12 to 2.44 in Station 10, richness index (D) ranges from 0 in Station 12 to 3.61 in Station 14 and evenness index (J) ranged from 0 in Station 12 to 1.0 in Station 11 (see **Table 4.4-10**). The wide range in values of species diversity index, richness index and evenness index is probably due to the differences in habitats among the sampling stations.

Table 4.4-10 The Value of Species Diversity (H'), Richness (D) and Evenness (J) Recorded From All the Study Stations

Station	H'	D	J
1	1.78	2.66	0.66
2	0.87	1.12	0.79
3	1.79	1.71	0.81
4	1.48	1.59	0.83
5	1.80	2.08	0.92
6	1.25	1.50	0.70
7	1.79	2.53	0.70
8	2.00	2.46	0.81
9	1.69	2.26	0.68
10	2.44	2.70	0.90
11	0.69	1.44	1.00
12	0	0	0
13	2.16	3.03	0.82
14	2.33	3.61	0.94
15	2.11	2.63	0.96

The values of the indices obtained in the present study are comparable to the pre-EIA study carried out by Universiti Malaysia Sabah. The index values are also comparable with indexes obtained from other rivers in Sarawak that are of similar order, altitude and degree of disturbances (Nyanti et al., 1995; Nyanti et al., 1998; Nyanti and Wei Wei, 2007; Nyanti and Jongkar, 2007; Nyanti, 2009).

Macro Invertebrates. Freshwater benthic macro-invertebrates are animals without backbones. These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. The benthos, i.e. the group of life forms living on or near the bottom of rivers and lakes, include crustaceans such as crayfish, molluscs such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

These animals are widely distributed and can live on all bottom types, even on manmade objects. They can be found in hot springs, small ponds and large lakes. Some are even found in the soil beneath puddles. Many species of benthos are able to move around and expand their distribution by drifting with currents to a new location during the aquatic phase of their life or by flying to a new stream during their terrestrial phase. Most benthic species can be found throughout the year[32].

Benthos is an important part of the food chain, especially for fish. Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Because of their abundance and position in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients in the ecosystem.

The benthic macro-invertebrates community assessment in the Upper Padas River within the potential impact area of the proposed hydroelectric Project shows that a wide variety of invertebrates have made their home in various difficult habitats (mainly at the upstream reaches) where conditions are constantly changing due to natural fluctuations in the river water level. The species recorded are adapted to these conditions. E.g. some are equipped with clinging mechanisms, while others have burrowing strategies enabling them to withstand the river flows and remain in the river habitat.

Although aquatic insects are important to the ecosystems and as indicator species in bio-assessments, the distribution of macro-invertebrates is still poorly documented, especially in Sabah rivers. The lack of knowledge is caused by a number of factors such as the high diversity of invertebrates and their numerical abundance, which has contributed to their neglect. In addition, invertebrates are small and difficult to identify.

<u>Literature review</u>. In 1999, Department of Environment (DOE) published a report on the classification of Padas River which included a classification based on river biota. This was performed using two indices, the Family Biotic Index (FBI) and Biological Monitoring Workers Party (BMWP) Score.

[32] *Voshell, J.R. 2002. A guide to common freshwater invertebrates of North America.*

Another study on the invertebrates from the rivers in Crocker Range Parks, Sabah has been carried out in 2002[33]. The upper parts of the rivers studied were Sungai Mawau, Sungai Ulu Senagang, Sungai Balayo, Sungai Liawan, Sungai Tandulu and Sungai Tikolud. All of the rivers feed into Padas River and are generally fast flowing. Other reports include SAMA Consortium[34] on the molluscs in the Pelagus area, and Sarawak. Abang et al. in 1995[35] on the status of the lotic invertebrate diversity of the upper Balui River, Sarawak. Five orders of macro-benthos, mainly insects, were reported from the rivers in Bario, Kelabit Highlands of Sarawak[36].

Indicator species. Benthos represents an extremely diverse group of aquatic animals, and the large numbers of species possess a wide range of responses to stress factors such as organic pollutants, sediments, and toxic agents. The macro-benthos as an indicator of river water quality are classified into three different groups with regard to their ability to survive at different water quality conditions. **Table 4.4-11** shows these three different groups of biological indicator organisms.

Table 4.4-11 Biological Indicator Organisms[37]

Pollution Sensitive Organisms	Pollution Intermediate Organisms	Pollution Tolerant Organisms
➢ Caddisfly larvae (Order Trichoptera), ➢ Mayfly nymphs (Order Ephemeroptera), ➢ Water penney beetle larvae (Family Psephenidae), ➢ Riffle beetles (Family Elmidae), ➢ Stonefly nymphs (Order Plecoptera), ➢ Other snails (Class Gastropoda).	➢ Beetle larvae (Order Coleoptera), ➢ Damselfly nymphs and Dragonfly nymphs (Order Odonata), ➢ Scuds (Order Amphipoda) ➢ Crayfish (Order Decapoda), ➢ Sowbugs (Order Isopoda), ➢ Clams (Order Pelecypoda), ➢ Crane fly larvae (Family Tipulidae)	➢ Aquatic worms (Phylum annelid and others), ➢ Pouch snails (Class Gastropoda), ➢ Black fly larvae (Family Simuliidae), ➢ Leeches (Class Hirudinea), ➢ Midge larvae (Family Chironomidae)

Sampling. A total of five sampling stations were established (see **Figure 4.4.11**). Two of these stations are upstream of the dam site (but within the future impoundment area), one station is located at the proposed dam site and two stations are located downstream of the dam site at the proposed power house site. The coordinates of these are provided in **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**.

33 Shabdin M. L., Fatimah A., and Khairul A. A. R. 2002. The Macro-invertebrate community of The Fast Flowing Rivers in the Crocker Range National Park Sabah, Malaysia.

34 Sama Consortium. 1982. Pelagus/Bakun hydro-electric projects: ecological impacts. German Agency for Technical Cooperation Ltd. Report for SESCO, 1982.

35 Abang. F., S. Mohd. Long and N. Ismail. 1995. Lotic invertebrate diversity of the upper Balui River: the current status. International Symposium and Workshop on Conservation Biology: Molecular, Biotechnological and Conventional Approaches, Kuching, Sarawak.

36 Shabdin, M. L. and F. Abang. 1998. The benthic invertebrate community of rivers in Bario, Kelabit Highlands, Sarawak. In: Ghazally, I. & D. Laily (eds), Bario the Kelabit Highlands of Sarawak, Pelanduk Publications, pp. 193-199.

37 Biological Stream Assessment, Water Watch Biological Monitoring Procedures.http://www.state.ky.us/nrepc/water/bioindpg.htm.

The upstream stations (MB1 and MB2) are located at a higher elevation with fast flowing rapids and full with big boulders. Only vegetation that have solid roots attached to rock are able to withstand the extreme current flow during the high water periods. These stations are described as a headwater stream and the water level can rise, flooding the river banks during rainy periods.

MB3 and MB4 at the power house site are situated in rapid areas. The water was flowing rapidly during the survey and sampling was difficult. Sampling was done in areas with relatively lower flow by dislodging rocks and brushing these to dislodge the invertebrates.

MB5 is located at the proposed dam site. Here the current was still fast with some deep pools downstream the rapids.

The stations at the dam site and at Sg. Maligan are dominated by large boulders with deeper water compared to the other stations.

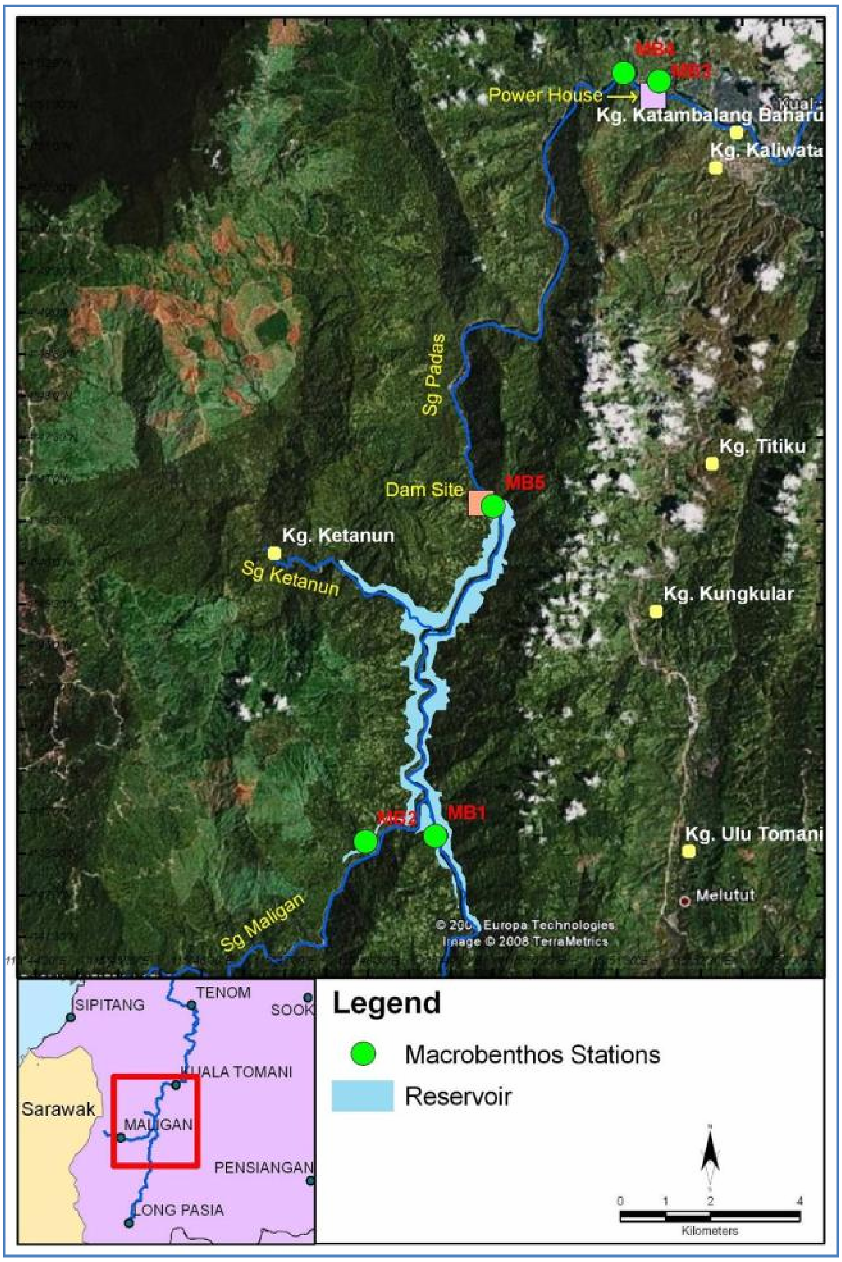

Figure 4.4.11 Location of Macro-benthos Sampling Stations Along Padas River

A total of 36 species belonging to 10 different orders were found in **Table 4.4-12**. A more detailed table is included in **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**. Station MB2 at Sg. Maligan and MB5 at the dam site had the lowest densities with less than 150 individual/m^3 (**Figure 4.4.12** and **Figure 4.4.13**). Other stations had densities above 1000 individual/m^3.

Station MB3 at the powerhouse site had the highest abundance among the five stations, with a total of 96 individuals sampled, or 2714.93 individual/m^3 followed by the Station MB1 at the upper reservoir site on Sg. Padas with 94 individuals in the sample, or 2658.37 individual/m^3. Station MB5 at the dam site had the lowest abundance, 113.12 individual/m^3, with only 4 individuals sampled.

Table 4.4-12 Benthic Invertebrate Taxa and Individuals/Species Per Sample Station (Summary)

Taxa : Station:	MB1	MB2	MB3	MB4	MB5
Anisoptera			2/2		
Crustacea	3/1		1/1	3/1	3/1
Coleoptera	3/3	4/3	3/2	3/2	
Ephemeroptera	81/3		30/2	23/4	
Hemiptera	3/1	1/1	2/1		
Odonata	1/1		1/1	1/1	1/1
Plecoptera			1/1		
Tabanidae	2/1			2/1	
Trichoptera	1/1		38/3	23/3	
Zygoptera			18/1		
Individuals per sample	**94**	**5**	**96**	**55**	**4**
Species per sample	**11**	**4**	**14**	**12**	**2**

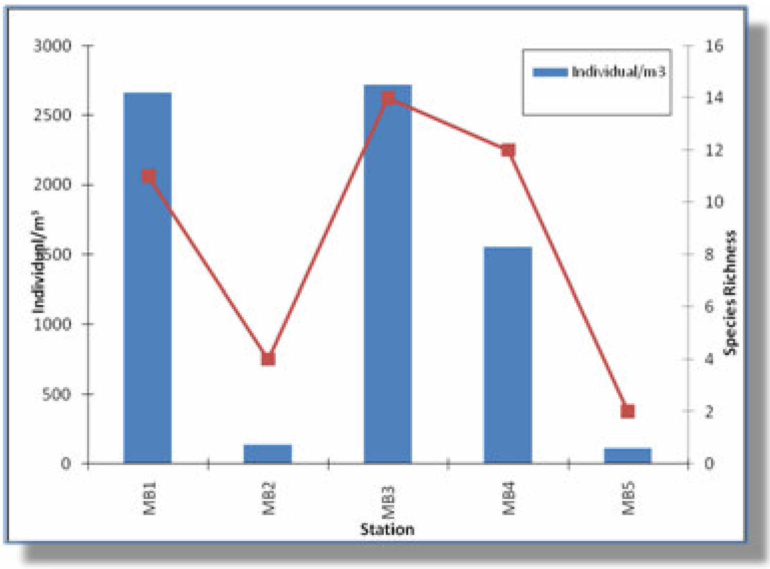

Figure 4.4.12 Macro-benthos: Abundance and Species Richness per Sampling Station

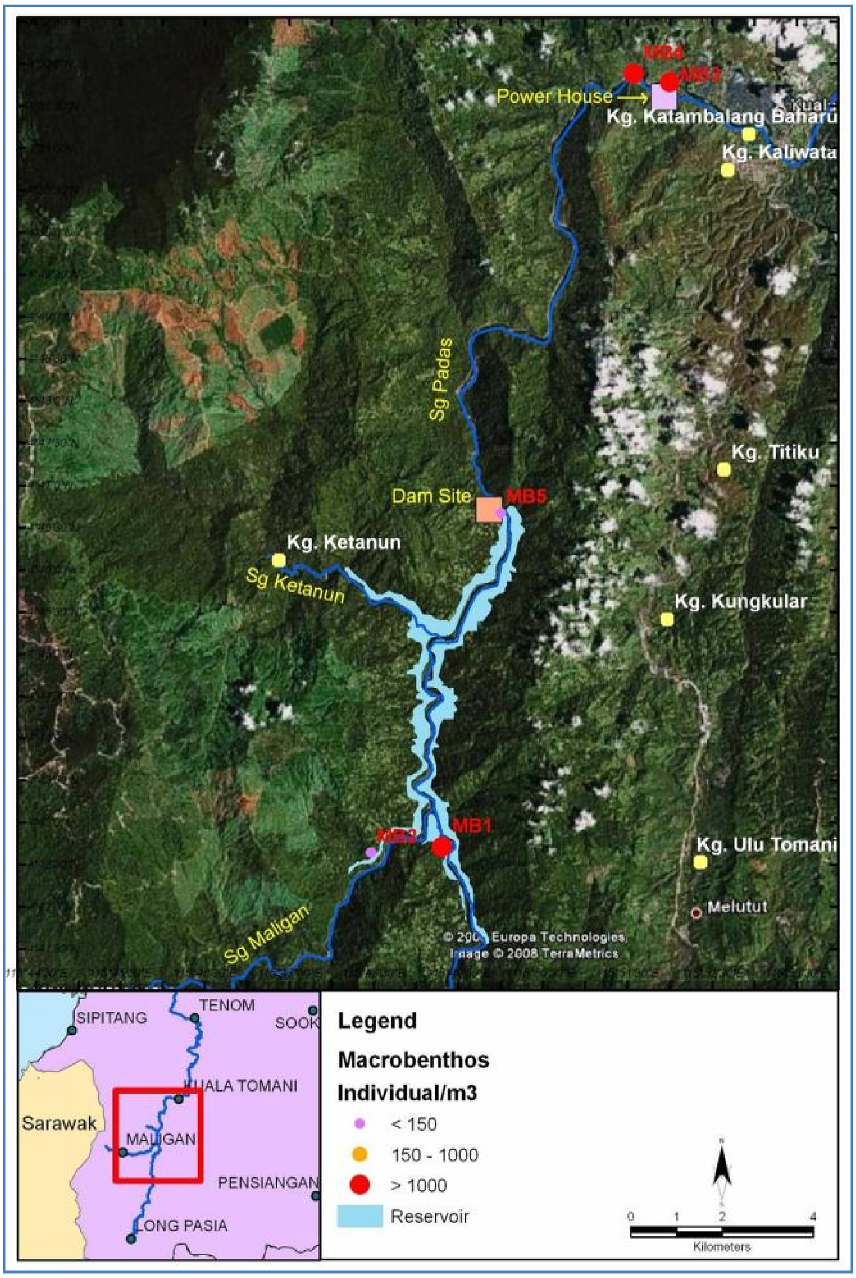

Figure 4.4.13 Macro-benthos Density at the Sampling Stations

Ephemeroptera (mayfly) were the most dominant taxa in the sampling area constituting 53% of total invertebrates identified at all stations. Eight different species from five genera were found. Ephemeroptera or mayfly is a typical insect found in most of the rivers of Sabah[38].

Mayfly (nymph) is found in a variety of aquatic habitats ranging from standing to running waters.

[38] *Shabdin M. L., Fatimah A., and Khairul A. A. R. 2002. The Macroinvertebrate community of The Fast Flowing Rivers in the Crocker Range National Park Sabah, Malaysia.*

There are also mayflies that live in lower water flow environments and some are able to burrow into sandy substrates[39]. Many mayfly nymphs collected in this survey were from the fast flowing sections of the river and one in gravel-sandy bottom.

Six species of Trichoptera constituted 24% of the total benthos count which makes it the second most dominant taxa while Zygoptera made up 7% of the total count (**Figure 4.4.14**). The least dominant taxa were Plecoptera, compromising 0.4% of the total count with only one individual found at station MB3.

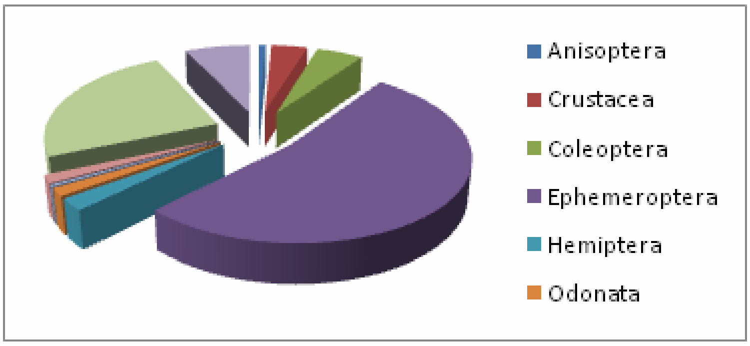

Figure 4.4.14 Composition of the Benthic Groups

Figure 4.4.15 show that the Sg. Maligan (MB2) and the Dam site (MB5) stations had the lowest species richness. Only two species were found in each of these stations. Coleoptera and Hemiptera were only found in Sg. Maligan while Crustacea and Odonata were found at the dam site.

[39] Khoo Soo Ghee. Insecta: Ephemeroptera by in "Freshwater invertebrate of the Malaysia Region, Academy of Science Malaysia. Pp 395.

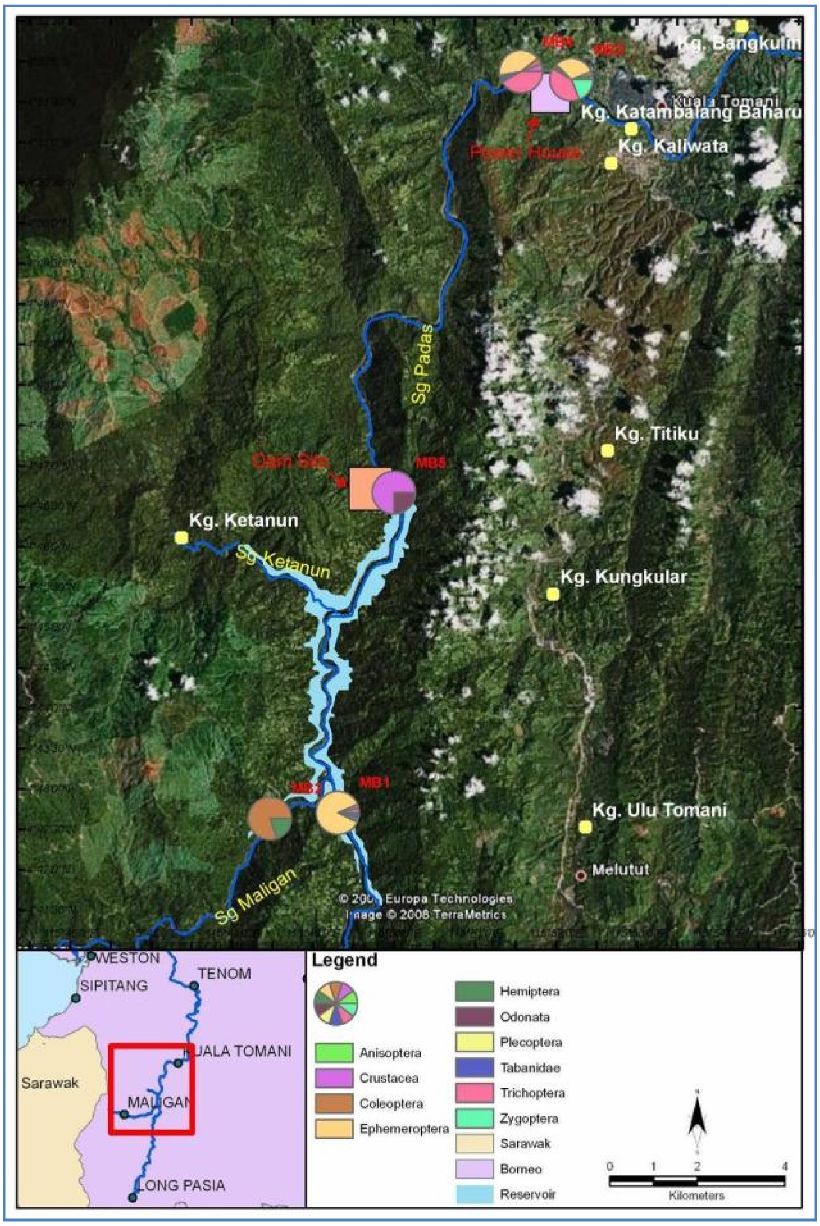

Figure 4.4.15 Macro-benthos Total Abundance According to Groups in the Sampling Stations

Campsoneuria sp. (Ephemeroptera) was the most dominant species found in the sampling area, making up 28.74% of all individuals identified. This is followed by *Hydropsyche spp. (Trichoptera)* with 13.39%. Additional analysis of species composition is included in **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**.

As mentioned above, a total 36 species of benthos were found at the five sampling stations. The highest species richness (number of species per sample) was found at the powerhouse site (MB3) with 14 species of benthos collected. The lowest species richness was found at the dam (MB5) with only two species recorded (see **Figure 4.4.16**).

In terms of diversity, the Shannon-Weiner index (H') ranged from 0.56 to 2.06 (see **Figure 4.4.17**). The highest diversities were recorded at the powerhouse site (MB4, 2.06 and

MB3, 1.86) followed by Sg. Maligan (MB2) with a diversity of 1.33. Lowest diversity index were found at the dam site (MB5, 0.56).

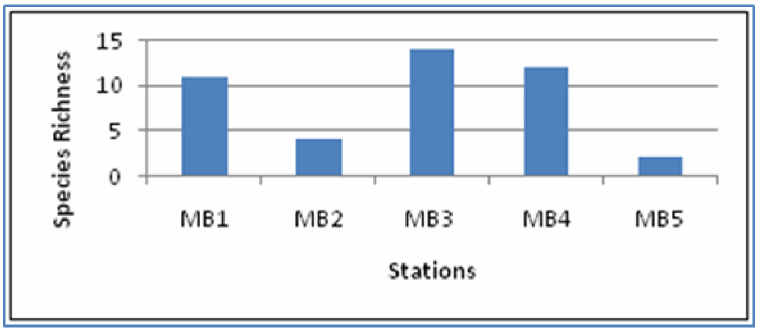

Figure 4.4.16 Species Richness of Benthos in the Study Area

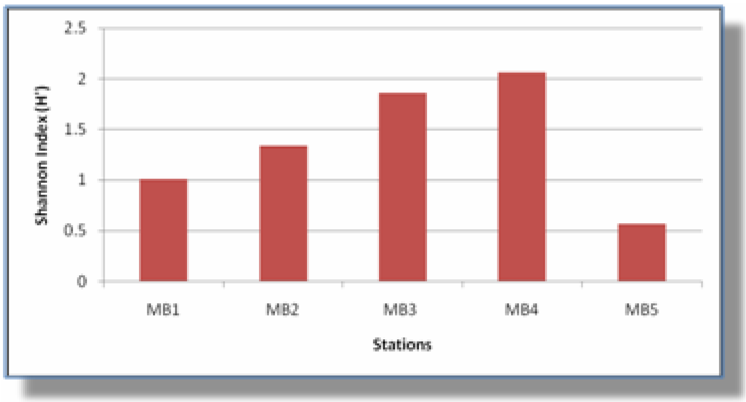

Figure 4.4.17 Shannon Index (H') Of Macro-benthos in the Study Area

Monitoring the richness of invertebrates is normally carried out using the EPT taxa richness classification (Ephemeroptera-Plecoptera-Trichoptera). The recognition of EPT is widely used to evaluate water quality worldwide[40].

These EPT can also be used as an indicator group of species, which are unique environmental indicators as they offer a signal of the biological condition in a water habitat. During this assessment, Ephemeroptera and Trichoptera were the most abundant species found (See **Table 4.4-13**).

These EPT can also be used as an indicator group of species which are unique environmental indicators as they offer a signal of the biological condition in a water habitat.

The Biological Monitoring Working Party (BMWP) score was used for measuring water quality using species of macro invertebrates as biological indicators. The method is based on the principle that different aquatic invertebrates have different tolerance to pollutants. The presence of mayflies or stoneflies for instance indicate the cleanest waterways and are given a tolerance score of 10 (See table in **Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**). The lowest scoring invertebrate are worms (Oligochaeta) which

[40] *Lenat, D.R. and Penrose, D.L. 1996. History of the EPT taxa richness metric. Bulletin of the North American Benthological Society Vol 13(2).*

score 1. The number of different macro invertebrates is also an important factor, because a better water quality is assumed to result in a higher diversity.

The scores for each family represented in the sample are then summed to give the BMWP score. A BMWP score greater than 100 generally indicates good water quality.

The EPT richness index is based on the total number of individual from the taxa Ephemoroptera, Plecoptera and Tricoptera over the total number of macrobenthic individual found in the sampled area. From the study, Ephemeroptera and Trichoptera were the most abundant species found in MB1, MB3 and MB4 with 0.872, 0.708 and 0.873 respectively. There was no species from the taxa Ephemeroptera, Plecoptera and Trichoptera found in Sg. Maligan (MB2) or at the dam site (MB5) wherefore the index is 0 for both stations.

Macro-benthos caught were given a score based on the BMWP. The high scores at the upper Sg. Padas (MB1), and the two stations at the powerhouse site (MB3 and MB4) would indicate that the water quality at these stations were relatively better compared to the other sampling points. The BMWP results correlate with the EPT Richness Index – see **Table 4.4-13**.

Table 4.4-13 EPT Richness Index and BMWP Score by Station

Station	EPT Richness Index	BMWP Score
MB1	0.872	818
MB2	0	35
MB3	0.708	874
MB4	0.873	446
MB5	0	26

Primary records from this assessment of dissolved oxygen, pH and conductivity at the time of the macro-benthos sampling are shown in **Table 4.4-14**. The DO ranged between 4.59 to 6.66 mg/l whereas the pH recorded a 6.3 to 8.2 which is under Class IIA and B based on INWQS.

DO in at the powerhouse site (MB4) shows a slightly poorer DO standard which falls into Class IIA and IIB of INWQS whereas the other stations are under Class I. Water quality surveys carried out at the macro-benthos stations at another occasion (during wet season) indicate a similar range of DO, although the lowest reading in this case is near MB2 in Sg. Maligan.

Table 4.4-14 Macro-benthos Primary Water Quality Readings

Station	DO (mg/l)	pH	Conductivity (µS)	Temp (°C)	Weather
MB1	6.34	6.5	178	21.9	Rain
MB2	5.35	6.3	210	24.1	Rain
MB3	5.12	8.2	221	25.2	Cloudy
MB4	4.59	7.2	189	22.3	Cloudy
MB5	6.66	8.2	223	21.9	Cloudy

Table 4.4-15 Water Quality Reading during Wet Season

Water Quality Station/ nearest macrobenthic station	DO (mg/l)	pH	Conductivity (µS)	Temp (°C)	TSS (mg/l)
W2 (MB1)	5.7	6.3	26.4	28.4	380
W1 (MB2)	4.6	6.7	28.1	28.0	296
W21 (MB3)	6.3	6.7	35.6	27.3	12
W19 (MB4)	6.4	7.2	31.9	27.8	5
W6 (MB5)	6.2	6.7	35.6	27.3	8

From the water quality data obtained, there is no obvious difference in the present water quality parameters between benthos stations to indicate the reason for high ETP and BMWP score in Upper Padas (MB1) and at the powerhouse site (MB3 and MB4). Therefore the reason for low ETP and BMWP score in Sg. Maligan (MB2) and at the dam site (MB5) may be due to an earlier history of events or change of environmental factors.

Secondary data from ‘Classification of Malaysian Rivers: Volume 8-Padas River’ was compared with three stations that are adjacent to the water quality monitoring station for this assessment as shown in **Figure 4.4.18**. **Table 4.4-16** shows the comparison between those data.

Table 4.4-16 Comparison Between Secondary Data Water Quality Reading from Padas River Classification Report

Station No.	Date	DO (mg/l)	Con-ductivity	Temp	pH	BOD (mg/l)	COD (mg/l)	NH_3-N	Turbidity
Panggi Hydro (SD) (DOE)	Oct-98	8.1	60.0	25.0	6.5	3.0	27.0	0.2	133.1
Panggi Hidro (SD) (DOE)	Jan/Feb 99	5.1	0.1	25.5	6.4	2.6	21.0	0.1	113.0
WQ35 (wet season)	30-Oct-08	6.7	57.1	27.2	6.7	2.0	27.2	0.2	21.0
SFI Bridge 2 (SD) (DOE)	Jan/Feb 99	7.8	0.06	23.6	5.56	0.49	11	0.08	29
WQ1 (wet season)	15-Oct-08	4.6	28.1	28	6.7	2	37.4	0.2	280
Long Pa Sia (SD) (DOE)	Jan/Feb 99	8.2	0.04	20.8	4.06	0.48	14	0	10
WQ2 (wet season)	14-Oct-08	5.7	16.4	28.4	6.3	2	47.1	0.2	320

Source: Department of Environment.

Unfortunately the Classification of Malaysia Rivers document does not report the BMWP scores determined for the monitoring stations. Rather, the BMWP scores were converted directly into river classifications without reference to the relevant formula (see **Table 4.4-17**). The classifications for the Padas River fell under Class IV and V based on the macro-benthos data, indicating a poor water quality / environment for the macro invertebrate community. This may be attributed to an earlier history of unchecked land conversion in the catchment area. It is known that the forest concessionaire, the Sabah Forest Industries, has undergone a change in environmental philosophy ownership and management in connection with a change of ownership. The benthic communities have, however, not yet had time to recuperate from earlier management regimes.

Table 4.4-17 Classification of Rivers based on BMWP Scores

Stations	BMWP
Sg. Pegalan	V
Sg Padas (Bt 61)	V
Sg Padas (Beringin)	V
Sg Padas (Kouran)	V
Sg. Padas (Kg Ansip)	V
Sg. Padas (Pangi Hidro)	V
Sg Maligan	IV
Sg Padas (SFI Bridge)	IV
Sg Padas (Long Pa Sia)	IV

Plate 4.4-7 Sampling at Station 1.

Plate 4.4-8 Fish caught at Station 1.

Plate 4.4-9 Sampling at Station 12.

Plate 4.4-10 Children fishing at Sungai Pangi.

Plate 4.4-11 Gill netting at Station 4.

Plate 4.4-12 Sampling at Station 10.

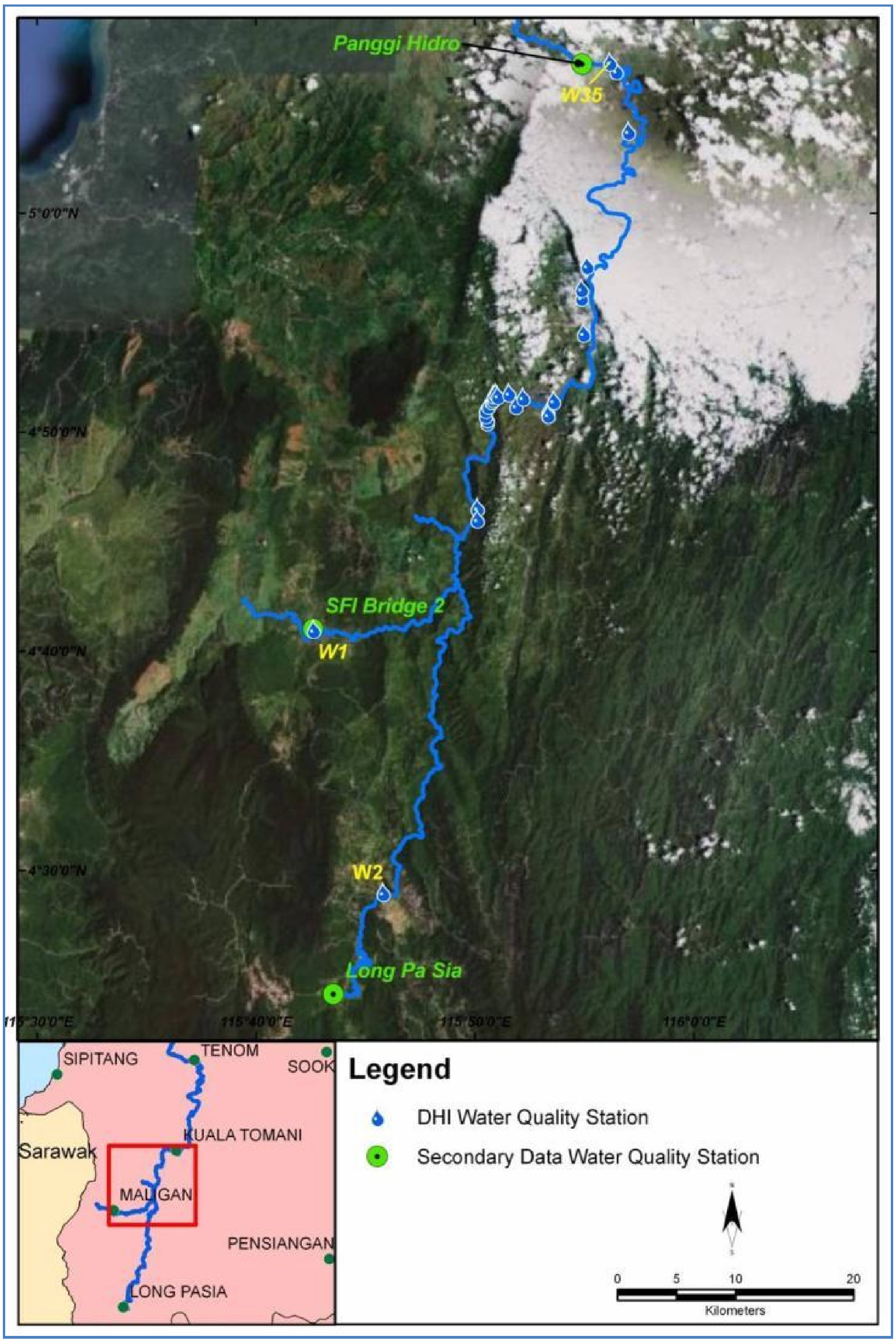

Figure 4.4.18 Water Quality and Secondary Data Water Quality Station

Macrobenthos	
	
Diptera larvae	Ephemeroptera
	
Aeshnidae	Caddisfly larvae
	
Gallastocoridae	Libbeluidae

4.4.8 LAND USE

The 188,500 ha catchment area includes several forest reserves and alienated land. The forest reserves are shown in **Table 4.4-18** below.

Table 4.4-18 Forest Reserves Within the Catchment Area

Forest Reserve	Indicative area (Ha)
Sipitang Forest Reserve (Class II)	150,527
Maligan Virgin Jungle Forest Reserve (Class VI)	8,878
Basio Virgin Jungle Forest Reserve (Class VI)	213
Ulu Sg Padas Forest Reserve (Class II)	31,297
Catchment area	**190,915**

Note: Area inaccuracies occur due to different mapping sources used for the assessment

In terms of human environment, there are eight villages in the upper catchment area, including Kg Meganit, Kg. Long Pa Sia and Kg Long Mio to the south, and Kg Maligan, Kg. Iburu, Kg. Mangkabong, Kg. Antarulan and Kg. Maligan to the north[41]. These villages are located within the gazetted state land which covers approximately 12,300 ha[42]. (See **Map 4.4- 2 Land Use in the Project Water Catchment**)

The Sabah Forest Industries has made a strategic planning for their areas dedicating the northern part of the catchment area as industrial tree plantation areas and the southern part as natural forest management: The brown and green areas respectively in **Map 4.4- 3 SFI Strategic Land Use Plan**. The red areas in that figure are the two virgin jungle reserves, Maligan and Basio.

4.5 ZONE 3: CONSTRUCTION SITES FOR DAM, POWERHOUSE AND PENSTOCK

The dam and the power generating facilities will be placed about 9.5 km from each other, connected primarily by a head-race tunnel with supporting features such as surge shaft and penstock. These features will be underground while the dam and the powerhouse containing the generators are placed on or near the river and will require substantial earth-works.

The powerhouse and thus the place where water is released after passing through the turbines, will be constructed very near the settlements of Tomani.

Physical and biological features do not differ significantly from the features in the rest of the catchment area.

[41] *EIA report for SFI Forest Logging of 73,212 Hectares, Sipitang, Sabah. Sinoh Environmental Sdn Bhd.*
[42] *Ulu Padas-Identification of Potential Protected Areas; Sabah Biodiversity Conservation Project.*

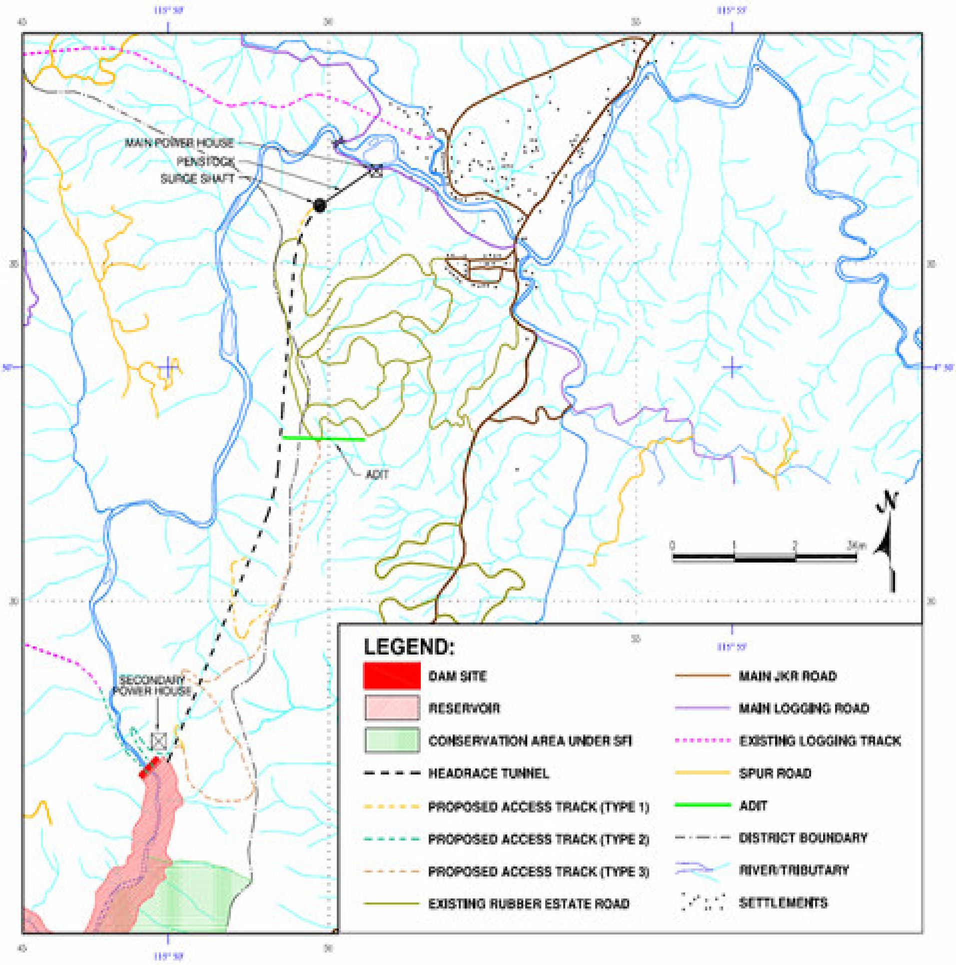

Figure 4.5.1 Dam and Power House Relative Location

The dam is proposed to be located about 10 km upstream from Tomani at a place where the river valley is conveniently narrow and the geology suited for such construction. The area for the powerhouse, on the other hand, is at a more level ground and conveniently closer to roads and other access at Tomani. The power station will be built on state land/village reserve, outside the Sabah Forest Industries concession.

The dam proper and the associated installations (secondary power plant, offices and service functions) will take up about one hectare while the installations around the main power house will require only 0.2 hectares. These areas will not only have to be cleared of vegetation but also excavated to remove the soil over burden; in case of the dam site down to the parent rock.

4.5.1 Site Geology

The dam site is underlain by a sequence of alternate sandstone and shale beds. Outcrops along the Padas River showed varied lithologies ranging from thick and well bedded, strong sandstone to thin bedded and laminated weak shales. According to the geological map published by Geological Survey Borneo Region, the sediments dip steeply towards west. The riverbanks are moderately steep to very steep, with the mean gradient estimated at 35° to 45°. Small and large boulders cover on the slopes, such that it is unknown if some of the so-called outcrops seen on the slopes are actually very large boulders.

Weathering does not appear deep. Based on refraction seismic survey results (on the soil profile), the topsoil layer (seismic velocity 600 – 1,100 m/sec) ranges from 2 m to 10 m, with a mean value of approximately 5 m. Residual soil occurs in the upper parts of the slope, and some slope-wash material and colluvium occur on the lower banks. The presence of an alluvial terrace (remnants derived from the down-cutting of the river banks) should not be discounted. The rock layer below the soil is highly weathered (seismic velocity 1,300 – 2,100 m/sec) and is approximately 15 m thick. The thickness varies between 10 m to 20 m. Below this layer is sound rock (seismic velocity 3,000 – 5000 m/sec) with varying rock mass density and strength due to the alternating steeply dipping sedimentary rocks. It should be noted that this geophysical method determining the properties of the rock mass are approximations only, and inaccuracies on the depths and velocities occur in the mathematical modelling if the ground is uneven and steep.

The proposed dam site consists of the sub-parallel ridges with steep to very steep slopes. Soils that remain on these slopes are usually firm to stiff and protected from raindrops by the thick foliage. If exposed, these soils are likely to fail. When an accurate topographic map is available, a slope angle distribution map is to be constructed to illustrate the areas of instability near the dam site if they are bared of vegetation. Since the soil cover is thin in most areas, any soil failures are of superficial nature only. However, the 30 m of soil at the power station area (BH-B) should be further investigated.

Natural rock slope stability. The main bedding structure in the area is steep to very steep, in the vicinity of 50° to the horizontal towards east. Instability would come from blocks or wedges of rocks formed from a combination of shallow dipping conjugate joints with the bedding joints resulting in daylighting of the slope. Such an event is possible since there are sandstone blocks and boulders (identified as colluvium) on the slope face. Very steep ridge slopes facing the west may produce toppling failures if the rocks dip steeply towards E.

4.5.2 VEGETATION

The vegetation surrounding the proposed dam site is still primary dipterocarp forest. One sampling station for flora was selected at this site:

Station 4 – Proposed Dam Site. The proposed dam site is at the boundary between Tenom and Sipitang District, and can be accessed via the Tomani area. Forest condition around the catchment towards the proposed dam site can be categorised as virgin mixed dipterocarp forest where no signs of logging were observed.

There are many mature trees at this station, and the areas are very steep. The slopes at the survey plots were between 20° - 38°. In addition, the area is quite moist and suitable for sponge moss habitat. Some areas are very rocky especially on the steep areas.

There were no protected or endangered tree species found within the survey site. Only one palm tree, *Arenga undulatifolia* was observed in the area but outside of the survey plots. This species of palm tree is listed as Protected in the Sabah Wildlife Conservation Enactment 1997.

The forest floor is clear with little seedlings and saplings. This is due to the dense canopy cover that does not allow much light penetration into the forest floor.

The analysis of data revealed that compared to the other two sampling plots in primary forest, plot 4 had the most open canopy with 18% gap, it had the lowest dry weight biomass per ha (68.8 t/ha) and the richest under-storey due to the open canopy. Under-storey species diversity in Station 4 was 6 species per 75 m^2 sub plot.

The highest mean tree species richness was observed at Station 4, where an average of eighteen species per 400 m^2 plot was observed, with the most dominant species being *Nageia wallichiana*. Diversity (H') was lowest at this station, owing to the predominance of *N. wallichiana*.

This is a sign that the forest, while being primary, is in a healthy regenerating stage after some dominant upper storey trees have been lost to age.

4.6 ZONE 4: RESERVOIR AREA

The proposed reservoir area covers approximately 590 ha or 5.9 km^2 involving three rivers, Padas, Maligan and Ketanun. It is sited within the Sipitang Forest Reserve (FMU 7) which is part of the Sabah Forest Industries concession area.

The reservoir zone will be all the area above the dam, which falls below the 470 m a.s.l. contour line. When the reservoir is at its fullest, only minor tributaries will be feeding directly into the reservoir in addition to the three main rivers Padas, Maligan and Ketanum.

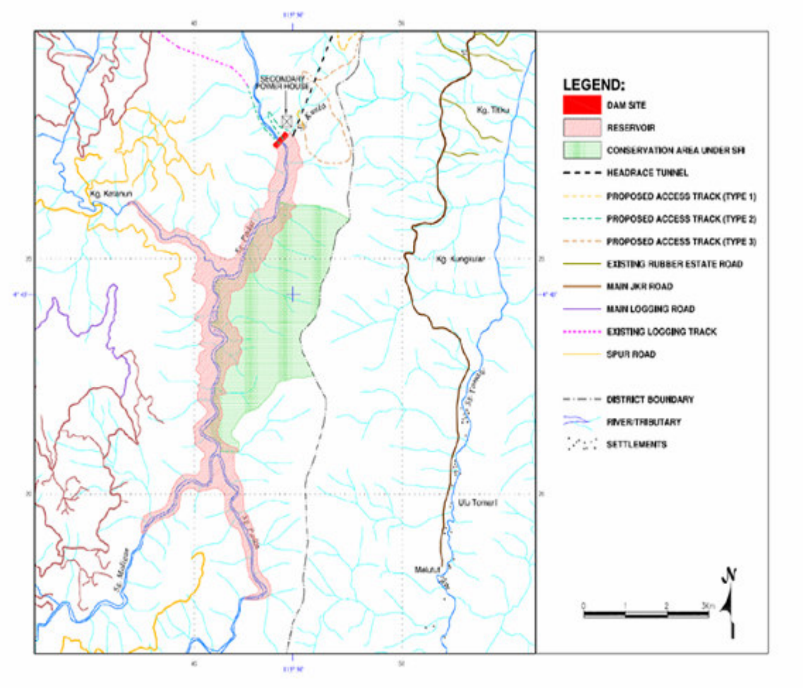

Figure 4.6.1 Reservoir

In the reservoir area the Padas River falls about 200 metres over a distance of 10 km. There are several small rocky rapids on this stretch. Also the banks are steep and at places dominated by rock outcrops. Most of the eastern bank is laid out as protection or conservation area due to its steep slopes.

The result is a four-armed, 5.9 km^2, 10 km long reservoir only 300-700 metres wide (See **Figure 4.6.1**).

4.6.1 SOIL

Labau. The valley floor of the reservoir belongs to the Labau association. This association, which also occurs as narrow bands in the downstream Padas normally occurs on narrow valley floors with small islands made from sediments, levees, narrow floodplains and terraces. The soils are formed on alluvium, which is derived mainly from sedimentary rocks, often coarse-textured.

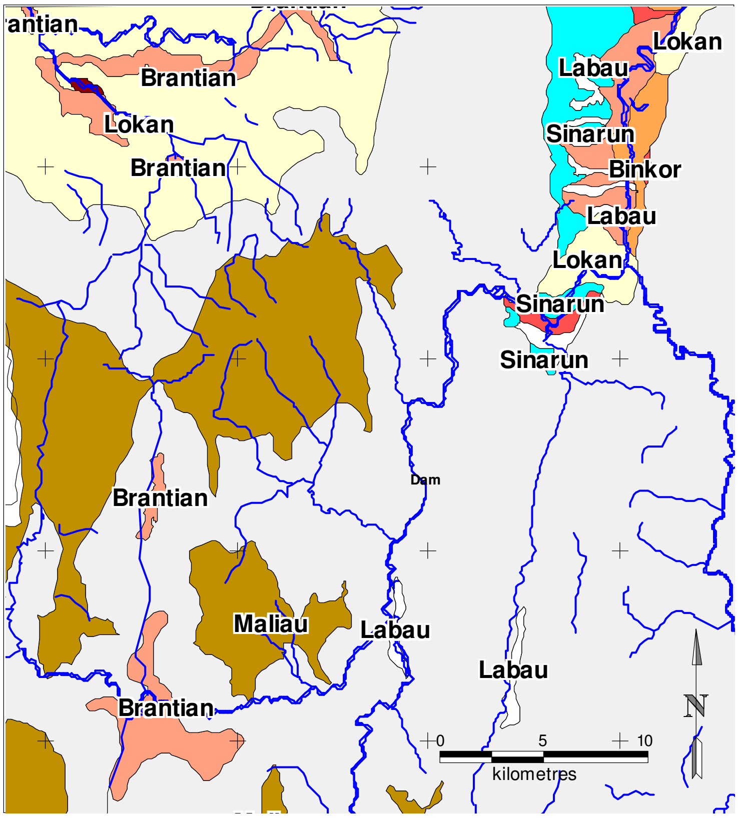

Figure 4.6.2 Reservoir and Padas Valley Soil Associations

Note: ▼ : Dam Site

The soils of the rim of the reservoir belong to the Crocker association as described under Zone 2: Catchment Area. These are not considered stable and minor slope failures and landslides are part of the natural landscape forming processes. Such slope failures often occur when slopes are no longer capable of supporting large over mature trees, which then fall and expose lower strata, which then again fail as they now lack the supporting forces of the roots of the large tree and they are exposed to rain and sun.

4.6.2 VEGETATION

The 590 hectare of the future reservoir area is currently mainly covered by undisturbed Mixed Dipterocarp forest (See **Figure 4.6.3**). The Sabah Forest Industries has prepared a Forest Management Plan (FMP) in line with the conditions of their licence.

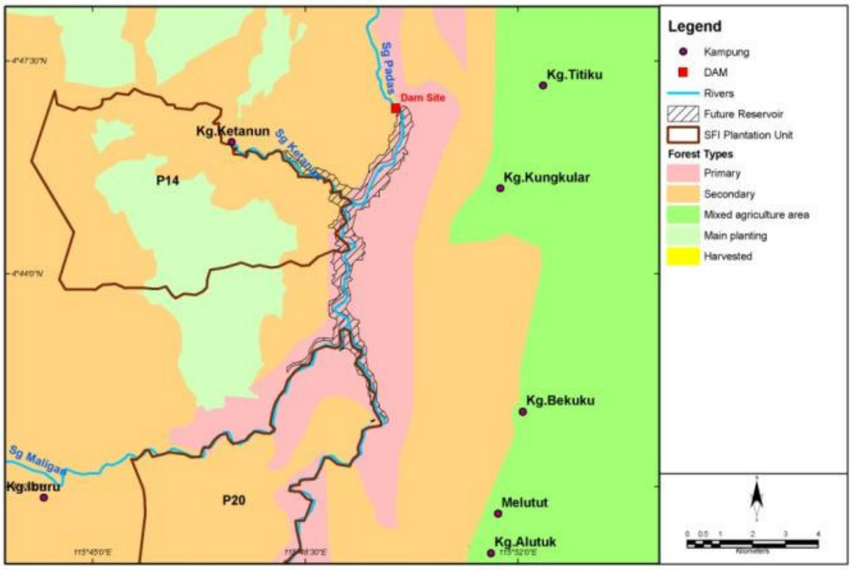

Figure 4.6.3 Forest Type within the Ulu Padas Reservoir Area

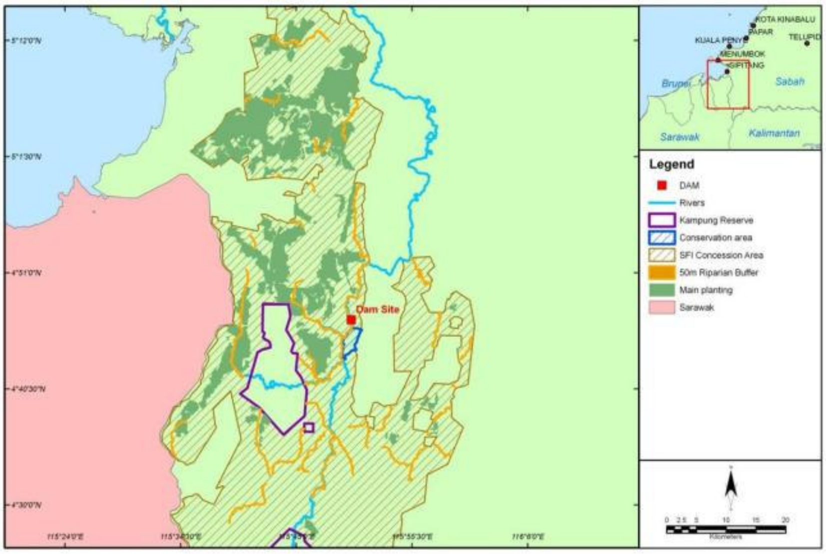

Figure 4.6.4 SFI Zoned Areas for Riparian Reserves, Conservation Zones and Settlement Reserve

<u>Compartments P03, P04, P07.</u> In the upper hills of Ketanun River the area is planted with *Eucalyptus grandis* and *Acacia mangium*. The slopes near the river are quite steep and with more than 30° slope in some areas.

The Google satellite imagery in **Figure 4.4.11** shows compartment P04 in the upper left quarter of the imagery. The imagery is from 2007 or 2008 and shows the compartment as it was newly cleared for planting. The compartment has by 2010 achieved full canopy closure.

Compartment P08. Most of the area to the east and south of the proposed dam site is still virgin forest and declared a protected Water Catchment Protection Zone under the SFI forest management plan for the area[43] (See **Figure 4.6.4**).

Compartment P 14. Secondary forest is present in the Sg. Ketanun area, Compartment P14 (SFI's ITP). The area is dominated by *Macaranga spp.* and some areas have been surveyed by SFI for plantation development.

Compartment P 20. Some areas between the Maligan and Padas River have been selectively logged 10-20 years ago. At the confluence of the two rivers, there is an undisturbed rocky and hilly forest locally referred to as Bukit Tandak. The area south of this hill, Compartment P20, is now reserved as part of SFI's Industrial Tree Plantation (ITP) area (**Figure 4.6.3**). It was logged about 15-20 years ago and secondary vegetation such as *Macaranga spp*. and rattan are now abundant.

Table 4.6-1 Overview of the Three Different Community Types Observed in the Area

Description/ Vegetation Type	Primary Forest (Undisturbed)	Logged-over Forest	Plantation Area
Station	2, 4 and 6	1, 3 and 5	7
Total no. of species found	47	46	5
Dominant species	Shorea curtisii	Macaranga triloba	Macaranga spp.
Average Tree Density per hectare	681	481	417
Average canopy closure (%)	84.7	80.7	11.5
Tree Biomass estimates (t/ha)	98.99	28.37	3.65
Under-storey Biomass (t/ha)	0.46	0.57	0.72

Based on findings from satellite imagery and a preliminary ground survey, seven sites were selected for detailed inventories over four field visits (**Table 4.6-2**). The seven stations were selected to represent different management regimes: one station in the plantation (conversion from natural forest to tree plantation) area, three stations in the primary forest area and three in the logged over forest area. **Table 4.6-1** lists the overall findings from the different forest types.

Table 4.6-2 Field Survey Details

Field Survey	Area	Station No.
1	Sg. Maligan above the reservoir & Plantation areas	STN 1 and STN 7
2	Padas above the reservoir	STN 5
3	Sg.Maligan & Sg. Padas	STN 2 and STN 6
4	Sg. Ketanun & Tomani	STN 3 and STN 4 (Dam site)

A summary of the methods are given below, while further details can be found in **Appendix 2-6: Terrestrial Flora**.

[43] *Sabah Forest Industries Sdn. Bhd. Management Plan. December 2000. Re-submission April 2002.*

During the field inventories, general observations were made on the vegetation community type, condition of the vegetation and the dominant species. Surveys were also carried out by vehicle, to track and note the condition of the forest and plantation area in general.

Tree inventories. The vegetation inventory was carried out based on the methods in Bertham et. al.[44] For each of the identified vegetation types, a set of inventory plots were set up, concentrating on the future impounded area. In addition, two stations were established upstream of the directly affected area. Geographical coordinates were recorded by GPS from nearby open areas. A compass bearing for the transect was then taken perpendicular to the river/road.

Survey plots were established every 65 m along a transect from the first plot towards forest area. The first survey plot was established approximately 1-5 meter from the river or road where the GPS waypoint was taken. At each station, three 20 x 20 m (400 m^2) plots were established. Estimation of the slope within the survey area was recorded using a clinometer. Species name, height, and diameter were recorded for all trees having a girth of 12.6 cm at breast-height (diameter at breast-height (DBH) of 4 cm) or more.

Under-storey inventory. An inventory of shrub and under-storey species was carried out by establishing three 5 x 5 m sub-quadrates within each plot to allow estimation of the other key indicators. All plants except trees (shrubs, climbers, creepers, palms and ferns) within the 5 x 5 m sub-quadrate were identified and recorded.

The above-ground biomass within each 5 x 5 m sub-quadrate was subsequently estimated from harvesting all plants except trees within the sub-quadrate in order to estimate the total above-ground biomass on a per-hectare basis.

Plants of significant importance (both economic and cultural), endangered and protected were noted, grouped and listed accordingly. Qualitative comments on the potential plant resources in residual (i.e. logged over) and undisturbed forest in terms of species important as traditional medicines, sources of minor forest products used by the local population and as wildlife habitat areas were made based on casual observations, previous experience and relevant published references.

Canopy cover. Canopy cover estimates were done in every plot. Each plot was divided into four quadrants and a photograph of the canopy cover was taken in the middle of subplot (pointing the camera directly upwards). The photos were then converted into black and white picture for analysis.

Vegetation composition. As outlined above, surveys were carried out within three different community types, namely (i) primary forest; (ii) logged over forest; and (iii) plantation area. The results in this section are presented according to the community type rather than in the order of the sampling station numbers. For reference, the stations within each community type are listed in **Table 4.6-3 and Figure 4.6.5** below.

[44] *Bertham Husch, Charles I.Miller, Thomas W.Beers. 1995*Pengukuran Hutan Edisi Ketiga *Penerbitan Universiti Pertanian Malaysia 1995.(page 167-213).*

Table 4.6-3 Survey Stations Within Each Community Type

Community Type	Stations
Undisturbed Forest	2, 4 and 6
Logged-over forest	1, 3 and 5
Plantation Area	7

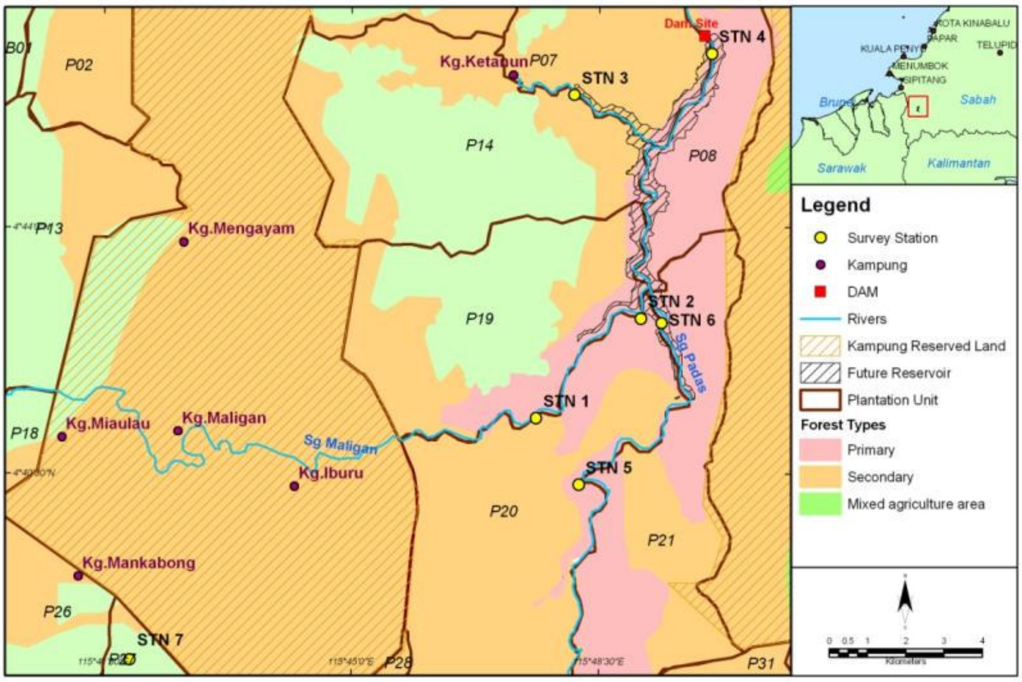

Figure 4.6.5 Flora Survey Stations

For each community type, the findings for floristic composition and community structure are presented. In addition, a summary of the biomass for all stations within the future reservoir area (Stations 2, 3, 4 and 6) and a summary of species recorded in the survey of conservation significance are given.

Undisturbed Forest. Survey stations within the undisturbed forest community type (in the future reservoir area) included Station 2 and Station 6 in the reservoir area and station 4 at the dam site.

<u>Station 2 – Maligan River.</u> This area is located on the northern side of Maligan River near to the confluence of Sungai Maligan and Sungai Padas. This station falls within the proposed reservoir area and is located approximately 0.6 km west of Station 6. Formation of rocky hills makes this area restricted for logging with slopes of up to 20°.

In the survey plot area, the slope was around 18° and higher in some areas. There were many large dipterocarp and fruit trees in this area. Tree density however was medium, possibly due to the rocky land as well as the maturity of the trees. According to the local hunters, the fruit trees attract wildlife such as long tailed macaque, pig tail macaque, Bearded Pig, Samba Deer, Mouse Deer and Borneon Yellow Muntjac.

Station 4 – The Dam Site. This station is described in Zone 3:

Station 6 –Padas River. Located Along Padas river upstream from confluence with Maligan River, the area can be classified as undisturbed, rocky/hilly forest with most of the area having slopes of 30° with rocky floor. This station is located within the proposed reservoir area and is approximately 0.6 km east of Station 2.

High moisture content in the air and the thick canopy cover of dipterocarp trees make the forest floor suitable for sponge moss. The difference of this site from the other survey sites is that this station contains notably more species of *Agathis* and most of these trees measured more than 27 centimetres Diameter at Breast Height (DBH). Agathis wood is important as one of the most beautiful softwoods, usually used for interior walls and panels

Other than dipterocarp species, fruit trees such as mango, *durian, rambutan, petai*, and *mata kucing* can also be found in this area.

Overall, this area contains mixed dipterocarp forest in an excellent condition with no evidence of human activities found.

Community composition. A total of forty seven (47) species were found in Stations no. 2, 4 and 6 (total area of 3600 m²), (see **Table 4.6-4** for the five most dominant species). The most common species in the undisturbed forest area is *Shorea curtisii* with a total of 21 individuals sampled in all plots and stations. Other abundant species were *Shorea pauciflora, Macaranga spp*. and *Nageia wallichiana* (19, 18 and 18 individuals respectively). The rare species found within site survey include fruit trees and commercial timber trees such as *Durio spp., Castanopsis foxworthyi, Diospyros discocalyx* etc.

Based on all the three survey stations within this community type, the relative density, dominance (based on estimated basal area) and frequency has been calculated for each species. The five most dominant species are shown in **Table 4.6-4**. The similar table for all species is included in **Appendix 1-5: Terrestrial Flora**. *Shorea curtisii* clearly dominates in terms of number of individuals (relative density) as well as biomass (relative dominance).

Table 4.6-4 Undisturbed Forest Area: 5 Most Dominant Tree Species

Species	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	Stn 2	Stn 4	Stn 6
Shorea curtisii (Seraya)	9.3	4.5	12.8	x	x	x
Toona calantas (Surian)	2.2	3.0	7.2	x		x
Parkia speciosa (Petai)	4.0	4.5	7.1	x	x	x
Agathis Borneensis (Mengilan)	3.1	3.0	6.6	x		x
Shorea pauciflora (Basuluk)	8.4	4.5	6.4	x	x	x

<u>Trees</u>. In general, three undisturbed sites did not vary much from each other in terms of species richness but the species composition did vary between the plots indicating a larger species richness in the overall forest. The highest mean tree species richness was observed at Station 4, where an average of eighteen species per 400 m^2 plot was observed, with the most dominant species being *Nageia wallichiana*. Diversity (H') was lowest at this station, owing to the predominance of *N. wallichiana*. An average of around seventeen species per 400 m^2 plot was found at Station 2 and sixteen species per 400 m^2 plot were found in Station 6. These figures are in line with the general experience of about 140 species per ha in undisturbed dipterocarp forests.

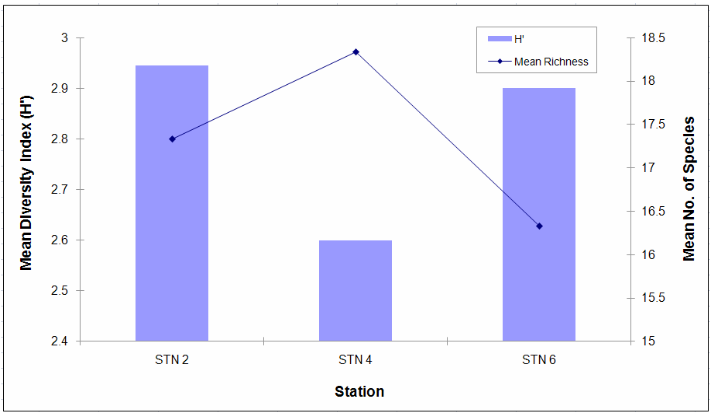

Figure 4.6.6 Species Richness vs Shannon-Weiner Diversity Index for Each Plot

<u>Under-storey</u>. (**Figure 4.6.7**) Only eight under-storey species were found in the three stations (total area of 225 m²) within the undisturbed forest. Only *Selaginella* (fern) and *Bambusa vulgaris* (herbs) were present in all stations. Under-storey species diversity was highest in Station 4 with a total of 6 species per 75 m^2 sub plot, followed by Station 2 with 4 species per sub plot and Station 6 with 3 species per sub plot. Plant density was highest in Station 2 with 82 individuals counted per sub plot, followed by 69 individuals per sub plot in Station 4 and 31 individuals per sub plot in Station 6. The poor variety of understory species in the undisturbed forest is not surprising due to shade and other environmental conditions. These forests are normally poor in the under-storey but rich in flora growing within the tree canopies as epiphytes. This plant community has not been investigated for this assessment.

One of the under-storey plants recorded, *Phaeomeria imperialis* has traditional medicinal and domestic use. An infusion made from boiling the fruit is a traditional cure for high-blood pressure and diabetes. The flower of *P. imperialis* can also be used in cooking.

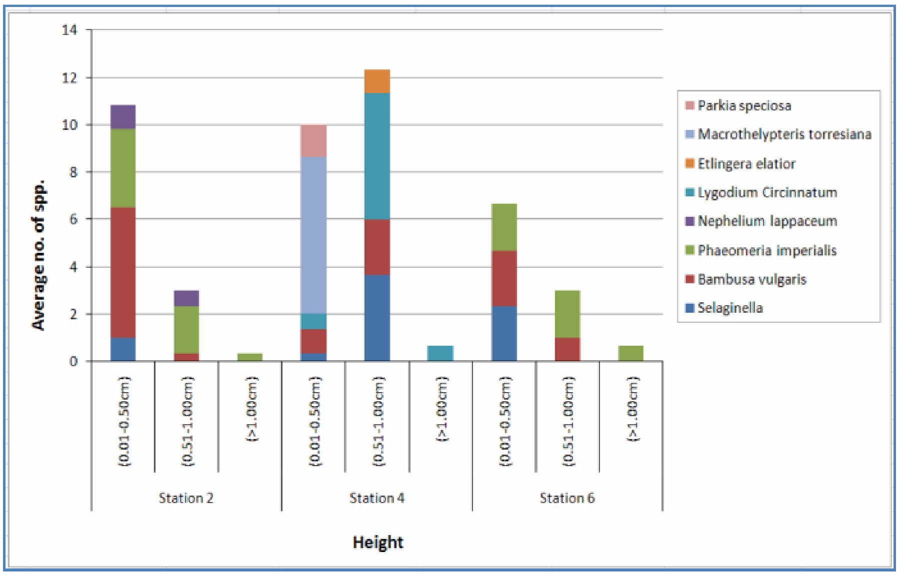

Figure 4.6.7 Average Number of Under-storey Species per 25 m^2 Plot for Each Station Found Within The Undisturbed Forest

Community Structure.

(i) Species Attributes.

Most trees were moderate in size with mean diameter at breast height (DBH) between 20 and 60 cm. The overall DBH range in the undisturbed forest was 9.2 cm to 67.5 cm. The average height of the forest at the study sites was moderately low with all trees below 30 m. Tree height (TH) in the undisturbed forest area varied between 9 m to 25.5 m with the lowest values for *Aquilaria malaccensis* and *Nageia wallichiana.* See details in **Appendix 1-5: Terrestrial Flora**.

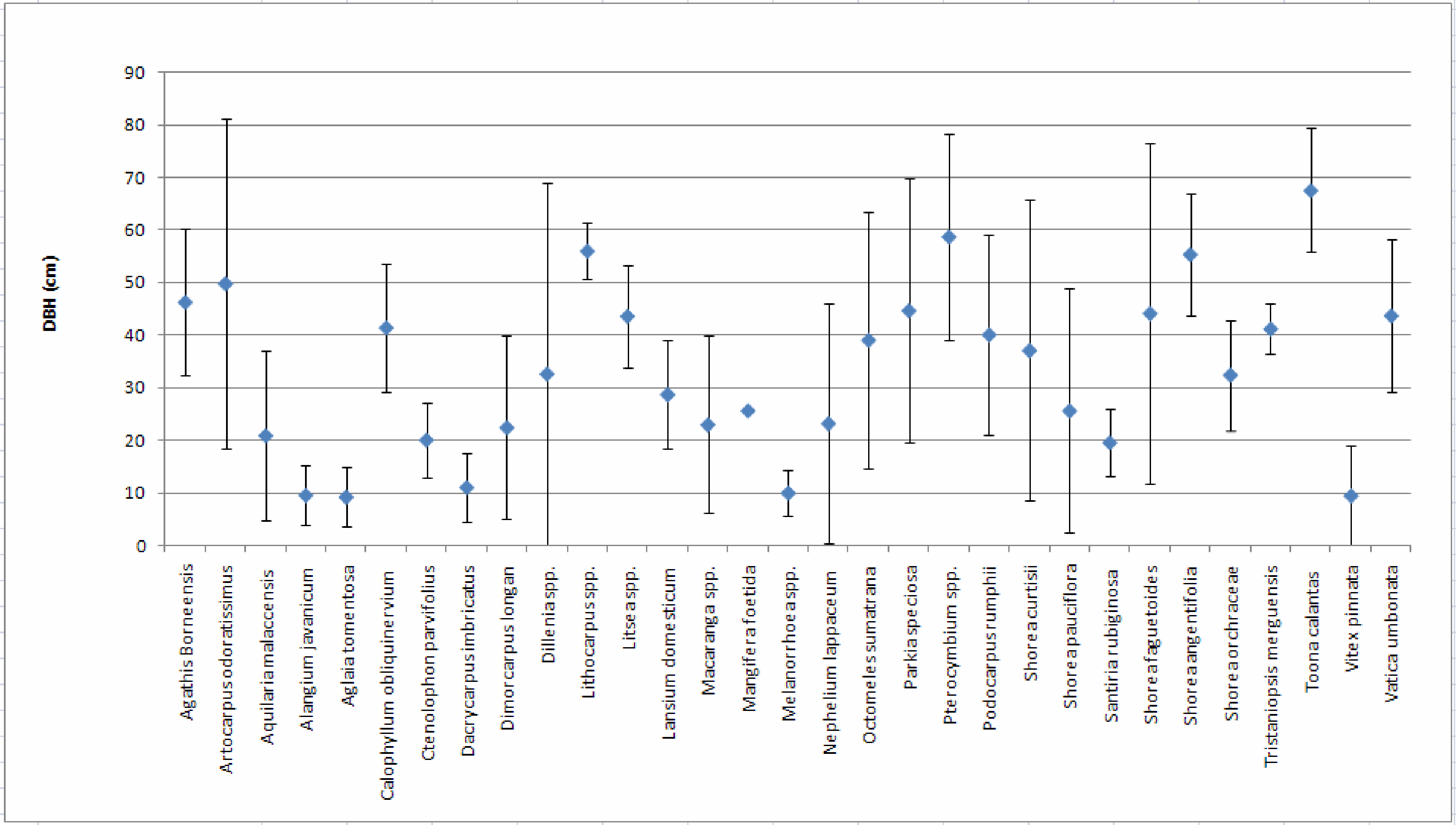

Figure 4.6.8 Mean DBH of Tree Species Encountered More Than Once at Stations 2, 4 and 6 (bars indicate standard deviations)

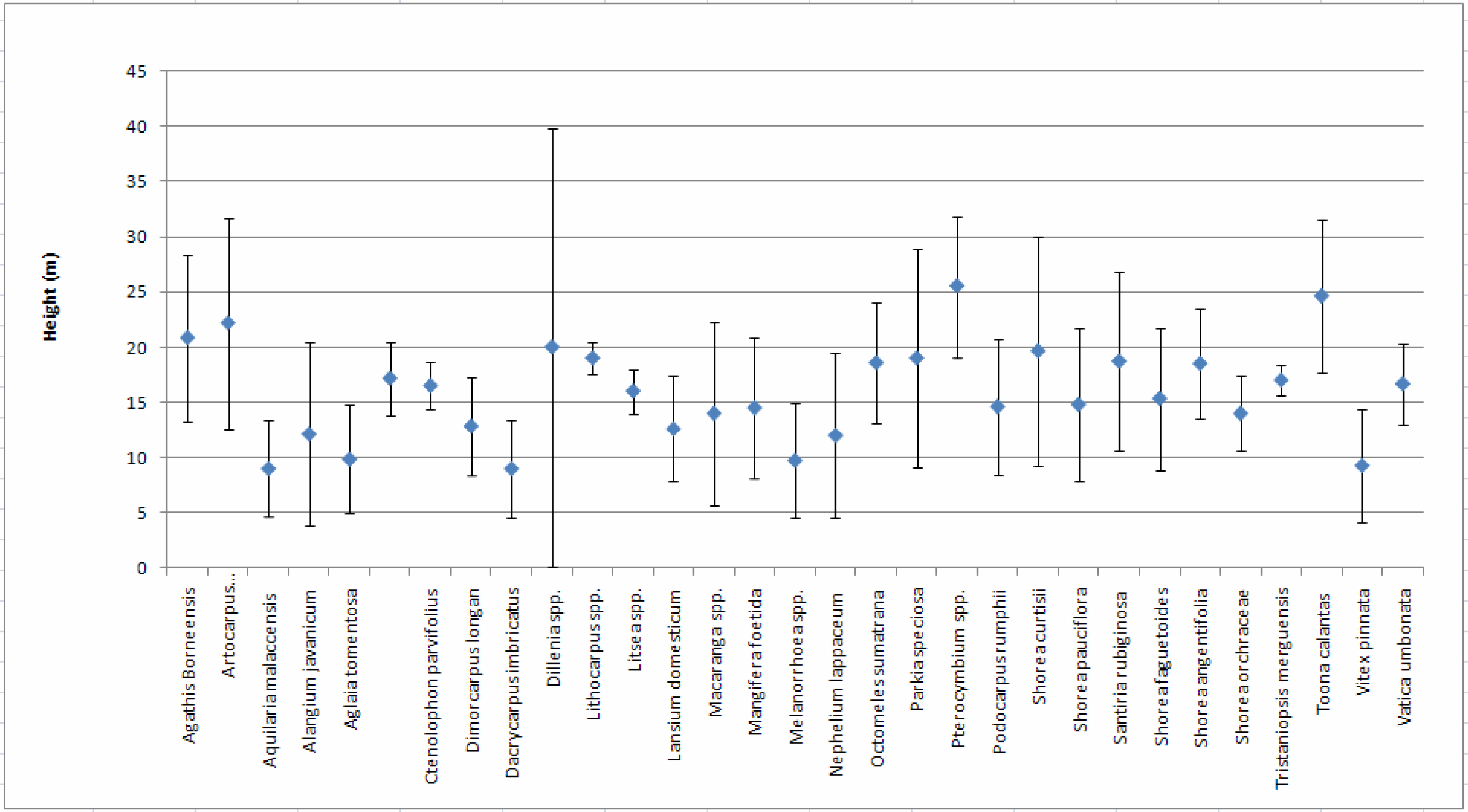

Figure 4.6.9 Mean Height of Tree Species Encountered More Than Once at Stations 2, 4 and 6 (bars indicate standard deviations)

(ii) *Stand attributes*

Tree density. The average tree density per station (average of three plots) in the undisturbed forest ranged from 550 trees per hectare to 908 trees per hectare. The overall estimated density of trees per hectare in the undisturbed forest is 681 trees per hectare.

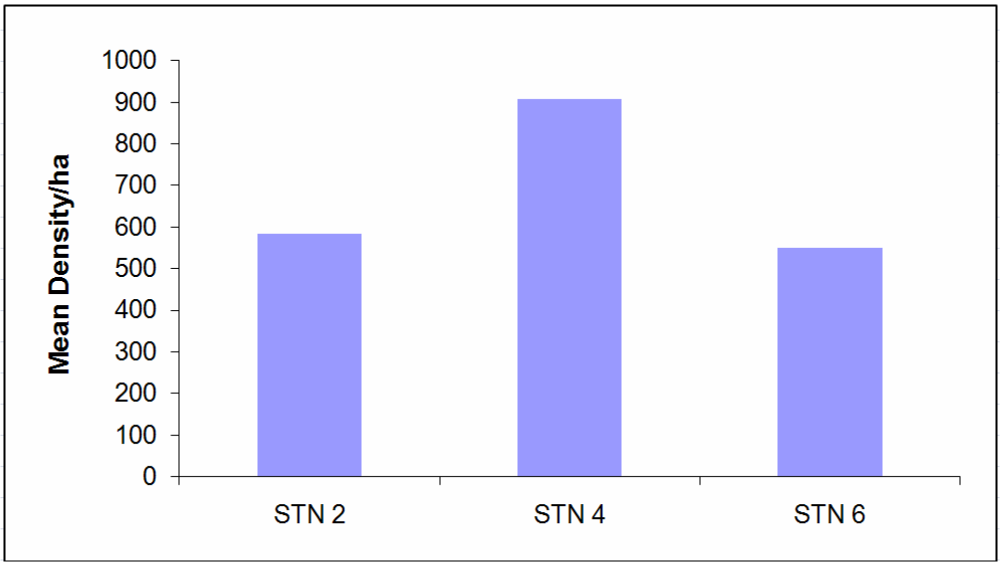

Figure 4.6.10 Mean Tree Density per Hectare at Each Station

Basal Area. The mean basal area (BA) for all sites was 77.97 m^2/ha ±20.23 m^2. The BA in station 2 and station 6 are quite similar with 90 m^2/ha and the lowest at BA is at station 4 with 55 m^2/ha.

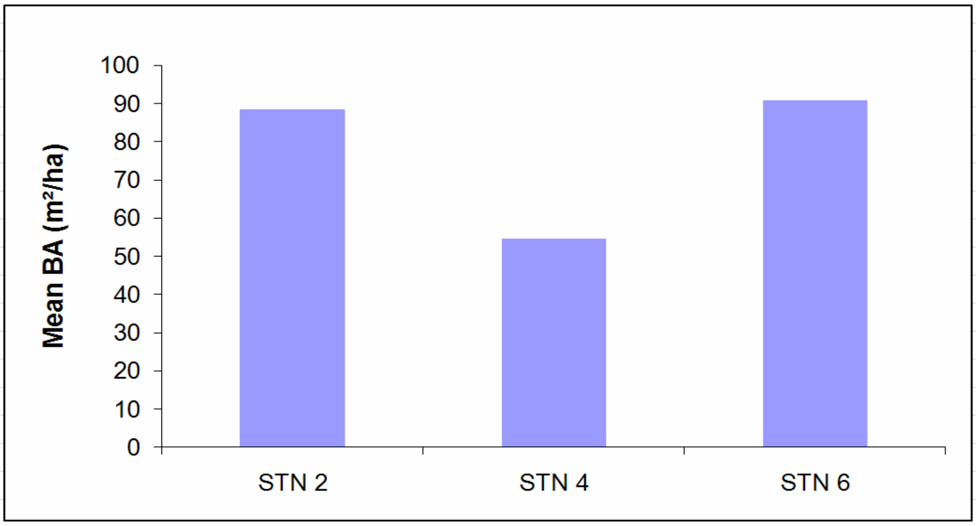

Figure 4.6.11 Estimated Basal Area (m^2/Ha)

Biomass. The average value for the trees is 98.99 tonne/ha and the under-storey is 0.46 tonne dry weight/ha. Tree biomass was highest in Station 2 and lowest in Station 4 whereas under-storey biomass as could be expected is the opposite; with the highest in

Station 4 and lowest in Station 2. A high tree storey biomass will out-compete the under-storey growth.

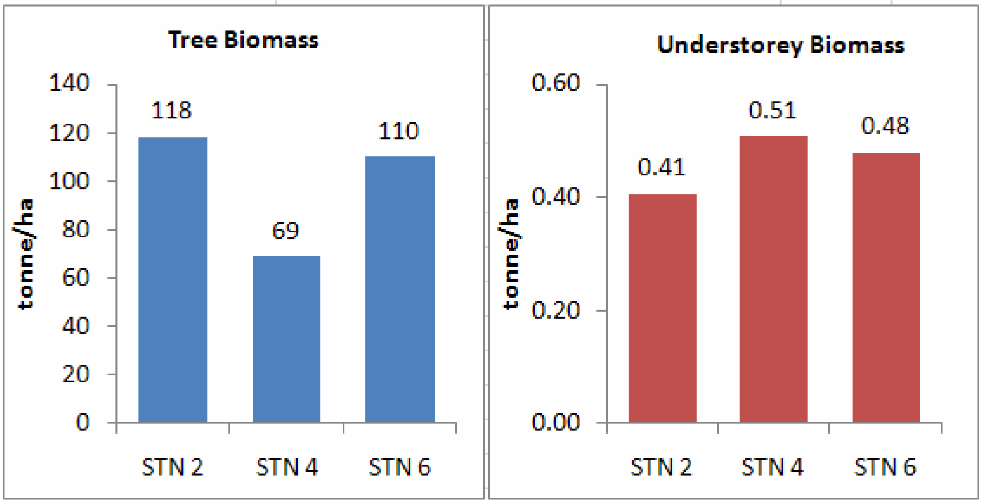

Figure 4.6.12 Estimated Above-Ground Biomass (Tree and Understorey) of the Stations That Are In the Undisturbed Area

Canopy Closure. The highest percentage canopy closure in the undisturbed area was found in Station 2 Maligan River with only 12% gaps followed by Station 6 (16% gap) and Station 4 (18% gap).

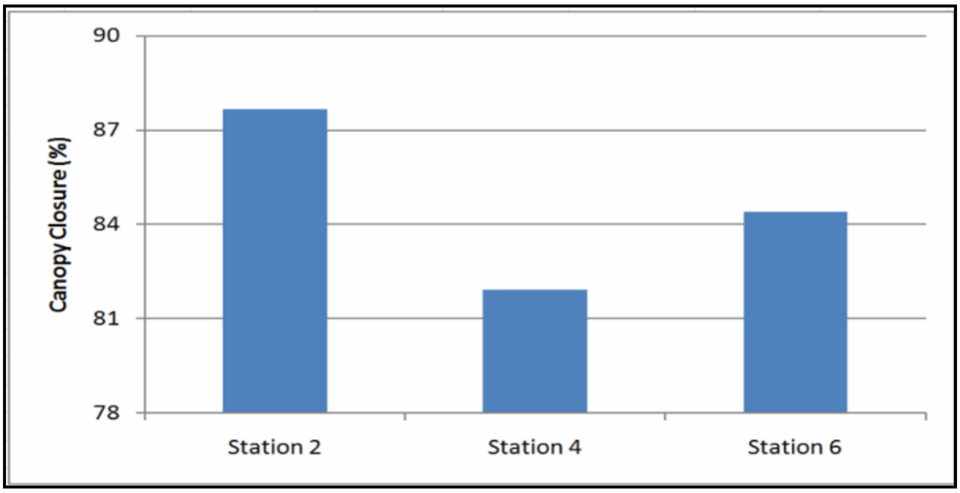

Figure 4.6.13 Canopy Closure (%)

Logged Over Forest. Survey stations within the logged over or disturbed forest community type (in the future reservoir area) included Station 1 at the Maligan River, Station 3 at Ketanun River in the reservoir area and station 5 at Padas River above the reservoir.

Station 1 –Maligan River. General observations of the area indicates that this area has been logged 10 to 20 years ago. Old skidding log tracks still can be found. However, most of the tracks have been colonised by secondary plants such as Rattan, *Macaranga spp.*

and *Mallotus spp*. Most of the areas around the site have around 15° slope or more. The dense Rattan growth surrounding the site makes walking in the area difficult.

Not many dipterocarp species were found in this area, reflecting the selective logging carried out in the past. The site survey revealed that the most common species are fruit trees with no commercial (timber) value.

The forest area within the site survey seems not to have been disturbed. Since this area is dominated by fruit trees, this attracts wildlife to come in the area for food supply. A number of foot prints were observed, and at the time of survey, the Lithocarpus lucidus tree was fruiting, which could attract animals such as the Bearded Pig, Samba Deer, Bos javanicus (tembadau) and Borneon Yellow Muntjac (Kijang).

Most common fruits species found in this area are *tampoi* or *Baccaurea macrocarpa* followed by *Dimorcarpus longan* or locally known as *mata kucing*.

Station 3- Ketanun River. Most of Ketanun catchment has been utilised for plantation of *Eucalyptus* and *Acacia*, some of which are now at the end of their rotation and eucalyptus harvesting can be seen nearby. Other areas appear to be recently cleared for planting purposes. However, the areas near the Ketanun River are still covered by – disturbed – natural vegetation.

The location of the survey plots for Station 3 was in a secondary forest area that the area may be converted to plantation area soon. Survey observations indicate that these areas have been logged a long time ago and most of the areas comprise steep hills with more than 25° slope in some areas.

The area was in the process of recovery and pioneer species had entered the area as part of the natural succession. The area is thus now dominated by *Macaranga spp* and under-storey plants such as lalang, *Eupatorium odoratum* and *Melastoma malabathricum*. From the field observation on the forest floor, other species such as *Zingiberaceae* and *Liberica viridiflora* (local name: *kopi*) can be found.

Station 3 has the lowest density of trees recorded. The highest density was 13 trees in the 20 x 20 m plot. This may be due to the logging activity and slow regeneration of secondary species.

Station 5 –Padas River above the reservoir. The description of this station is included in Zone 2

Community Composition. A total of forty five (45) species were found in the logged over forest community type (Stations 1, 3 and 5). The most common species within the study site was *Macaranga triloba* with a total of 25 individuals sampled in all plots and stations (3600 m^2). Other abundant species were *Baccaurea macrocarpa* and *Calophyllum obliquinervium* (16 and 11 individuals/ 3600 m^2 respectively). The rare species found within the survey stations include fruit trees and commercial timber trees such as *Artocarpus odoratissimus* (fruit tree, common names *marang* or *tarap*), *Ficus carica* (fruit tree, common name ara), *Xanthophyllum spp*. (timber tree, common name *minyak berok*) etc.

The average (over three stations) relative density, dominance (based on estimated basal area) and frequency has been calculated for each species (See **Appendix 1-5: Terrestrial Flora**). **Table 4.6-5** shows the five most dominant species. *Macaranga triloba* clearly dominates in terms of number of individuals (relative density) and *Nephelium lappaceum* dominates the biomass (relative dominance).

Table 4.6-5 Undisturbed Forest Area: Relative Density, Frequency and Dominance of 5 Most Dominant Species

Species	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	Stn 1	Stn 3	Stn 5
Nephelium lappaceum (Rambutan Hutan)	1.8	3.6	21.8	x		x
Ficus carica (Ara)	0.6	1.8	9.9	x		
Toona spp. (Surian)	1.2	1.8	7.8	x		
Dimorcarpus longan (Mata Kuching)	2.4	3.6	7.2	x		x
Macaranga triloba (Sedaman)	15.1	1.8	5.2		x	

<u>Trees</u>. The highest species richness was observed in Station 1, where an average of fifteen species per 400 m^2 plot was recorded, the most dominant species being *Baccaurea macrocarpa*. Station 3 had an average of nine species while Station 5 had an average of eight species. Diversity (H') was lowest at STN 3, owing to the predominance of *Macaranga triloba*.

<u>Under-storey</u>. A total of fourteen under-storey species were found in the three stations of the logged over forest community type (See **Figure 4.6.14**. Only *Selaginella, Bambusa vulgaris* and *Macaranga sp*. were present in all stations. Species diversity was highest in Station 3 with a total of 10 species per 75 m^2, compared to Station 1 and 5 with only 6 species per 75 m^2. Coverage was highest in Station 1 with 65 individual counted per 75 m^2, followed by 38 individual per 75 m^2 in Station 3 and 36 individual per 75 m^2 in Station 5.

Mimosa pudica's roots are used as an ingredient to make tonic. The crushed leaves are used to cure swollen areas and it is also traditionally believed that placing *Mimosa pudica* under the bed sheet will help children sleep better. Similar to the undisturbed forest, the logged over forest also contain *Phaeomeria imperialis*.

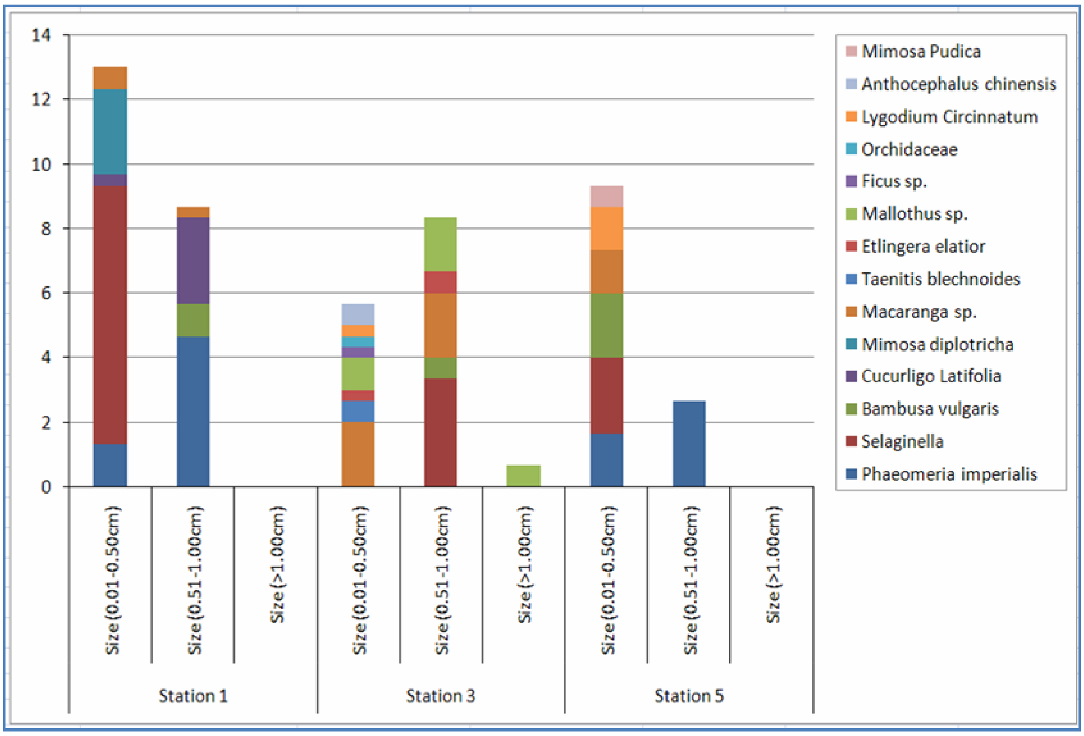

Figure 4.6.14 Average Number of Under-storey Species per Plot for Each Station Found Within the Undisturbed Forest

Community Structure

(i) Species Attributes

Most tree trunks were thin with a mean diameter at breast height (DBH) between 6.5 and 45.2 cm with the lowest values for *Gynotroches axillaris*. Mean tree height (TH) varied between 4.8 m to 32.5 m with the lowest values for *Dillenia bornensis*. Highest for both DBH and height was calculated for *Shorea curtisii* which is a timber species.

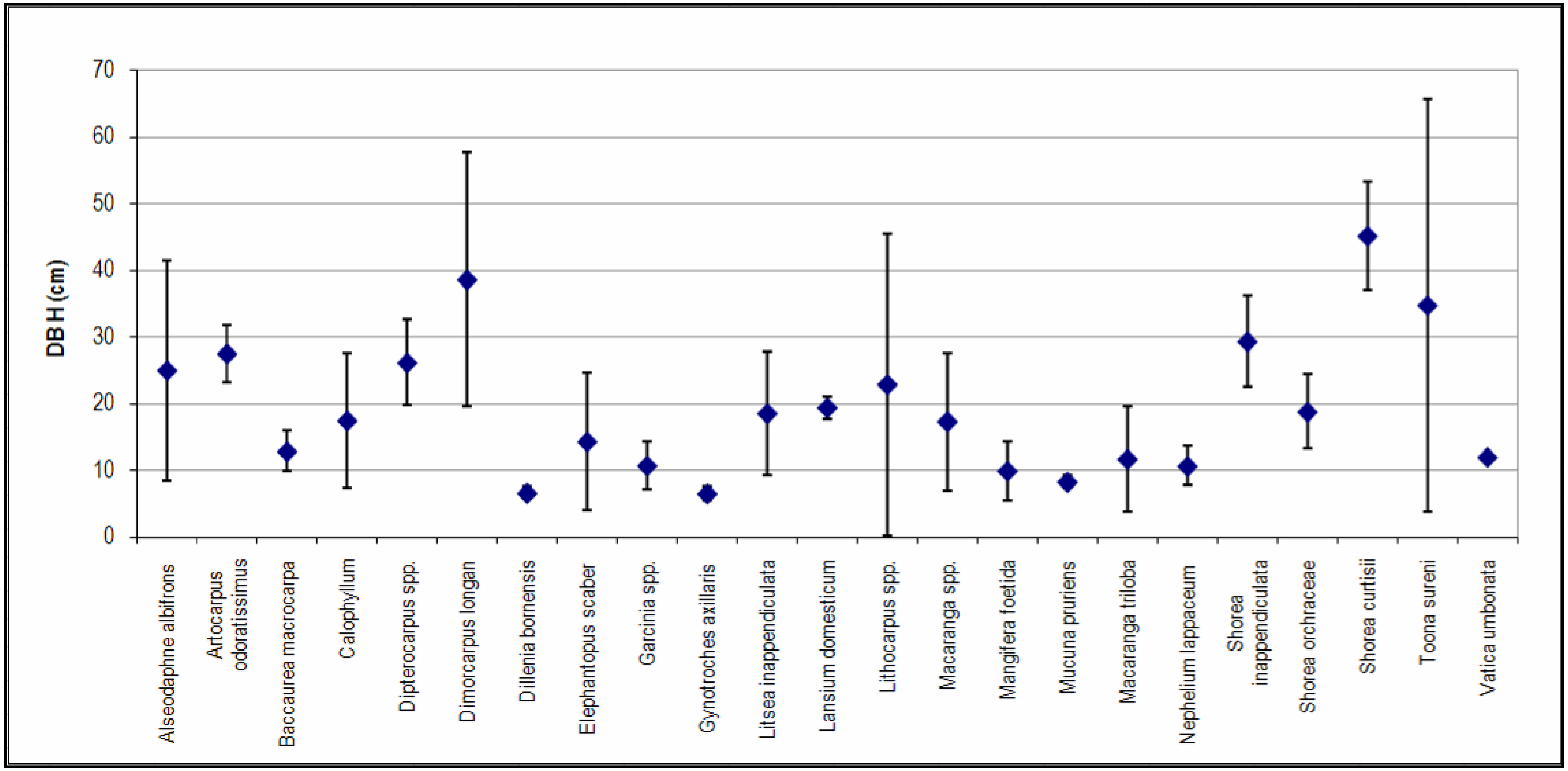

Figure 4.6.15 Mean DBH of the Species Encountered More Than Once at Stations 1, 3 and 5 (Bars Indicate the Standard Deviation)

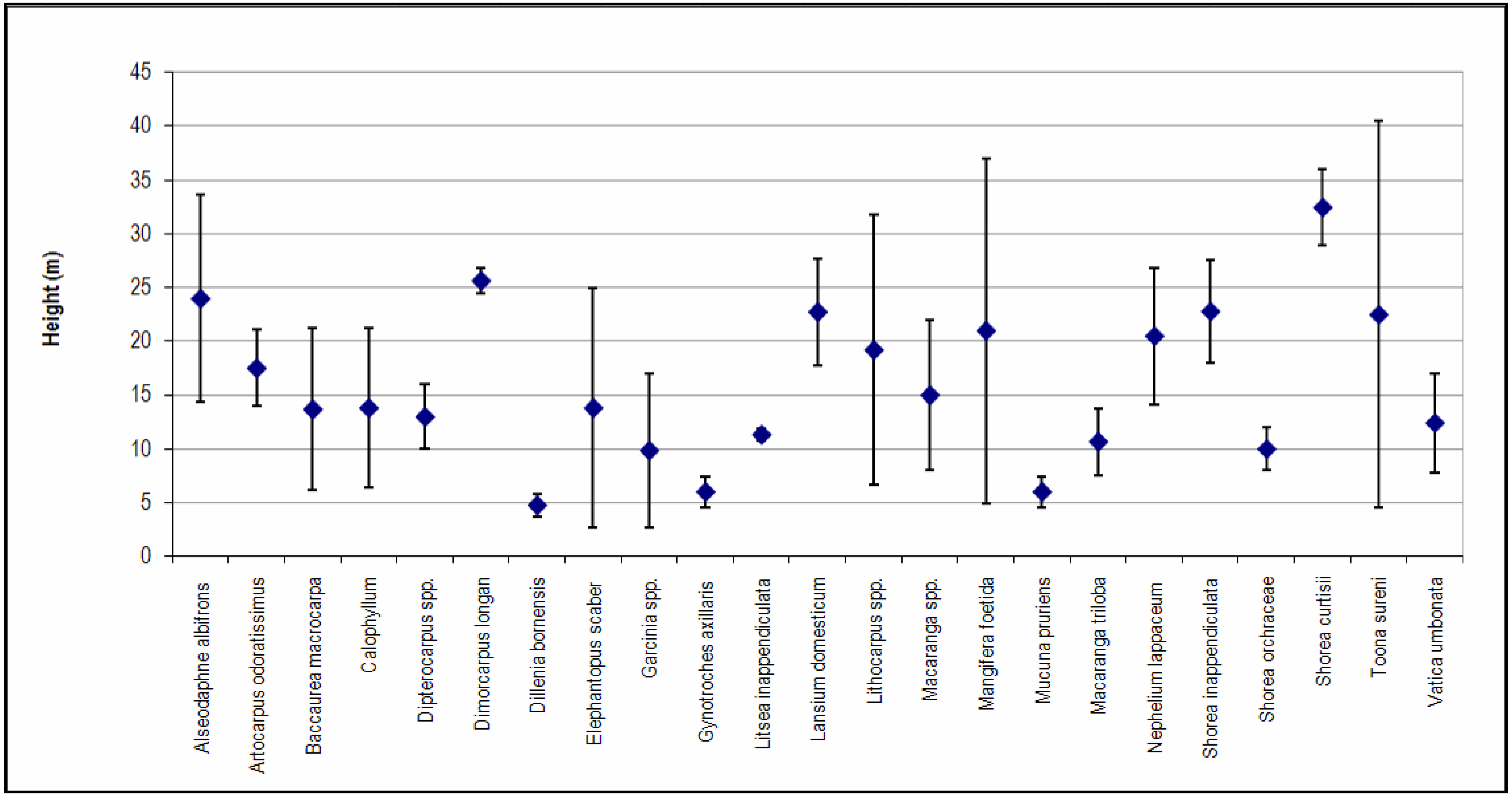

Figure 4.6.16 Mean Height Of The Species Encountered More Than Once At Stations 1, 3 and 5 (Bars Indicate the Standard Deviations)

(ii) Stand attributes

Tree density. The mean value for tree density at the three stations in the logged over forest range from 317 trees per hectare to 650 trees per hectare. The average density at logged over forest area (average of three stations) is 481 trees per hectare.

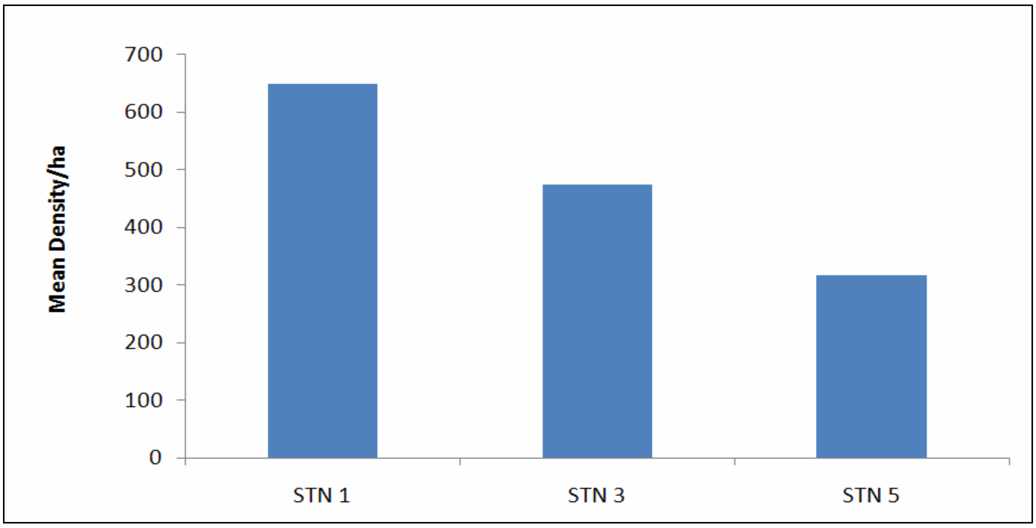

Figure 4.6.17 Mean Tree Density per Hectare at Each Station

Basal Area. The mean basal area at the logged over forest area was 22.69 m^2/ha ±9.45 ha The BA varied among the stations, with the lowest at station 3 and highest at station 1

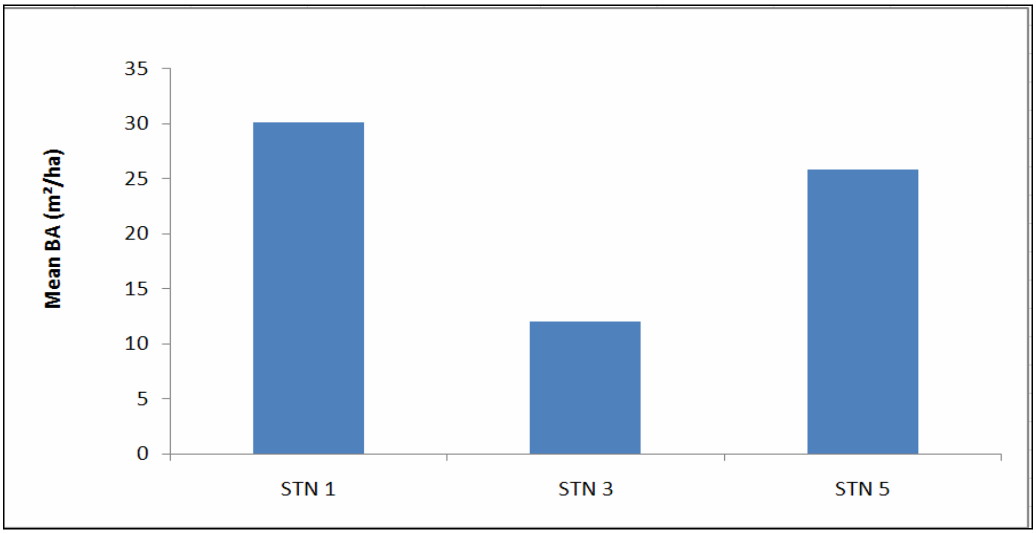

Figure 4.6.18 Basal area (m^2/ha)

Biomass.. The overall site average for the trees is 28.37 t/ha and the under-storey is 0.57 t/ha. Both tree and under-storey biomass was highest in Station 5 and lowest in Station 3.

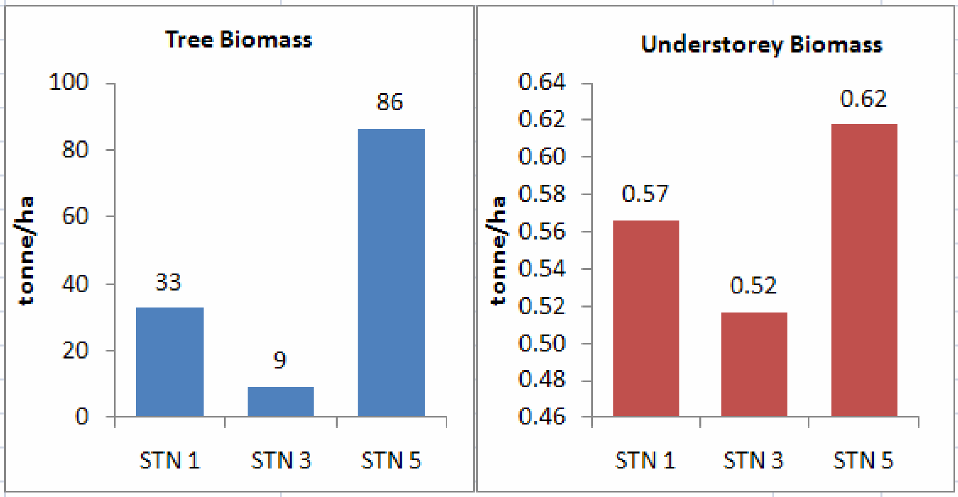

Figure 4.6.19 Estimated Above-Ground Biomass (Tree and Understorey) of the Stations that are in the Logged Over Area

Canopy Closure. The canopy closures at all stations are similar, with between 18-20% canopy gaps.

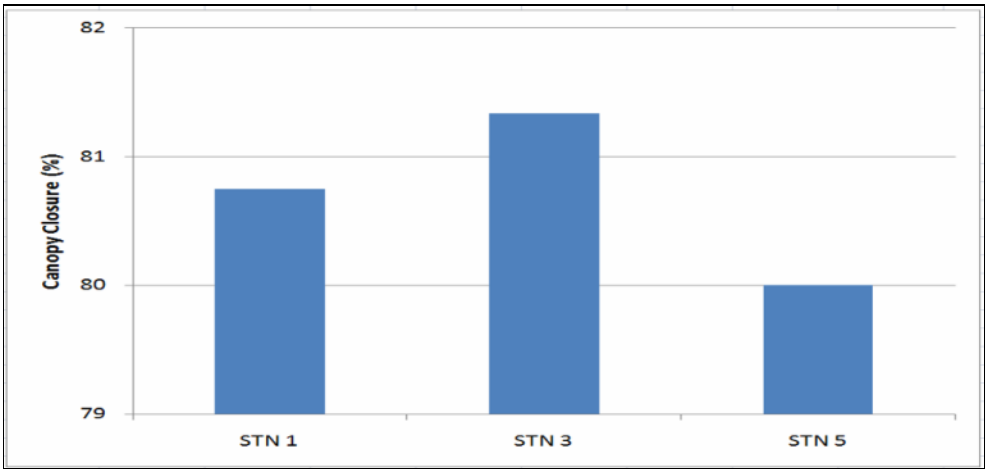

Figure 4.6.20 Canopy Closure (%)

Important Species

Species of Conservation Significance

Sabah Wildlife Conservation Enactment 1997

There are three species observed within the Padas forest area which listed in the Sabah Wildlife Conservation Enactment 1997 Part (II) Section 54 (1)(b) Protected Plants. These are:

- *Ceratolobus spp* – Rotan
- *Podocarpus spp.* – Lampias
- *Arenga undulatifolia* - Polod

Most of the *Ceratolobus* species was observed within the secondary forest however this species was not found in the survey plots. Only one *Podocarpus* species was found in Station 6 (in the undisturbed forest within the future reservoir area). *Arenga undulatifolia* was also observed on the way to station 4 (Dam site), but it is located outside of the proposed reservoir boundary and none were recorded in any survey plots.

CITES and IUCN Red List

Only one species is found listed under CITES (Convention on International Trade in Endangered Species). This species is *Aquilaria malaccensis*, locally known as *Gaharu.* This was recorded in Stations 2 & 6 (reservoir area) and Station 5 (logged over forest).

Seventeen species recorded in the plot inventory surveys are listed in the IUCN Red List (**Table 4.6-6**). Three species are listed as Critically Endangered species (*Dipterocarpus spp., Parashorea malaanonan, and Shorea inappendiculata*), which were observed within the future reservoir area. Two species are listed as Endangered; *Shorea pauciflora* and *Shorea argentifolia*, with the former recorded in all stations in the future reservoir area as well as the logged over forest area. *Shorea argentifolia* was recorded at one station in the future reservoir area and also at one station in the logged over forest.

Three species are listed as Vulnerable (*Aquilaria malaccensis, Knema hookerana and Durio spp.*) which were recorded in the future reservoir area.

Table 4.6-6 Species in Survey Plots that are Listed in the Red List

Species	Location	Estimated density / ha[45]	Red List Category & Criteria	Major Threat(s):
Dipterocarpus spp.	Reservoir area (Station 3 and 6)	17 trees/ha	Critically Endangered	Habitat destruction.
Parashorea malaanonan	Reservoir area (Station 4)	8 trees/ha	Critically Endangered	Used as white seraya timber and is the most important commercial timber of northern Borneo.
Shorea inappendiculata	Reservoir area (Station 6), Logged over forest (Station 5)	25 trees/ha	Critically Endangered	It is cut for balau timber but its slow growth does not allow it to reach maturity within the current logging cycle.
Shorea pauciflora	Reservoir area (Station 2, 4, and 6), Logged over forest (Station 1 and 5)	35 trees/ha	Endangered	The species is exploited for its valuable dark red meranti timber.
Shorea argentifolia	Reservoir area (Station 6), Logged over forest (Station 1),	13 trees/ha	Endangered	

[45] *Based on average density in all stations that the species was recorded.*

Species	Location	Estimated density / ha[45]	Red List Category & Criteria	Major Threat(s):
Aquilaria malaccensis (Gaharu)	Reservoir area (Station 2 and 6), Logged over forest (Station 5)	11 trees/ha	Vulnerable	For centuries the species has been traded internationally for the wood infected with fungi, called agar or gaharu amongst other things; it is used as incense, perfume and in traditional medicine. Most of the agar wood on the market is collected from the wild since the few plantations set up in the early 1900's are either under serious pressure or have been destroyed.
Knema hookerana	Logged over forest (Station 1)	8 trees/ha	Vulnerable	
Durio spp.	Reservoir area (Station 2)	8 trees/ha	Vulnerable	The natural habitat of this species is threatened by forest degradation due to logging and shifting agriculture.

(i) Commercial Timber Species

From the list of commercial tree species for sale in July 2009 provided by the Forest Research Institute of Malaysia (FRIM), only three genera existed in Padas forestry area. These are *Shorea spp., Dipterocarpus spp.,* and *Garcinia spp*.

(ii) Other culturally and Commercially Important Species

Other culturally important and commercially important species are *Tongkat Ali*, rattan and bamboo. Tongkat Ali and rattan were not in the survey plots but were observed on the way to the survey station. Most of the rattan can be found scattered around Bukit Tandak and Ketanun area. Bamboo can be observed around all stations except station 7 (plantation area).

Eurycoma longifolia, known in Malaysia as *Tongkat Ali*, is an important herbal plant that has great local demand as a health tonic. The plant owes its popularity locally and worldwide to its aphrodisiac claim and has been sought after as an essential component for its anti-malarial and anti-ulcer properties, anti-tumour promotion and anti-parasitic agents, and also as a health supplement. Quassinoids and canthin-6-one alkaloids contained in the Tongkat Ali root are the main substances that have an active function for the human body. The highest quassinoid content was found in the roots of Tongkat Ali, followed by the stem whilst the leaves contain the least[46].

Rattan is the most important internationally traded non-wood forest product (NWFP).There are more than 600 species of rattan, some 10% of which are commercially used. Bamboo

[46] *Dr. Rusli Ibrahim. August 2005. Commercialization of Advance Bioreactor Technology; http://www.symbiosisonline.com/aug05_bioreactor.htm*

(more than 500 species) is the most commonly used NWFP in Asia, where about 20 million tons are produced annually[47].

Reservoir Area above Ground Biomass

Four stations were set up within the future reservoir area: Station 2, Station 3, Station 4 and Station 6.

The average tree biomass for these four stations is 76.55 t/ha while the under-storey biomass is estimated at 0.48 t/ha. Therefore, if there was a total clearing and removal within the 590 hectare of the future reservoir area, approximately 45,165 metric tons of tree biomass will be removed and approximately 283 metric tons of under-storey biomass will be left to rot under the water.

4.6.3 WILDLIFE

Mammals, Birds and Herpetofauna. Due to the mobility of the wildlife and the relative small size of the reservoir – compared to the entire river system – there seems to be no major difference between wildlife around this stretch of river from that found around rivers in the rest of the catchment area. The rivers are a natural magnet for all wildlife as they search for water, but the banks in the reservoir area are rather inaccessible for most larger species. Even water based species such as otters may at times have trouble getting in and out of the water such places.

Macro invertebrates. The overall picture of the macro invertebrate communities in the river system is discussed in the section describing Zone 2: the catchment area. The results clearly show a great variation in macro-benthos, i.e. macro invertebrates, through the river system from the upper Sg. Padas and Sg. Maligan through the reservoir area to the proposed power house site. Of these sites, the middle, i.e. the dam site, generally showed a poorer macro-benthos community composition and density than the other stations. This supports the earlier statement that the Padas River is a mosaic of many habitats or maybe as also indicated of many sites at different stages of recuperation after earlier destructive land conversion regimes. The important part here is that the upstream rivers and streams are healthy and diverse and are capable of providing fresh invertebrate stock for rehabilitation of lost diversity or density downstream. That the powerhouse area is also rich indicates that there are patches throughout the system, which can provide this gene pool for rehabilitation.

4.6.4 LAND USE

There are no human settlements in the area planned for inundation. Resettlement of whole communities from the reservoir area is thus not part of the Project planning as it is not expected. There may be some local adjustments of individual households in study zone 5: Transmission-line Right of Way.

[47] *Ecosystems and human well-being by Millennium Ecosystem Assessment. v. 1 - 2005 - 917 pages*

Sabah Forest Industries has, for management reasons and as a legal requirement, subdivided its area into numbered compartments, which primarily follow natural features such as rivers and ridges. A map of the compartments surrounding the reservoir area is given in **Figure 4.6.21** for reference as these numbers occasionally are referred to in the text. Compartments P08 and P21 are managed as natural forest for protection purposes while compartments P07, P14, P19 and P20 are managed for industrial tree plantation.

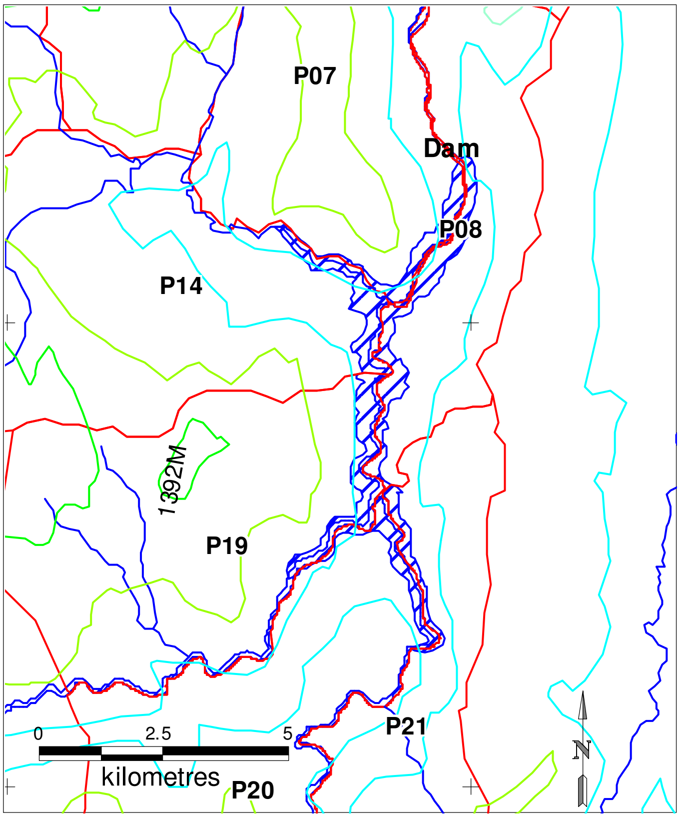

Figure 4.6.21 SFI Compartments near the Reservoir

Adapted from SFI maps, ICZM/DANCED

4.7 ZONE 5: TRANSMISSION-LINE 'RIGHT OF WAY'

4.7.1 TOPOGRAPHY

In general, the terrains encountered along the transmission- lines towards Tenom consist of flat to undulating land mostly occupied by scattered villages and oil palm plantations whereas slightly hilly but generally falling areas are encountered along the proposed alignment towards Sipitang which are occupied by villages and rubber plantations. From the dam site to Tenom, the transmission line is aligned more or less along the 695 m asl contour (See **Figure 4.7.1**).

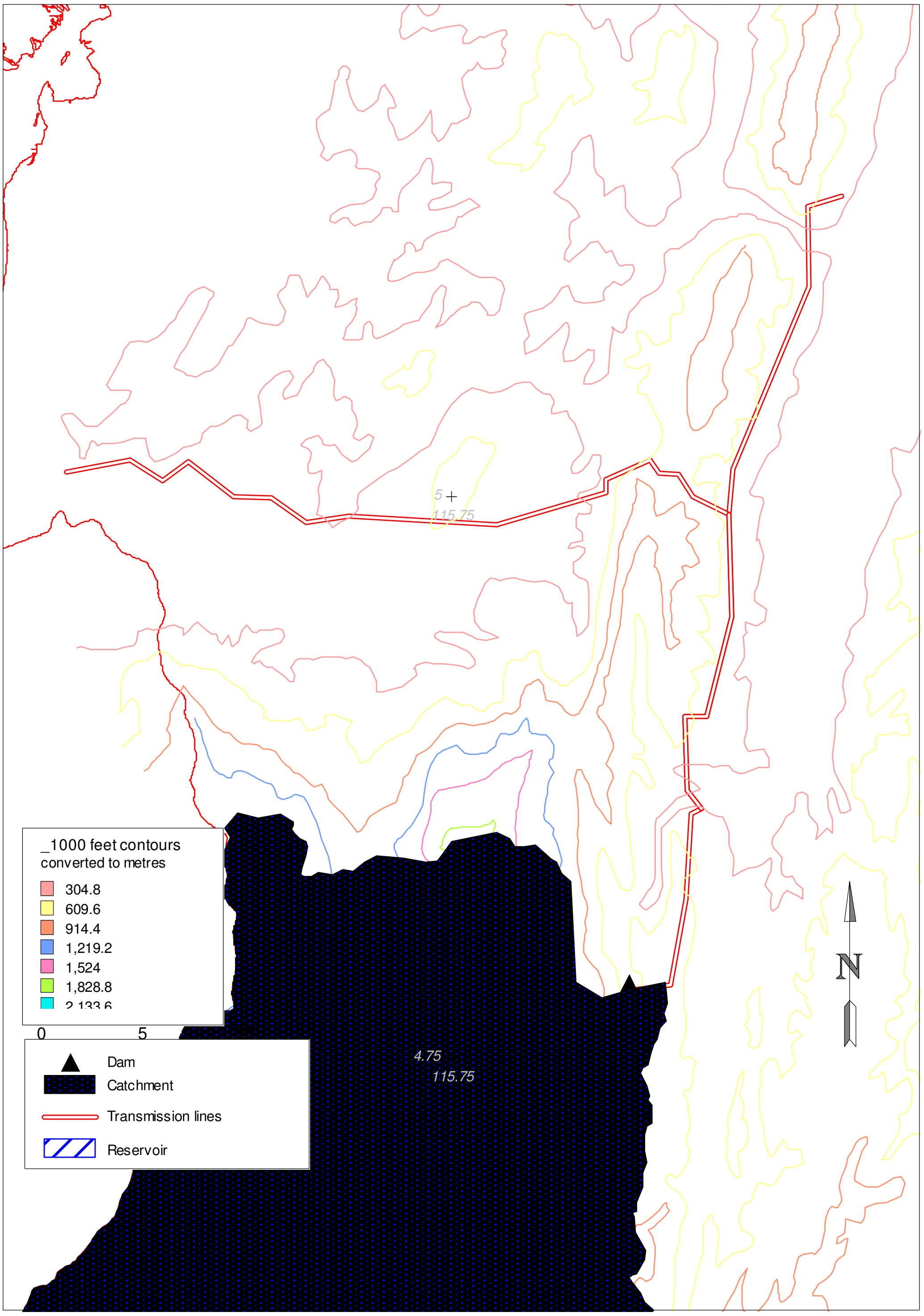

Figure 4.7.1 Topography along the Transmission Line

4.7.2 SOIL

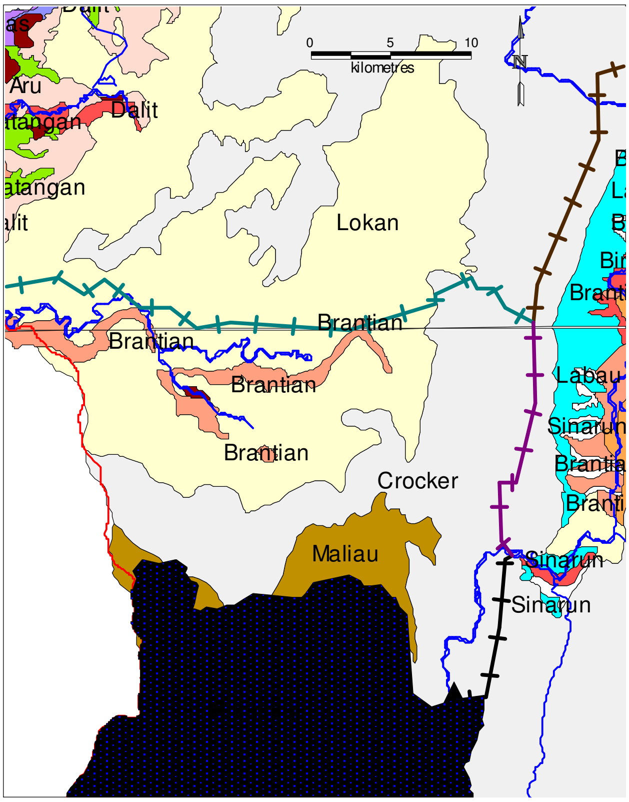

Figure 4.7.2 Soils along the Transmission Line

The soils along the South-North transmission lines from the dam to Tenom all consist of the Crocker association, similar to the northern part of the catchment area. The soils along the East-West line from Kg. Bamban to Sipitang, however are of the Lokan association. The two associations are rather similar and but not very suitable for agriculture. The Lokan association is often dominated by sharp ridges and steep slopes. The hills are formed of interbedded sandstone and mudstone and the original vegetation has been dipterocarp forest.

4.7.3 LAND USE

The alignment roughly touches 5 types of land uses:

1. Areas gazetted as Class I Protection Forest reserve.
2. Areas under natural forest management by the Sabah Forest Industries (Dark green areas in the maps below).
3. Small-holder rubber plantations.
4. Small-holder oil palm plantations.
5. Areas under industrial tree plantation management by the Sabah Forest Industries (Brownish areas in the accompanying maps).

Most of the alignment is along the boundary between small-holder plantations and Sabah Forest Industries areas. Whether the alignment is in the boundary, i.e. 50% of the right-of-way in the Sabah Forest Industries area and 50% in the plantation area or whether the alignment shall be fully in either of these areas has not been determined yet.

Chemsain recommends following ranking of protection priority:

1. Areas gazetted as Class I Protection Forest reserve.
2. Areas under natural forest management by the Sabah Forest Industries (Dark green areas in the maps below).
3. Small-holder plantations and agriculture.
4. Areas under industrial tree plantation management by the Sabah Forest Industries (Brownish areas in the accompanying maps).

In other words, where there is a choice, the alignment should lie fully in areas of priority 4, 3, 2 or 1 in that order.

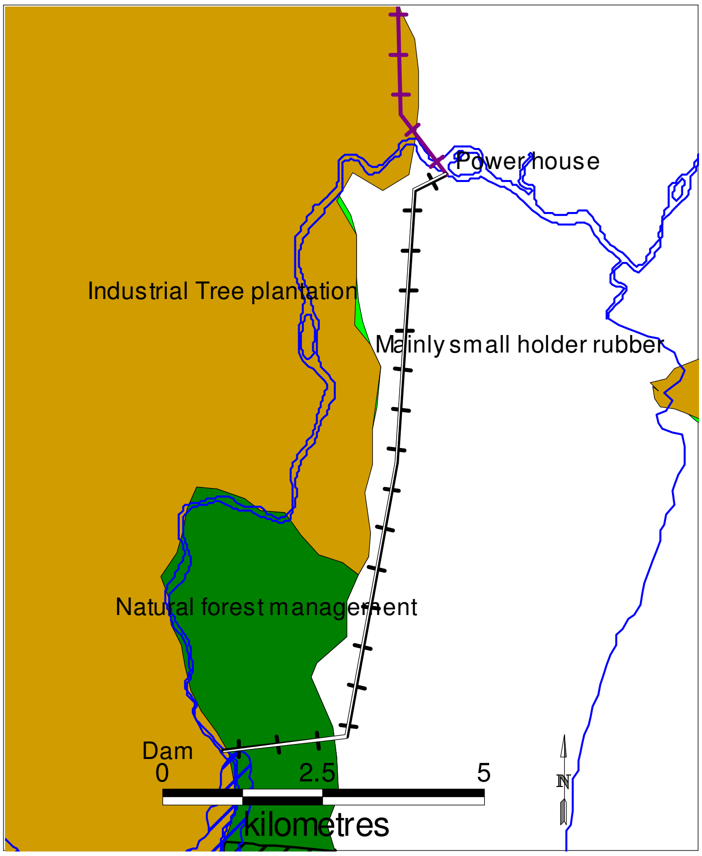

Figure 4.7.3 Proposed Transmission-Line Alignment (Right of Way) and Land Use Dam Site – Power House

The proposed transmission- lines alignment and locations for the new substations are still in their planning stage (**Figure 4.7.3**). There will in principle be four lines:

1. A 11.5 km local line connecting the dam and the auxiliary power station for the compensation flow with the main power station. This line will first go 1.9

km through the Sabah Forest Industries compartment P08, which is managed as natural forest, later 9.6 km along the boundary between the concession and the adjacent village reserve/state land. The first 2.8 km of this stretch still follows compartment P08, the remaining along P06, which is planned for industrial tree plantation The land use pattern in the village area is dominated by small holder rubber plantations, some of which are united in the Lembaga Industri Getah Sabah (LIGS) rubber scheme.

2. A 16.01 km double, i.e. 2 x 40 m width, corridor from the powerhouse to approximately 5 km west of Kg. Bamban/Kg. Paal (**Figure 4.7.4**). This line will from the powerhouse and north (4.6 km) be aligned at the boundary between the Sabah Forest Industries concession (industrial tree plantation areas) and the village reserve/state land till it meets the Gunung Lumaku Protection Forest reserve on the lower slopes of Gunung Lumaku. From here, the line will run 11.41 km following the boundary between the protection Forest reserve and the village reserve/state land till its termination at a road reserve cutting through the Gunung Lumaku Protection Forest Reserve west of Kampong Bamban. The road is the main road from Tenom to Sipitang. Overall, the alignment follows the access road planned for the Upper Padas Hydroelectric Project. The land use pattern in the village area is predominantly small holder oil palm plantations mixed with some rubber.

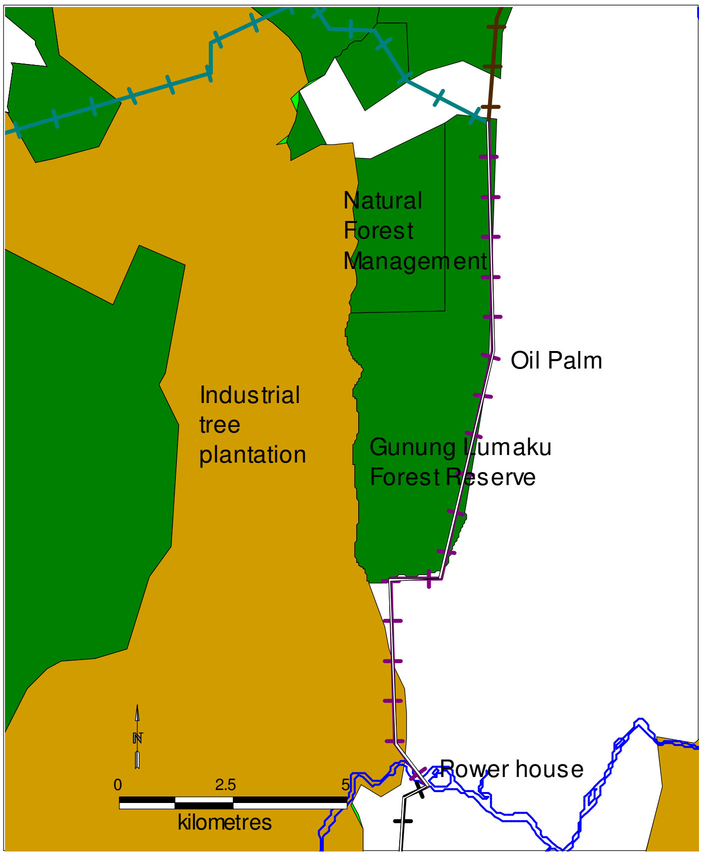

Figure 4.7.4 Proposed Transmission Line Corridor (RoW) Power House - Kg. Bamban

3. From Bamban there will be a 18.87 km line to Sipitang, first following approximately the road reserve cutting an East-West corridor through the Gunung Lumaku Protection Forest Reserve after which it will in rough terms follow the road through the Sabah Forest Industries concession compartments L24 (4.1 km natural forest), L32 (4 km industrial tree plantation areas and 2.4 km natural forest), and L33 (1.45 km industrial tree plantation areas) before following the boundary between the Sabah Forest Industries area and the village reserve/state land to the location of the new substation which is proposed to be within a rubber plantation area South of Sipitang. The overall land use in this sector outside the Sabah Forest Industries area is small holder rubber plantations mixed into old, secondary forest, patches of small holder oil palm and some other tree plantations. The plantations are in general not well maintained. The alignment is taken a safe distance north of the Ulau village (see **Figure 4.7.5**).

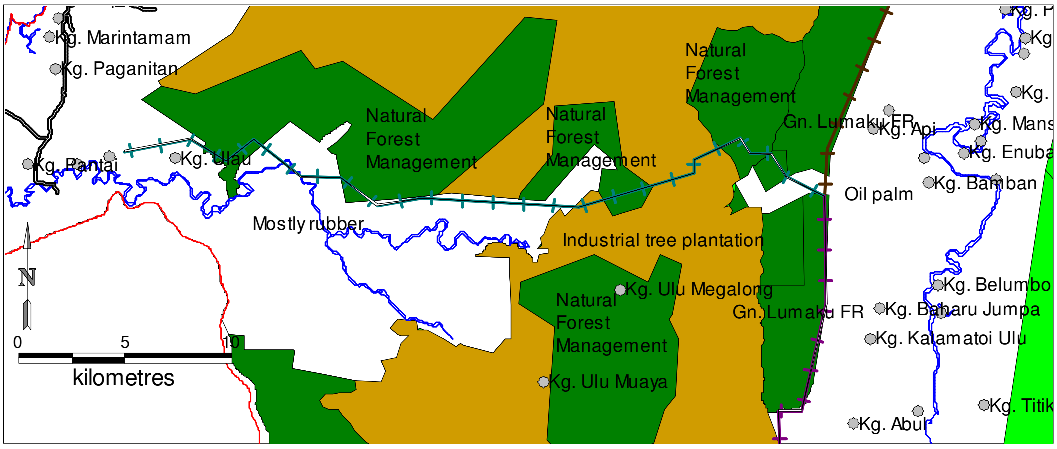

Figure 4.7.5 Proposed Transmission Line Alignment (RoW) Kg. Bamban - Sipitang

4. From Kampong Bamban, there will be a 17.87 km line to Tenom continuing along the boundary between the Gunung Lumaku Class I Forest Reserve and village reserve, which in that area is predominantly hilly areas with large scale, industrial oil palm plantations (**Figure 4.7.6**). The main estate in this area belongs to Sime Darby. The line terminates at the site for the new substation which is proposed to be located at the northern part of the existing Pangi Hydroelectric Station.

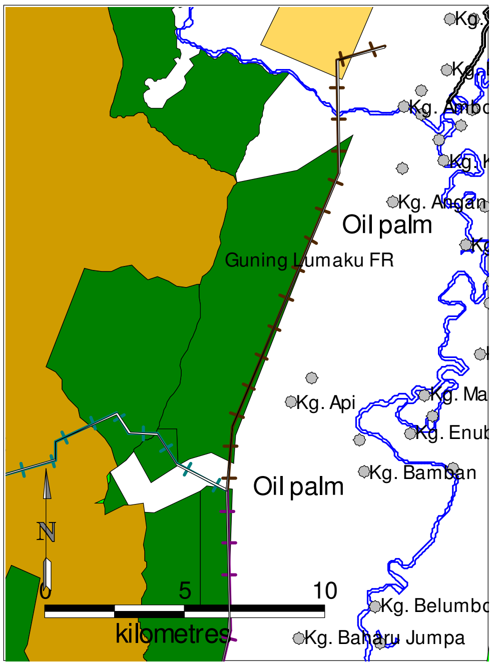

Figure 4.7.6 Proposed Transmission Line Alignment (RoW) Kg. Bamban - Tenom

At present, the proposed alignments and substation locations do not go through any settlements. The next stage for the Proponent and his engineering consultant will be to overlay the proposed alignments onto a more accurate topographic mapping to determine if there are any physical or engineering impediments (e.g. steep slopes, etc) which may require adjustments to the current alignments.

Table 4.7-1 lists the land use under the transmission lines if the alignment principles and protection priorities above are adhered to. A right-of-way width of 40 metres is assumed.

Table 4.7-1 Land use under the transmission lines (Length (Km) / area (Ha))

Sector	Protection forest	Natural Forest	Industrial Tree Plantation	Oil Palm	Rubber	Total Length / Area
Secondary power house - Main power house	0 km 0 ha	1.9 km 7.60 ha			9.6 km 38.40 ha	11.50 km 46.00 ha
Main power House - Kg Bamban (16.01 km Double line)	0 km 0 ha			32.02 km 128.08 ha		16.01 km 128.08 ha
Kg Bamban - Tenom	0 km 0 ha			17.87 km 71.48 ha		17.87 km 71.48 ha
Kg Bamban - Sipitang	0 km 0 ha	8.83 Km 35.32 ha	5.45 km 21.80 ha	1.93 km 7.72 ha	20.55 km 82.20 ha	36.76 km 147.04 ha
Total	**0 km** **0 ha**	**10.73 km** **42.92 ha**	**5.45 km** **21.80 ha**	**51.82 km** **207.28 ha**	**30.15 km** **120.60 ha**	**98.15 km** **392.60 ha**

Note: Slight variations in line lengths with other tables is due to different map sources in use

4.8 ZONE 6: THE WATER OF PADAS, MALIGAN, KETANUM AND MENGALONG RIVERS

Figure 4.8.1 below shows the JPS river level/flow stations in the Sg Padas catchment.

Figure 4.8.1 JPS River Level / Flow Stations

Using the data from the aforementioned river level/flow stations, various methods have been applied to estimate mean flow and the flow duration curve at the dam site.

From this work, the following estimates have been made for the Sg Padas at the proposed dam site (period: 1989-2008, catchment area 1,912 km^2):

- Mean flow: 71.6 m^3/s
- Median flow: 52.4 m^3/s
- 10% low flow: 15.5 m^3/s

From the runoff modelling, a long duration series of runoff has been prepared, as shown in **Figure 4.8.2** (1989 – 2008).

The long record provides a statistically meaningful record of the variability of runoff, providing a basis for assessment of hydrology/hydraulics, water quality and sediment transport processes.

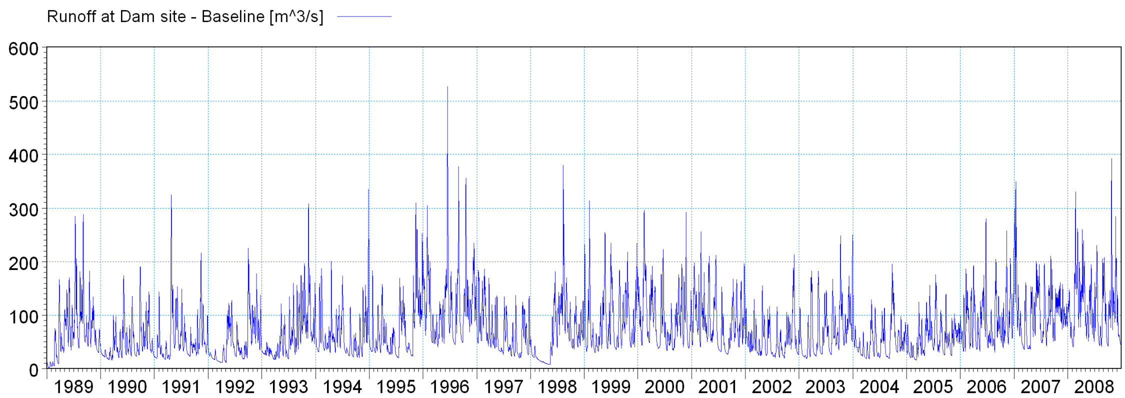

Figure 4.8.2 Simulated Runoff (m^3/sec) at Upper Padas Dam Site (1989-2008)

Historical Data. To further understand the background of the Padas River, historical data was researched and compiled with regards to any studies conducted in the Padas River. The Department of Irrigation and Drainage (DID) has installed monitoring stations throughout the river system in Sabah to record the hydrographic information.

Alam Sekitar Malaysia Sdn. Bhd (ASMA), an organization that monitors river water quality throughout Malaysia, also has monitoring stations along the Padas river system, including one at Tenom.

Monitoring data from the Department of Irrigation and Drainage include information such as total suspended solids (TSS), discharge flow and water level. Only one (1) station, Kemabong (ID: 4959501), is within the Tenom area (**Figure 4.8.3**). The period of data received from DID for this station is from 1992 – 2006. It is noted that the sampling was not conducted regularly, hence during some years more sampling campaigns were carried out within a particular season compared to others. The number of sampling campaigns per season for a given year is indicated on the graph (**Figure 4.8.4**).

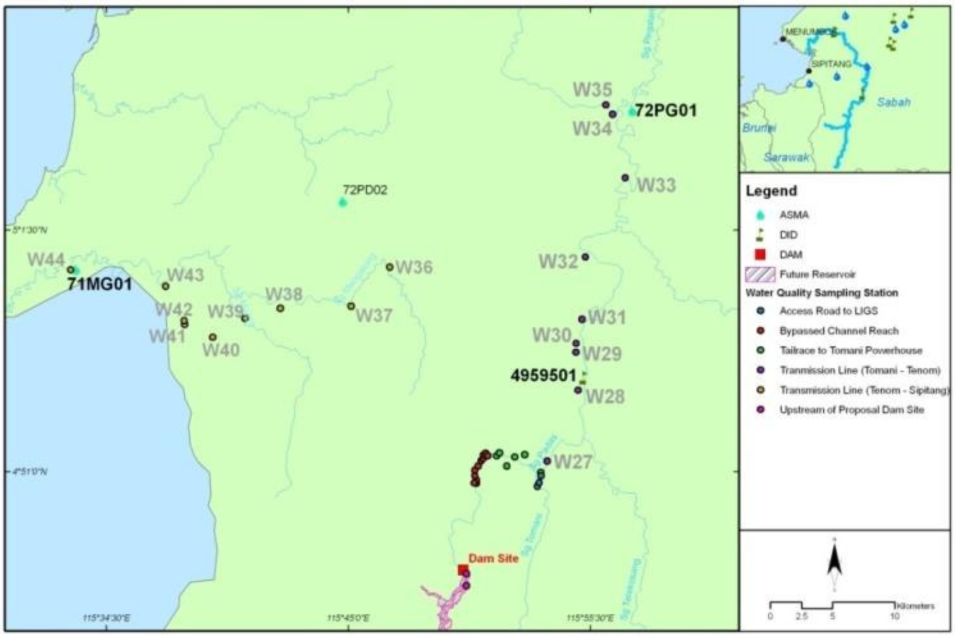

Figure 4.8.3 DID and ASMA Stations in Relevance to the Study

As summarized in **Figure 4.8.4**, the average total suspended sediments (TSS) concentrations recorded at Kemabong monitoring station exceeded the DOE 50 mg/l standard for both the wet and dry season except for year of 1998, 2000, 2004 and 2005, where TSS during both seasons were below the standard limit with the lowest monthly average TSS concentration of 7 mg/l in year 1998 for wet season and 8 mg/l in year 2000 for dry season.

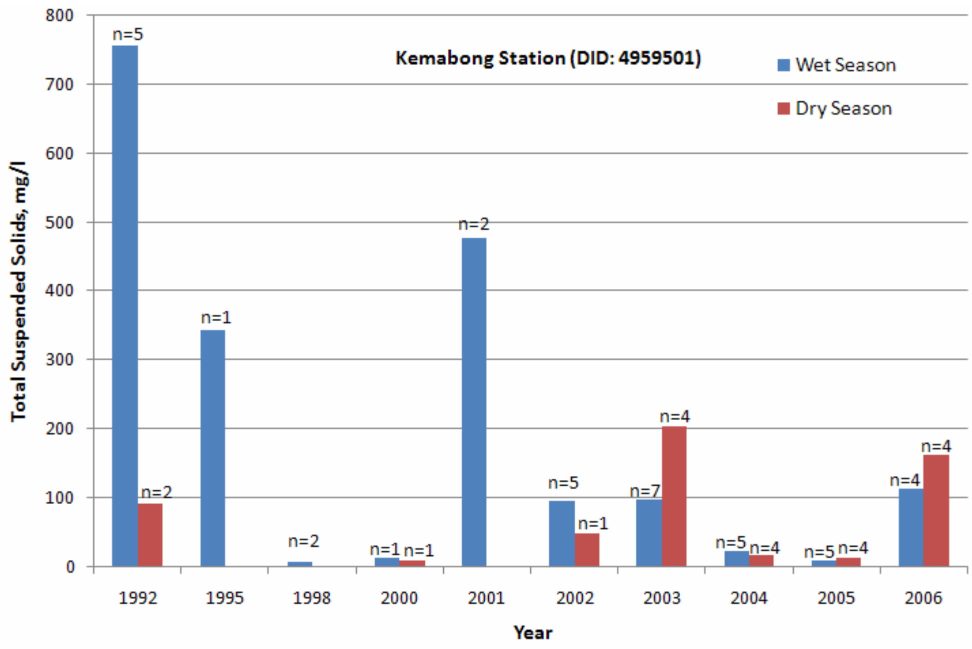

Figure 4.8.4 Average TSS Concentration Derived from DID Data

4.8.1 BASELINE WATER QUALITY CONDITION

4.8.1.1 CATCHMENT POLLUTION LOAD

Annual pollution load generated at the catchment scale was estimated using DHI's LOAD model. All pollutant loads are calculated as total annual loads (e.g. kg/year) accumulated through the river system (full details on the LOAD model setup and calibration can be found in the Appendix document).

Annual pollution load for each sub-catchments are given for biological oxygen demand, total nitrogen, total phosphorous and E-Coli as shown in **Table 4.8-1** to **Table 4.8-4**. It should be noted that the distinction is made between load generated from non-point sources and domestic sources. The percentage of contribution of non-point, point and domestic sources to the total annual biological oxygen demand, total nitrogen, total phosphorous and E-Coli load per sub-catchment is shown in **Figure 4.8.5** to **Figure 4.8.8**.

Table 4.8-1 Annual Pollution Load - BOD (ton/yr)

Sub-Catchment Name	BOD Total	BOD (non-point)	BOD (domestic)	BOD (point)
Padas_DS1	154	149	5	0
Padas_DS3	181	122	54	5
Dam_US	646	639	7	0
Padas_DS2	123	110	13	0
Beaufort	260	157	95	8
Biah	468	287	179	2
Padas_US	256	165	76	15
Kemabong	17	13	4	0
Dam_DS	71	51	21	0
Ansip_Gauge	12,245	651	736	10,858

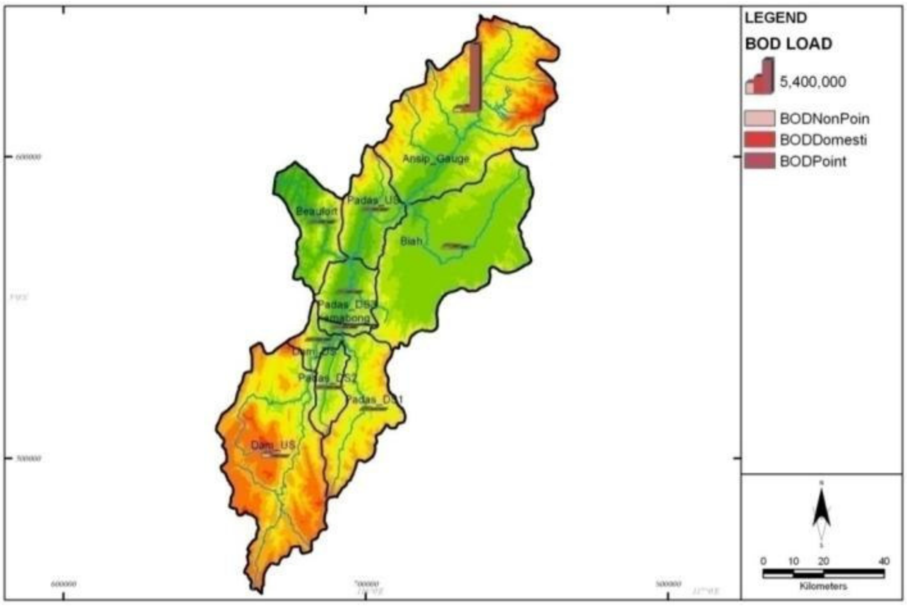

Figure 4.8.5 Contribution of Non-Point, Point and Domestic Sources to the Annual BOD Load Per Sub-Catchments

Table 4.8-2 Annual Pollution Load - TN (ton/yr)

Sub-Catchment Name	TN Total	TN (non-point)	TN (domestic)	TN (point)
Padas_DS1	106	101	5	0
Padas_DS3	145	99	44	2
Dam_US	424	418	6	0
Padas_DS2	66	54	11	0
Beaufort	186	97	66	23
Biah	440	276	154	10
Padas_US	200	125	64	11
Kemabong	17	13	4	0
Dam_DS	44	29	15	0
Ansip_Gauge	1,074	419	580	75

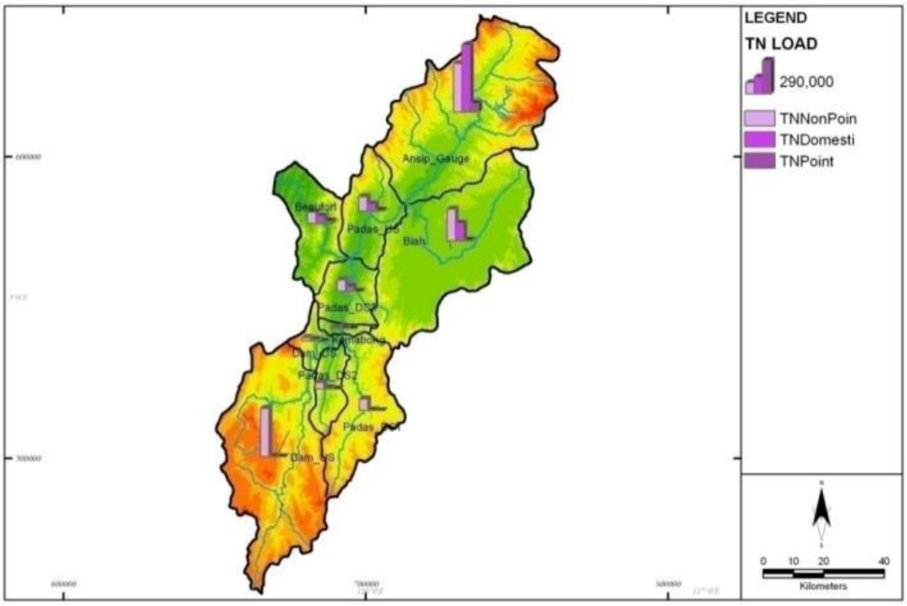

Figure 4.8.6 Contribution of Non-Point, Point and Domestic Sources to the Annual TN Load Per Sub-Catchments

Table 4.8-3 Annual Pollution Load - TP (ton/yr)

Sub-Catchment Name	TP Total	TP (non-point)	TP (domestic)	TP (point)
Padas_DS1	48	48	1	0
Padas_DS3	54	48	4	2
Dam_US	161	160	1	0
Padas_DS2	28	27	1	0
Beaufort	55	47	7	1
Biah	150	134	15	1
Padas_US	71	60	6	4
Kemabong	7	6	0	0
Dam_DS	15	14	2	0
Ansip_Gauge	307	202	58	47

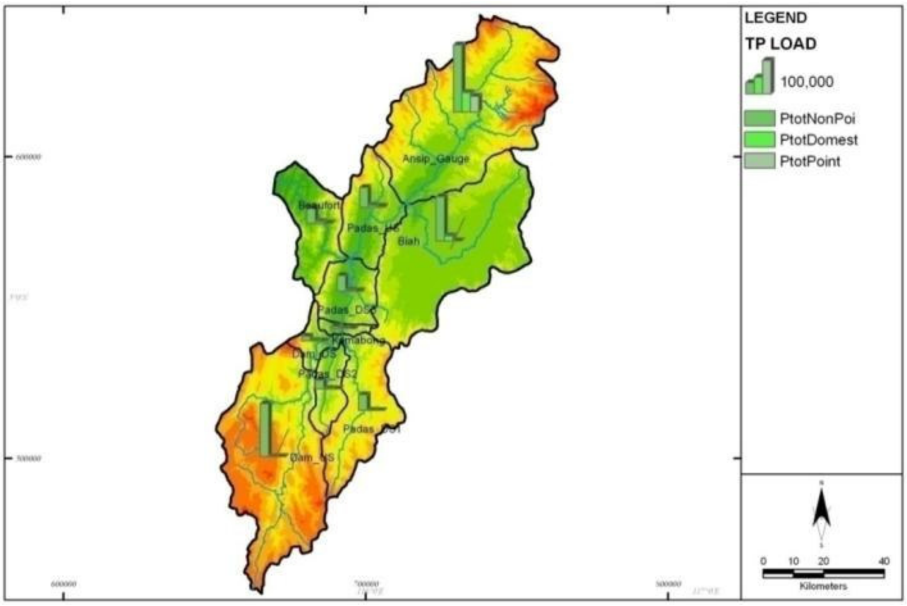

Figure 4.8.7 Contribution of Non-Point, Point and Domestic Sources to the Annual TP (Total Phosphorus) Load Per Sub-Catchment

Table 4.8-4 Annual Pollution Load – E-Coli (1012/yr)

Sub-Catchment Name	E-coli Total	E-coli (non-point)	E-coli (domestic)	E-coli (point)
Padas_DS1	1,063	744	319	0
Padas_DS3	4,502	472	3,971	59
Dam_US	2,501	2,064	437	0
Padas_DS2	1,225	379	847	0
Beaufort	7,986	539	7,447	0
Biah	13,893	1,045	12,849	0
Padas_US	6,164	657	5,402	105
Kemabong	317	42	274	0
Dam_DS	1,799	223	1,576	0
Ansip_Gauge	58,546	2,714	53,856	1,976

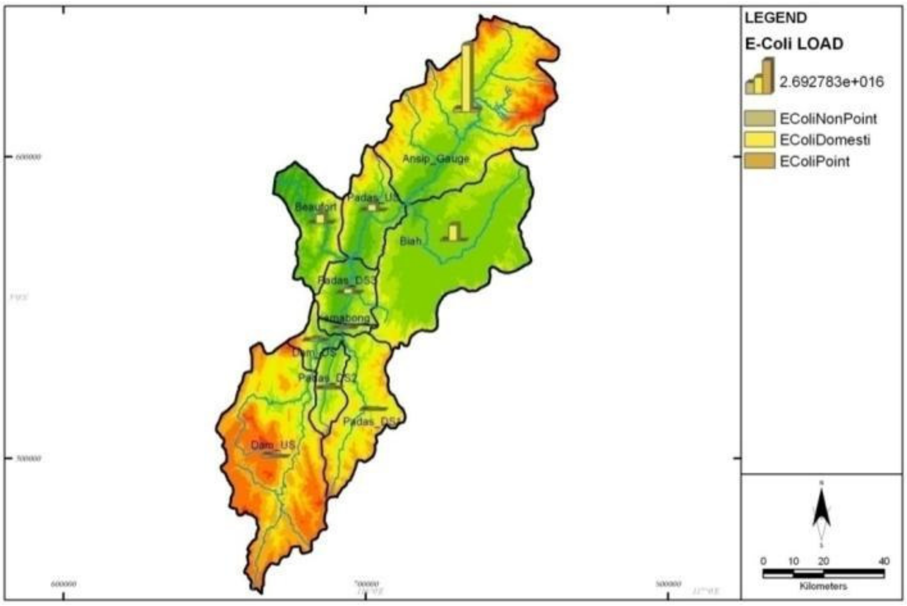

Figure 4.8.8 Contribution of Non-Point, Point and Domestic Sources to the Annual E-coli Load Per Sub-Catchment

Chemical oxygen demand (COD) level found at most of the downstream sampling stations showed COD level to be below the standard limit of 25 mg/l set by INWQS under Class IIA/B while Biological oxygen demand (BOD) reading for dry and wet seasons are below 2 mg/l at all the downstream sampling stations (Frachisse et al. 2009). Turbidity at most stations recorded 320 to 650 NTU and for wet season was at W2 with 320 NTU, exceeding the standard limit of 50 NTU for INWQS Class IIA/B (Frachisse et al. 2009). However, the chlorophyll *a* data collection coincided with rainy season; the results might not represent other seasons of the year.

Historical water quality data for the Padas River as described above are not enough or sufficiently distributed for a complete assessment of the water quality condition of the entire river. Therefore, further sampling was conducted to obtain a clearer understanding of the water condition.

4.8.1.2 WATER QUALITY AT/NEAR PROJECT SITE

The existing water quality condition prior to the implementation of the proposed Project was determined through a water quality sampling campaign conducted over two climatic periods, i.e. dry and wet seasons. Sampling for the dry season started on June 2008, whereas sampling for the wet season was on October 2008. However, due to accessibility issues, sampling for both dry and wet season for stations W7 – W16 was conducted at the same month on September 2008 with samples for “wet season” being collected following a downpour.

The sampling locations (**Map 4.8- 1 Water and Flow Measurement Sampling Points**) were chosen to represent the water quality of Padas River and its tributaries upstream and downstream of the proposed dam site, power station area and along the transmission lined alignment. See sampling locations description in **Table 4.8-5** and **Appendix 2-4: Water Quality** documents the sampling methodology and laboratory results.

Table 4.8-5 Water Sampling Location Description

Locations	Date	Weather	Description
Upper dam - dam			
W1 (Sg. Maligan, at the cement bridge)	17/06/08	Fine	Water flowing very rapidly; turbid.
	15/10/08	Fine	
W2 (Sg. Padas, at the cement bridge)	17/06/08	Fine	Water flowing very rapidly; turbid.
	14/10/08	Fine	
W3 (Sg. Pa Sia)	22/07/08	Fine	Water flowing slowly, brownish and slightly turbid
	15/10/08	Fine	
W4 (Upstream of Sg Padas and Sg Maligan)	22/07/08	Fine	Water flowing slowly, turbid
	15/10/08	Fine	
W5 (Sg. Padas.Upstream of dam site)	24/07/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river.
	29/10/08	Fine	
W6 (Sg Padas near dam site)	24/07/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes both sides.
	29/10/08	Fine	
Dam - Tailrace			
W7 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W8 (Tributary into Sg Padas)	24/09/08	Fine	Water flowing slowly.
	26/09/08	Fine	
W9 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W10 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W11 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W12 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W13 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W14 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
W15 (Tributary into Sg Padas)	24/09/08	Fine	Water flowing slowly; turbid; rocky formation on both sides of river.
	26/09/08	Fine	

Locations	Date	Weather	Description
W16 (Sg Padas upstream of powerhouse)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river.
	26/09/08	Fine	
W17 (Tributary into Sg Padas)	24/09/08	Fine	Water flowing rapidly; turbid; rocky formation on both sides of river. Steep slopes on both sides.
	26/09/08	Fine	
Powerhouse-Tomani			
W18 (Sg Padas upstream of powerhouse; after the bridge)	10/07/08	Fine	Water flowing rapidly; turbid
	30/10/08	Fine	
W19 (Sg Padas upstream of powerhouse; before the bridge)	08/07/08	Fine	Water flowing rapidly; turbid
	30/10/08	Fine	
W20 (Tributary into Sg Padas)	08/07/08	Fine	Water flowing slowly; slightly turbid
	30/10/08	Fine	
W21 (Sg Padas downstream of powerhouse)	08/07/08	Fine	Water flowing slowly and turbid
	30/10/08	Fine	
W22 (Unnamed tributary into Sg. Padas)	08/07/08	Fine	Water flowing slowly and slightly turbid
	30/10/08	Fine	
W23 (Sg Tomani)	09/07/08	Fine	Water flowing slightly rapid and turbid
	30/10/08	Fine	
Access road @ LIGS			
W24 (Tributary into Sg Tomani)	08/07/08	Fine	Water flowing slightly rapid and slightly turbid
	30/10/08	Fine	
W25 (Tributary into Sg Tomani)	08/07/08	Fine	Water flowing slightly rapid and slightly turbid
	30/10/08	Fine	
W26 (Tributary into Sg, Tomani)	08/07/08	Fine	Water flowing slightly rapid and turbid
	30/10/08	Fine	
Transmission Lines (Tomani-Tenom)			
W27 (Sg. Tomani)	14/07/08	Fine	Water flowing slightly rapid and turbid
	30/10/08	Fine	
W28 (Sg Padas)	15/07/08	Fine	Water flowing slightly rapid and turbid. Agriculture and settlements on both sides.
	30/10/08	Fine	
W29 (Sg Padas)	15/07/08	Fine	Water flowing slightly rapid and turbid. Agriculture and settlements on both sides.
	30/10/08	Fine	
W30 (Sg Padas)	15/07/08	Fine	Water flowing rapidly and turbid. River sand and stone mining downstream. Agriculture and settlements on both sides.
	30/10/08	Fine	
W31 (Sg Padas)	15/07/08	Fine	Water flowing slightly rapid and turbid.

Locations	Date	Weather	Description
	30/10/08	Fine	Agriculture and settlements on both sides.
W32 (Unnamed tributary into Sg Padas, beside intersection to Sipitang)	15/07/08	Fine	Water flowing slowly and slightly turbid. Settlements located nearby.
	30/10/08	Fine	
W33 (Sg Padas)	15/07/08	Fine	Water flowing slowly and turbid. Agriculture area.
	30/10/08	Fine	
W34 (Sg Padas)	28/07/08	Fine	Water flowing slowly and turbid. Agriculture and settlement area.
	30/10/08	Fine	
W35 (Sg Padas)	29/07/08	Fine	Water flowing slowly and turbid. Agriculture and settlement area.
	30/10/08	Fine	
Transmission Lines (Tenom-Sipitang Highway)			
W36 (Bridge crossing, Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid.
	23/10/08	Cloudy	
W37 (Bridge crossing, Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and clear water.
	23/10/08	Cloudy	
W38 (Bridge crossing, Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and clear water.
	23/10/08	Cloudy	
W39 (Bridge crossing, Sg Muaya, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.
	23/10/08	Cloudy	
W40 (Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.
	23/10/08	Cloudy	
W41 (Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.
	23/10/08	Cloudy	
W42 (Bridge crossing; Tributary into Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.
	23/10/08	Cloudy	
W43 (Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.
	23/10/08	Cloudy	
W44 (Bridge crossing; Sg Menggalong, beside the Sipitang-Tenom Road)	28/07/08	Fine	Water flowing slowly and slightly turbid. Surrounded by settlements.

Results

Temperature

Water temperature for the sampling stations ranged from 24.9° C to 33.5° C for the dry season campaign and ranged from 26.5° C to 28.8° C during the wet season campaign.

pH Value

The ph value recorded during the dry season campaign ranged from 6.2 to 8.6 and wet season recorded values ranging from 6 to 7.4. In general, the pH value in Padas River remains within the range of 6 – 9 set by the Interim National Water Quality Standards (INWQS) for Malaysia under Class IIA/B for which the quality of water is defined as suitable for sensitive aquatic species and/or recreational use with body contact. See **Figure 4.8.9**.

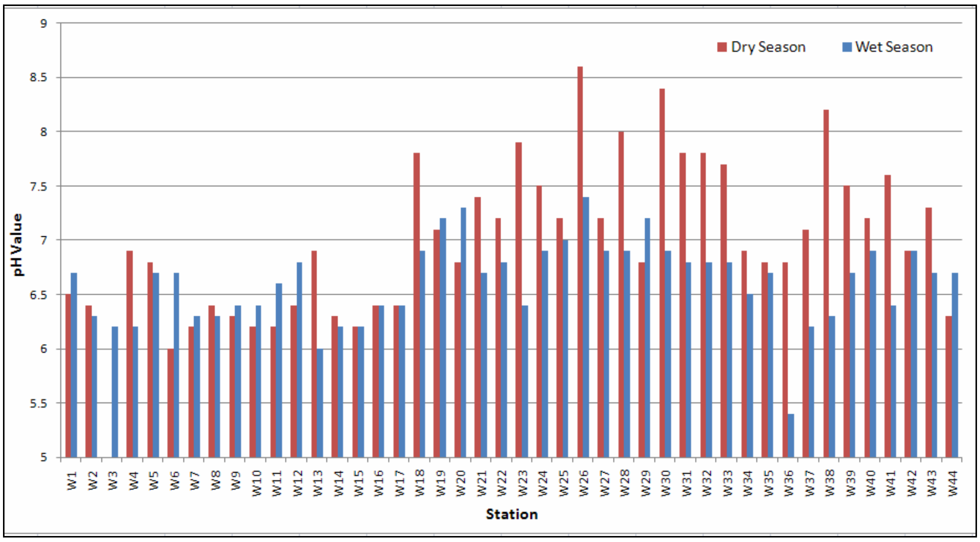

Figure 4.8.9 pH Value for Both Dry and Wet Seasons Campaign

Conductivity

Conductivity is a measure of the presence of ions within the water, usually due to saline intrusion or natural leaching within the watershed. It may also indicate industrial discharges. From **Figure 4.8.10**, it is seen that at the majority of the stations the presence of ions are higher during dry the season compared to the wet season except station W25 and W26 which recorded the highest conductivity reading during wet season at 254 μS and 200 μS, respectively.

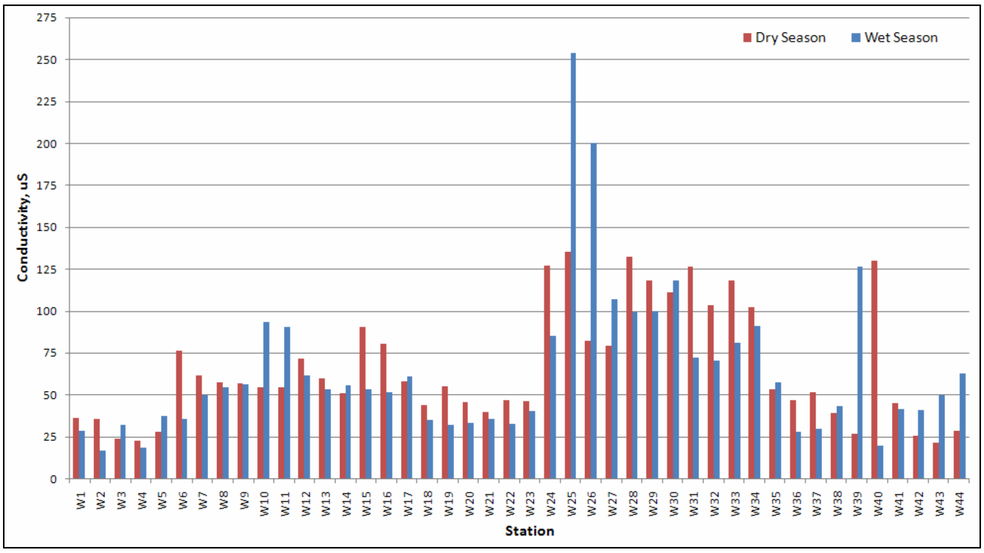

Figure 4.8.10 Conductivity Levels Found for Dry and Wet Seasons in Padas River

Salinity

The salinity recorded in the Padas River is less than 4 g/kg for both dry and wet seasons except for station W2 with 13.8 g/kg during the dry season.

Dissolved Oxygen

The presence of Dissolved Oxygen (DO) is essential for all higher aquatic lifeforms. DO concentrations less than 2 mg/l affect most aquatic species. **Figure 4.8.11** shows the DO level recorded during the dry and wet seasons. The DO levels are generally within the standard limit of 5 – 7 mg/l set by the Interim National Water Quality Standards (INWQS) for Malaysia under Class IIA/B with the exception of low DO levels recorded during dry season at stations W1 and W2, (2.3 mg/l), and during the wet season at station W30 (4.3 mg/l). The highest DO level recorded during the dry season was at W2 (9 mg/l) and during the wet season at stations W20 and W29 (6.9 mg/l).

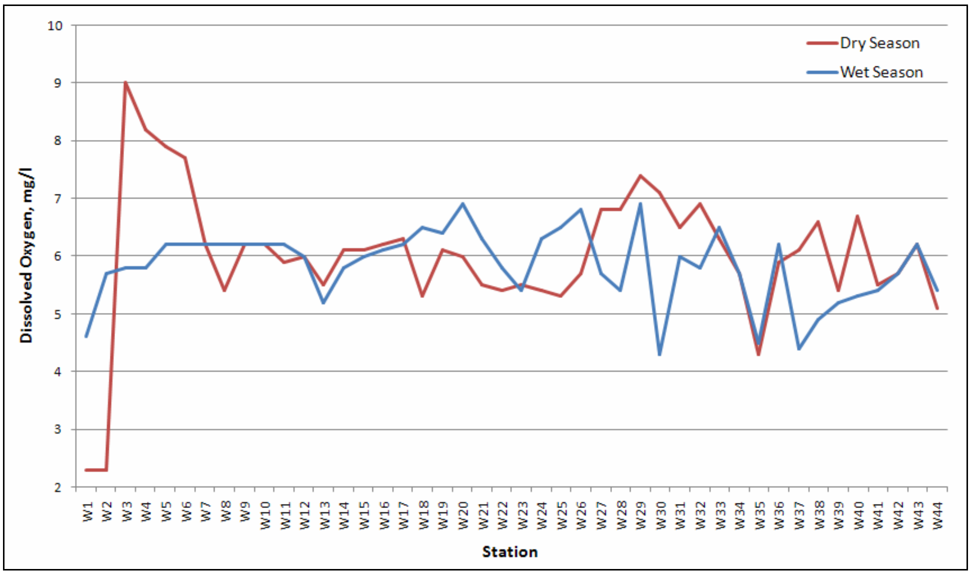

Figure 4.8.11 Dissolved Oxygen Levels for Dry and Wet Seasons

Turbidity

Increased turbidity in river waters are normally due to the presence of organic and/or inorganic suspended material. Increased turbidity reduces light penetration thereby affecting the light dependent photosynthesis by plankton and epiphytes. **Figure 4.8.12** shows that the turbidity levels recorded at the majority of the stations during the dry and wet seasons exceed the standard limit of 50 NTU set by the INWQS Class IIA/B. The highest turbidity recorded during dry season was at W1 with 650 NTU located on the upstream of the river and for wet season was at W36 with 630 NTU, located on the downstream of the river.

The high turbidity at stations W7-W16 exceeding the standard limit during wet season could be due to samples being collected right after a heavy rain combined with recent work in the catchment area by Sabah Forest Industries, while, for these stations, the “dry season” samples were collected two days before the downpour. At all other stations, the samples collected for wet and dry seasons were collected over a spread of three months.

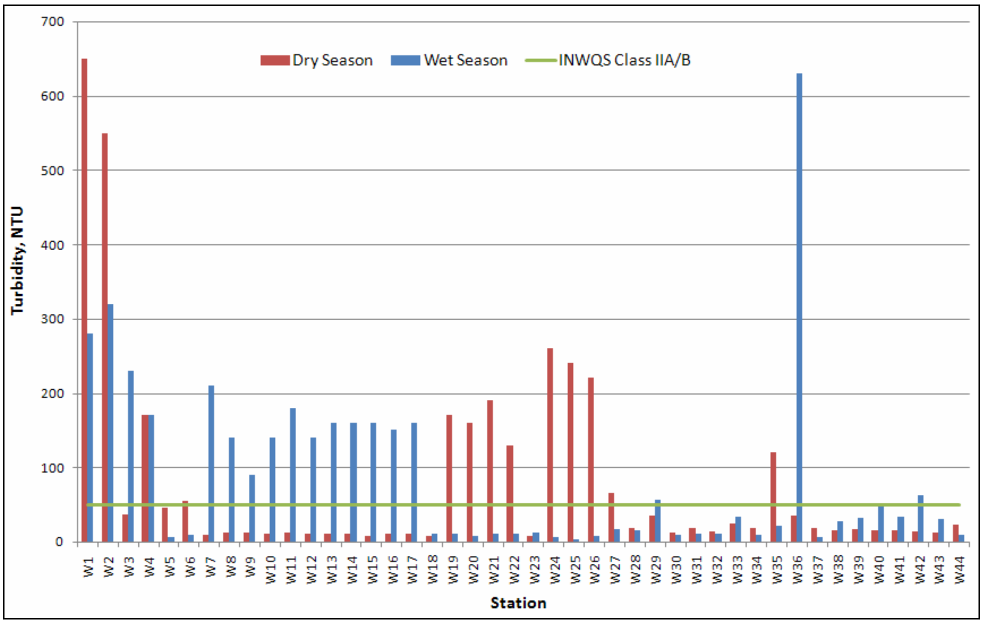

Figure 4.8.12 Turbidity Levels for Both Dry and Wet Seasons

Total Suspended Solids

Total Suspended Solids (TSS) concentrations indicate the rate of erosion in the watershed. High concentrations of TSS affect the aquatic species composition. As shown in **Figure 4.8.13**, the high TSS recorded during the wet season exceeds the 50 mg/l limit set by INWQS for Class IIA/B for the majority of the upstream river stations (W1 to W17) with the highest reading at W36 with 511 mg/l.

High TSS values were recorded during dry season as well at stations W1, W2, W6, W19 to W26, W35 and W44, while the levels recorded at the remaining stations were below the Class IIA/B standard limit.

The highest TSS value was recorded during the dry season at station W35 (at Tenom) with 695 mg/l. It is noted again that samples taken at stations W7 - W16 to represent the "wet season" were in fact taken after a downpour two days after samples for dry season were collected. Recent forestry activity and accumulation of dust over the dry period are likely to have caused this increase in TSS.

When compared with the turbidity results, there is a clear correlation between these two parameters for most stations, except at W35 for level recorded during dry season. The exreme high TSS level could be due to active agricultural activities happening on the upstream on the particular day of sampling.

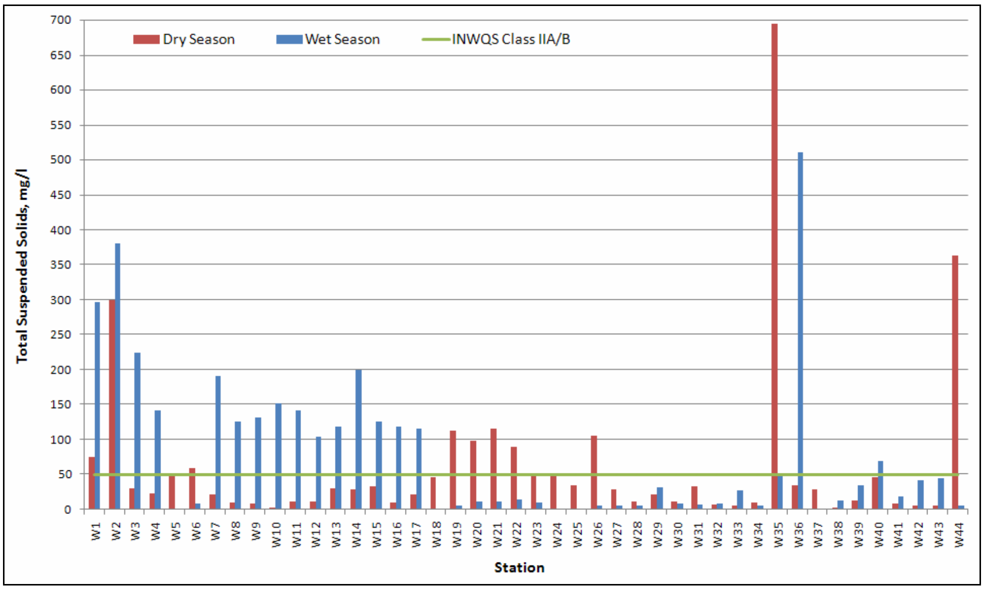

Figure 4.8.13 TSS Levels for Dry and Wet Seasons

Biochemical Oxygen Demand

Biochemical Oxygen Demand is a measurement of the amount of biologically degradable organic material in water expressed in its equivalent oxygen consumption, normally measured over 5 days (BOD_5). A high BOD reading expresses the risk of oxygen depletion and is an indication of poor water quality.

The BOD readings for the dry and wet seasons were less than 2 mg/l at all stations, well below the standard limit of 3 mg/l set by the INWQS for Class IIA/B.

Chemical Oxygen Demand

Chemical Oxygen Demand (COD) is an indicator of contents of organic and inorganic material in the water that can be oxidised, expressed in its equivalent oxygen consumption. The COD concentration levels found at the majority of downstream sampling stations were below the standard limit of 25 mg/l set by INWQS under Class IIA/B. However, the upstream stations had COD levels exceeding the standard limit.

During the wet season, the COD levels at the majority of stations exceeded the standard limit with the highest reading at station W2 of 47.1 mg/l. For the dry season stations W1 – W4, W17, W23, W24, W26, W27, W33 and W44 exceeded the standard limit. The highest COD level recorded during the dry season was at station W2 with 47.8 mg/l. (**Figure 4.8.14**).

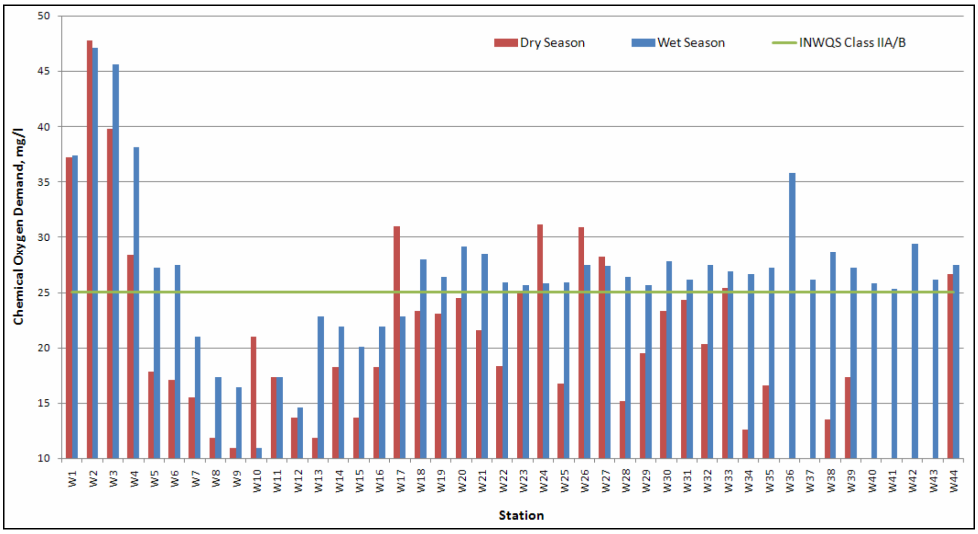

Figure 4.8.14 Chemical Oxygen Demand Levels for Dry and Wet Seasons

Ammoniacal Nitrogen

Ammoniacal nitrogen (*NH^3*-N) is a product of bacterial activity, and when found in high concentrations in natural water is regarded as an indicative of sanitary pollution and in excess, it may affect aquatic life. The majority of the downstream sampling stations recorded an ammonical nitrogen concentration at 0.2 mg/l or below 0.2 mg/l during the wet season. During the dry season, the ammoniacal nitrogen levels recorded were slightly higher ranging from below 0.2 mg/l to 0.4 mg/l. The highest ammoniacal nitrogen was recorded at station W27 during dry season with 0.4 mg/l which exceeds the standard limit of 0.3 mg/l set by INWQS for Class IIA/B.

Total Nitrogen

Higher levels of total nitrogen were recorded at stations W7 – W17 for both dry and wet seasons compared to the remaining the stations. The highest reading for the dry season was recorded at stations W10, W12, W13, W15 and W16 (3.2 mg/l). The highest level recorded during the wet season was 3.8 mg/l at both stations W10 and W15. On the other hand, at stations W1 – W6 and W18 – W44 low levels of total nitrogen at 0.06 mg/l were recorded for the dry season and ranges from 0.6 – 0.9 mg/l for the wet season. (**Figure 4.8.15**).

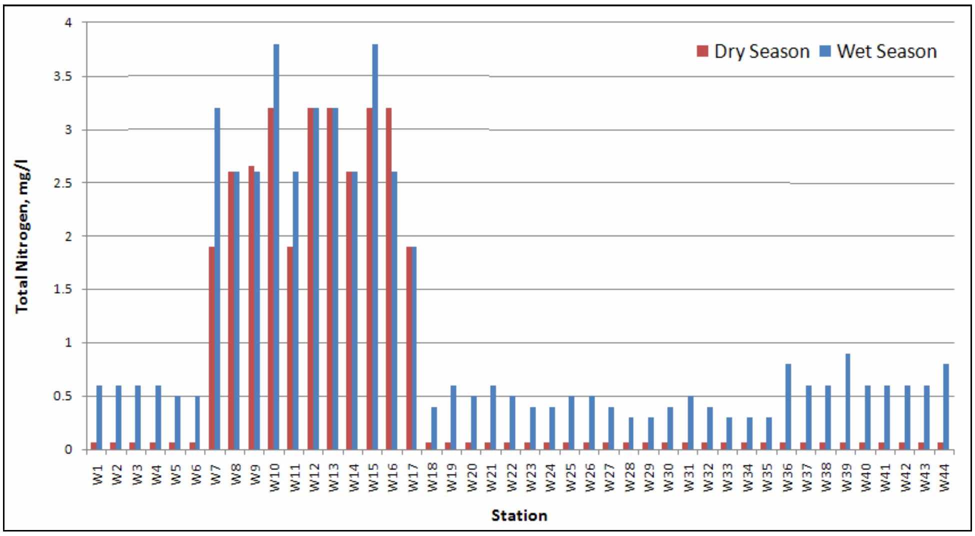

Figure 4.8.15 Total Nitrogen Concentrations during Dry and Wet Seasons

Nitrate Nitrogen

Nitrate is part of the nitrogen cycle. It can be taken up by phytoplankton (algae) and macrophytes (aquatic plants). As shown in **Figure 4.8.16**, the nitrate concentrations at stations W22, and W24 - W29 were higher compared to the remaining upstream and downstream stations during the dry season with the highest level recorded at station W24 (0.84 mg/l). At stations W27 and W28 the highest levels of nitrate nitrogen was recorded during the wet season with 0.38 mg/l and 0.44 mg/l, respectively. The upstream stations W1 - W4 recorded the highest level of nitrate nitrogen when compared with the rest of the stations ranging between 2.89 mg/l to 3.37 mg/l, respectively.

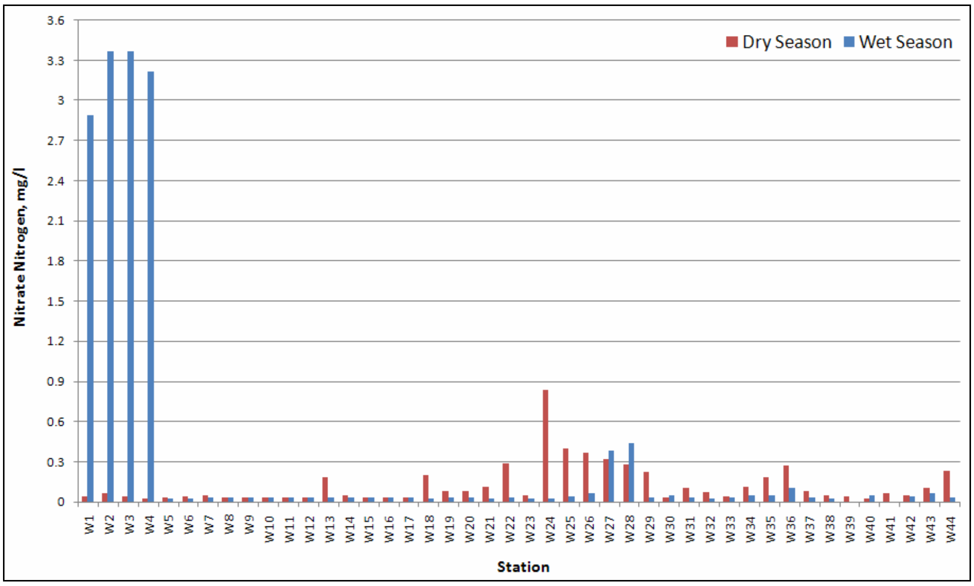

Figure 4.8.16 Nitrate Nitrogen Concentrations in Padas River

Total Phosphorus

High total phosphorus concentrations indicate fertilizer run-off, domestic waste discharges including detergents, or the presence of industrial discharges, or both. Excess phosphorus stimulates the growth of algae and bacteria. **Figure 4.8.17** shows the total phosphorus level found in Padas River for both the dry and wet seasons. The highest level recorded during dry season was at station W32 (0.15 mg/l) and during wet season at station W40 (0.12 mg/l).

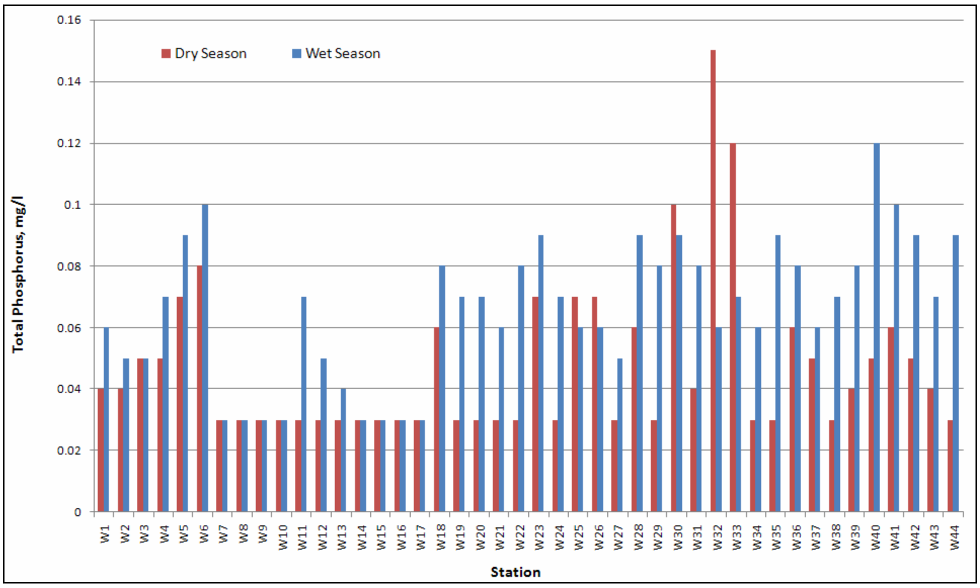

Figure 4.8.17 Total Phosphorus Concentration Found In Padas River for Both Dry and Wet Season

Phosphate

Figure 4.8.18 shows the concentration of phosphate during wet and dry season in Padas River. The highest phosphate level recorded during the dry season was at station W32 (0.46 mg/l) and for the wet season at station W40 (0.37 mg/l). Relatively, the further downstream sampling stations showed higher phosphate concentrations, however with the upstream stations of W5 and W6 showing slightly higher phosphate reading when compared to the sampling stations immediately downstream.

There is a clear correlation between the level of phosphorus and the areas of the river that are inhabited. There are higher concentrations upstream near Long Pasia and Long Mio as well as on Sg. Mengalong.

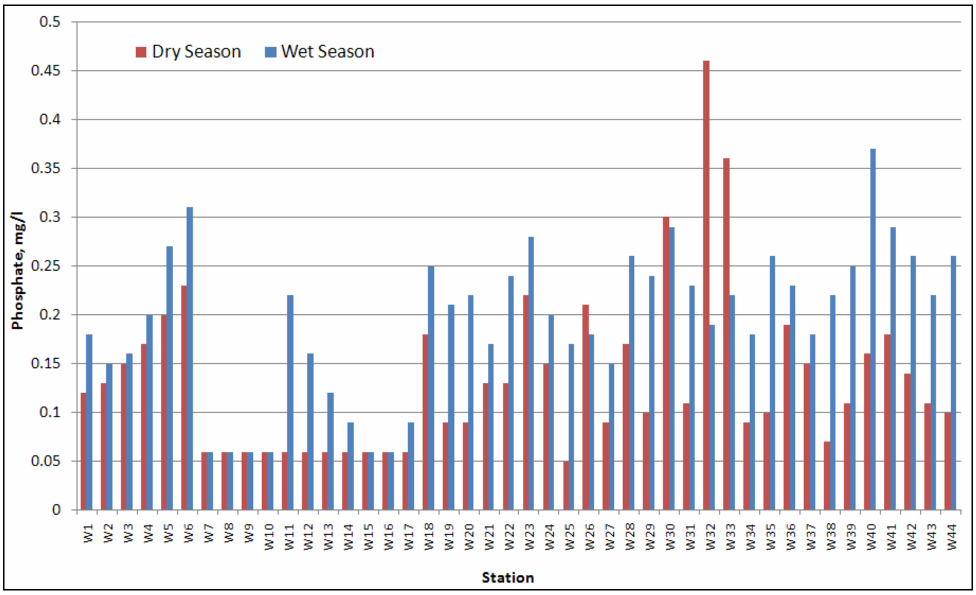

Figure 4.8.18 Phosphate Concentrations Recorded During Dry and Wet Seasons

Heavy Metals

Heavy metal parameters such as calcium, potassium, iron, manganese, lead, aluminium, arsenic, selenium, cadmium, nickel, chromium and sulphite were also tested for the water samples collected at all 44 sampling stations. See test reports in **Appendix 1.3: Water Quality**. Based on the results obtained, it can be concluded that most of the parameters tested were within the stipulated limit of Class IIA/IIB of the Interim National Water Quality Standards (INWQS) except for iron, nickel and manganese. For iron, the levels detected at stations W1-W4, W6, W18-W22, W24-W27, W29, W33, W35 and W44 in dry season and stations W7-W17 in wet season were relatively high, i.e. above the limit of 1.0 mg/L. As for nickel, the levels detected at W7-W17 were slightly above the limit of 0.05 mg/L while for manganese, it has also slightly exceeded the limit of 0.1 mg/L at stations W27, W29 and W35 in dry season. The relatively high levels of iron detected are mainly due to the soil characteristics of the Project area which is dominated by Maliau association.

Total Coliform

As seen in **Figure 4.8.19**, during the dry season the total coliform counts at stations W3, W20, W22, W25, W31, W33, W34, W37, W38, W40 and W44 exceeded the standard limit of 5000 MPN/100 ml set by Interim National Water Quality Standards (INWQS) under Class IIA and IIB. However, these readings remain within Class III and IV standards of 50,000 MPN/100 ml; the highest counts were below 16,000 MPN/100 ml at stations W3, W25, W31, W33, W34, W37, W38 and W44.

For the wet season, total coliform at stations W1, W2, W4, W25, W30, W32, W33, W34, W36, W40 and W43 exceeded the standards limit of 5000 cfu/100 ml set by INWQS for Class IIA/B but remained below 16000 cfu/100 ml.

The stations downstream of W20 had higher total coliform counts when compared to the stations upstream. High total coliform counts were also observed at the upstream stations W1, W2 and W4 during the wet season.

Faecal Coliform

High counts of faecal coliform in the water bodies could indicate that water has been polluted with faeces of humans or other warm-blooded animals. As shown in **Figure 4.8.20**, higher counts of faecal coliform that exceeded the standard limit for Class IIB was recorded at the upstream and also further downstream sampling stations. The highest counts recorded during dry season were at stations W31, W33 and W38 with counts of 16,000 MPN/100 ml which exceeds the standard limit of 400 MPN/100 ml set by INWQS for Class IIB but remains within the standard limit of 20000 MPN/100 ml under Class III and IV. The highest count of faecal coliform during wet season was at stations W1 and W2 (both with 16000 MPN/100 ml). This is not surprising considering the sampling points are just below two major settlements, Long Pasia and Long Mio. Sampling stations W5-W22 are in uninhabited areas whereas the habitation increases downstream Mengalong River at sampling stations W30-W44.

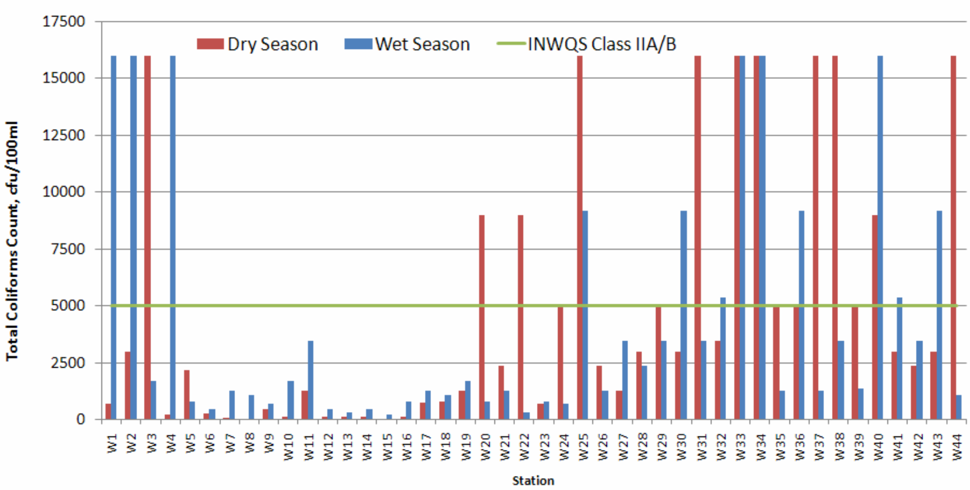

Figure 4.8.19 Total Coliform during Dry and Wet Seasons at Padas River

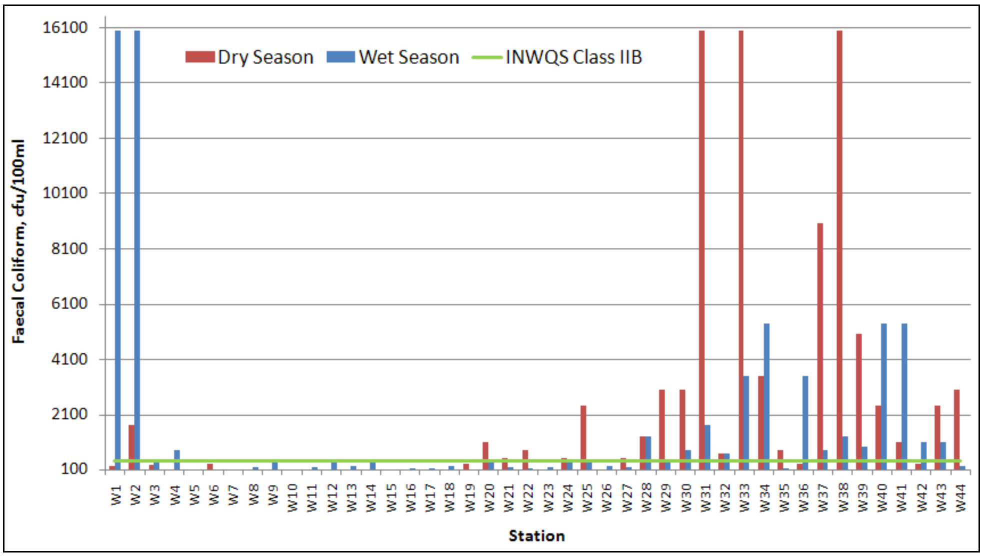

Figure 4.8.20 Faecal Coliform Counts during Dry and Wet Seasons at Padas River

4.9 SUMMARY AND CONCLUSIONS

Baseline studies have been carried out in 6 zones:

Zone 1: Sabah and the region

Zone 2: Catchment area

Zone 3: Construction sites for dam, powerhouse and penstock

Zone 4: Reservoir area for the reservoir

Zone 5: Transmission-line ‘Right of Way’

Zone 6: The Padas, Maligan Ketanum and Mengalong rivers

The baseline studies provide

- a description of the physical (abiotic), biological (biotic) and human environments;
- an identification of conservation values and fragile environments; and
- baseline data against which monitoring results may be compared.

The physical environment includes climate, air, geology, soils, and water issues.

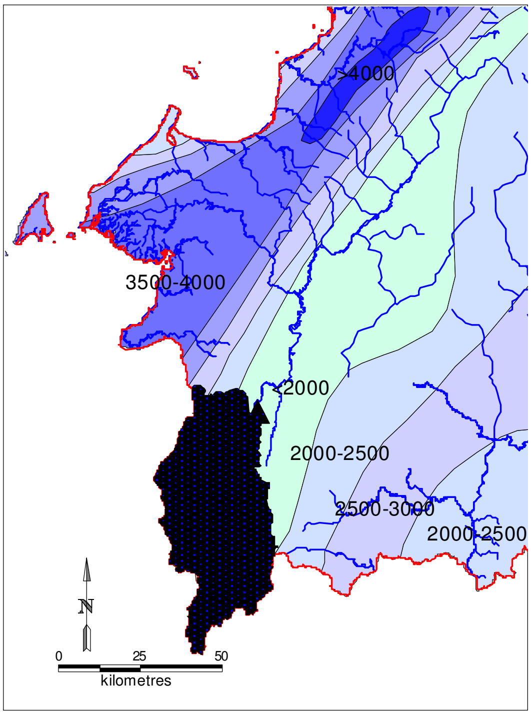

Figure 4.9.1 Local Rainfall

The catchment area lies in a rain shadow behind the Crocker Range. In the reservoir area, the mean annual rainfall is less than 2000 mm whereas it is slightly higher (2000-2500) in the upper reaches of the catchment. Rainfall is fairly evenly distributed throughout the year although there is some monsoon related seasonal variation. Temperatures are also rather constant throughout the year with daily mean temperatures around 27^0 Celsius.

Geologically, the area is stable with very few seismic events recorded in the vicinity. There are no karst formations, i.e. no caves, ultrabasic rock formations or other high conservation value geological features other than the frequent rapids in the river.

The catchment area is dominated by the Maliau and the Crocker soil associations: Maliau south of the reservoir site and Crocker in the northern part (See **Figure 4.4.2**) The Crocker Associations occur on high mountains and is dominated by Acrisols and Cambisols. It is the most extensive soil association in Sabah. The Maliau Association also contains many soils common to the Crocker Association, but it is formed on distinctive cuesta-form mountains with well defined dip slopes on which Podzols sometimes occur. The soils under the transmission line are similar, belonging to the Crocker and Lokan associations. None of these associations are very good for agriculture.

The catchment area makes up about 22% of the entire Padas River catchment, or 27% of the catchment draining through the Padas Gorge at tenom (Panggi Hydro station). The main tributaries upstream of the dam site are the Ketanum and Maligan rivers. There is a mean flow of 70 m^3/second at the dam site, with a 90% exceedance flow 16 m^3/second based on annual means. Water quality in most samples has been within the Malaysian Class IIA/IIB limitations although the water is highly turbid due to the intensive land use activities in the catchment area. There are, however indications that the water quality –

and turbidity – has improved over the latest years due to improved land use practices in the Sabah Forest Industries concession area.

The original Dipterocarp and Agathis forests can still be found in the southern part of the catchment area even though most is seriously logged over. The northern part of the catchment area is under conversion to industrial tree plantation areas, mostly Eucalyptus and Acacia. There are, however, several areas of steep slopes, where the area is maintained as natural forest vegetation. Some of these areas may be managed as commercial forest some is laid out as protection areas. This is the case with most of the forest on the Eastern bank of the future reservoir. Diversity is good in these areas but overall stocking very low. The biomass is less than 100 tons per ha where international standards indicate 250-450 tons per ha in well stocked, undisturbed rainforests. No particular high conservation value species were identified within the area to be flooded.

The vegetation along the transmission line has all been cleared and replaced by rubber and oil palm.

The wildlife fauna is extremely poor in this area. Habitat loss and easy access for hunters have had their toll on the wildlife populations. Earlier reports of the wild ox, Tembedau, could only be confirmed as ‘occasional visitors’. The wildlife is now mostly dominated by birds and rodents.

The aquatic life is equally poor in volume although the species diversity seems at a ‘normal’ level.

The overall conclusion is that the catchment is a seriously disturbed area with little conservation values in the area to be directly affected by the Project. Similarly, there are no physical or biological issues of particular protection value in the planned right-of-way for the transmission lines.

4.10 PLATES

Overall View of the Project Site

Upper Dam – Dam

Plate 4.10-1 Sg. Pasia

Plate 4.10-2 Sg. Maligan

Plate 4.10-3 Sg Padas (Sipitang)

Plate 4.10-4 Sg. Padas (Dam Site)

Sg Padas : Dam – Tailrace (downstream of dam; upper stream of powerhouse)




Plate 4.10-5 Sg Padas : Dam – Tailrace (downstream of dam; upper stream of powerhouse) I-IV

Sg Padas & Tributaries : Powerhouse - Tomani

Plate 4.10-6 Sg Padas & Tributaries : Powerhouse - Tomani

Access Roads




Plate 4.10-7 Access roads

Transmission Lines (Land Use)

Plate 4.10-8 Area of more intensive land use near Sipitang

Plate 4.10-9 Access roads Road cutting through Gunung Lumaku Forest Reserve

Plate 4.10-10 Access roads Kg. Bamban-Sipitang Transmission Corridor: Secondary forest with SFI ITP in the background

CHAPTER 5 ENVIRONMENTAL IMPACT ASSESSMENT AND POTENTIAL MITIGATING MEASURES

5.1 INTRODUCTION

This chapter combines the knowledge of the existing environment with the intended activities, i.e. the Project plan. The outcome is an assessment of the impacts – negative or positive – which the planned activities are expected to have on the environment. The chapter is therefore built up according to the plan stages: 1: Investigation and preparation including detailed design; 2: Construction including handing over from the contractor to the Project Proponent and impoundment of the reservoir; 3: Operation; and 4: decommissioning or abandonment.

Prior to the detailed design of the dam and associated facilities, there will be a need to perform geotechnical investigations, hydrological investigations and to initiate public consultation processes. These activities, including the public consultation and information of the public are already underway.

The geotechnical investigation may require establishment of temporary access roads or tracks to get the machinery in and initial dialogues are held in order to prepare for catchment area management. This stage of pre-construction activities ends when one or more contractors are commissioned to provide the permanent structures.

The construction stage, which includes construction of the dam, coffer dams, diversion tunnels, powerhouse and associated installations and tunnels, access road, clearing and filling the reservoir, will end when the reservoir has been filled, the turbines have been tested by the suppliers and contractors and all installations subsequently are handed over to the Project owner to operate. The construction stage thus includes all the cleaning up of construction waste, landscaping of construction sites and other issues the contractor(s) must do before leaving the site for good.

The impoundment itself will be dealt with as a parallel stage to the construction. The impoundment only starts when the dam is completely built and includes clearing of vegetation, closing of diversion tunnels, removal of coffer dams, releasing of compensation flow and the inundation of the reservoir till the water is released through the turbines.

Quarries, borrow areas and land disposal areas have not yet been identified. Detailed assessment of such activities have thus been excluded from this assessment and will therefore be subject to separate environmental assessments. This report will limit itself to general mitigation activities for such activities.

During the pre-construction and construction periods most, if not all, field work will be carried out by contractors and subcontractors. The Project Proponent will monitor and supervise the work but will not carry it out himself. This does not, however, change the issue of responsibility. The responsibility for sound environmental management and for keeping laws, regulations and environmental agreements still rest with the Project Proponent. This responsibility cannot be subcontracted. The Project Proponent shall therefore ensure that his contractors and sub contractors all are contractually obliged to maintain the environmental standards as if he himself did the work. He must also ensure that all contractors and sub contractors are capable of honouring such requirements and when needed, he must ensure training and logistics for this is provided.

The operational stage impact assessment deals with catchment management, water issues in the reservoir and downstream plus the prospect of dam failure.

Finally, the impact assessment addresses the prospect of Project abandonment and decommissioning.

Impacts are assessed based on four criteria:

a) Magnitude of change / effect: Score: 1 Change / effect only within the Project site, 2: change / effect to local conditions and/or to areas immediately outside the Project site, 3: Change/effect at regional / national / international level

b) Permanence of impact. Score: 1: no change/not applicable – 2 temporary – 3 permanent

c) Reversibility of condition. Score: 1 no change/not applicable – 2 reversible – 3 permanent

d) Cumulative impact. Score: 1 no change/not applicable – 2: non cumulative, single – 3 cumulative

The overall significance is rated insignificant, moderate, significant.

The tables below reflect this assessment. Each row in the table is repeated below each assessment.

Table 5.1-1 Impact Assessment

Impacts	Magnitude of Change / Effect	Permanence of Impact	Reversibility of Condition	Cumulative impact	Overall Significance
Investigation and Preparation Stage: Dam and Power house					
Invasive Site Investigations: Geology	2	1	1	3	Moderate
Disclosure and Communication	3	2	2	3	Significant
Land Use Planning (Catchment Area Management, Right of Way)	2	3	3	3	Significant
Resettlement	1	3	3	3	Significant
Land Acquisition	1	3	3	3	Significant
Temporary Access	1	1	1	1	Insignificant
Investigation and Preparation Stage: Transmission-line					
Selection of Options	1	1	1	3	Insignificant
Topographic, Geological and Soil Investigations	1	1	1	1	Insignificant
Disclosure and Communication	2	2	2	3	Significant
Construction Stage					
Procurement	3	2	2	3	Significant
Transfer and Mobilization Operations	2	2	2	3	Significant
Workshops and Other Mechanical Support Facilities	2	2	2	3	Significant
Quarries	1	3	3	2	Significant
Concrete Production	1	2	2	2	Moderate
Road Building	2	2	2	2	Moderate
Camp and Service Installations	1	2	2	1	Moderate
Tunnelling for Diversion Tunnel Head Race Tunnel and Penstock	1	3	3	1	Moderate
Coffer Dam Construction	3	2	2	3	Significant
River Diversion					
River Flow and Water Quality	1	1	1	1	Insignificant
Dam Construction					
Workers' Safety	1	2	2	2	Moderate
Soil and Water	2	2	2	3	Significant
Air	3	2	2	3	Significant

Impacts	Magnitude of Change / Effect	Permanence of Impact	Reversibility of Condition	Cumulative impact	Overall Significance
Vegetation	2	3	3	3	Significant
Blasting	1	2	2	1	Moderate
Power house Construction	1	2	2	1	Moderate
De-commissioning of Temporary Site Installations	1	2	2	1	Moderate
Transmission Line Construction					
Land Use.	1	2	2	3	Moderate
Aesthetics	1	2	2	1	Insignificant
Soils	1	2	2	2	Moderate
Vegetation	1	2	2	3	Moderate
Fauna	1	1	1	1	Insignificant
Impoundment Stage					
Closing of Diversion Tunnels					
Terrestrial Vegetation					
Loss of Biodiversity	1	3	3	3	Significant
Biomass Loss	3	2	2	3	Significant
Loss of Significant Species	2	2	2	3	Significant
Aquatic Flora	2	1	1	3	Moderate
Terrestrial Fauna	2	2	2	1	Moderate
Fish Fauna	2	3	3	3	significant
Removal of Coffer Dams	2	2	2	3	Moderate
Releasing Compensation Flow	1	2	2	1	Insignificant
Operation Stage					
Dam					
Spillway Operation	2	3	3	3	Significant
Risk of Dam Breach / Failure	3	3	3	3	Significant
Reservoir					
Access	1	2	2	3	Moderate
Impact on Downstream Water Levels and Flows					
Upstream of Reservoir	1	3	3	3	Significant
Downstream of Reservoir	1	3	3	3	Significant

Impacts	Magnitude of Change / Effect	Permanence of Impact	Reversibility of Condition	Cumulative impact	Overall Significance
Kemabong	1	3	3	3	Significant
Tenom and Beaufort	1	1	1	3	Moderate
Water Quality Impact					
Reservoir Water Quality	1	3	3	1	Moderate
Downstream Riverine Water Quality	2	3	3	3	Significant
Saline Intrusion	1	2	3	3	Significant
Fisheries/Aquaculture	2	2	3	3	Significant
Air Quality	3	2	2	3	Significant
Macro-benthos	1	2	2	1	Insignificant
Fishes	1	2	3	3	Significant
Power Houses	3	2	2	3	Significant
Transmission- lines					
Environmental Health	1	2	2	1	Insignificant
Dam Break	3	3	3	3	Significant
Abandonment	2	3	3	3	Significant

Legend	**Number**		
Criteria	**1**	**2**	**3**
Magnitude Measure of the importance of the condition in relation to spatial boundaries.	Change/effect within projet site only	Change/effect to local conditions and/or to areas immediately outside	Regional/national/international change/effect
Permanence To define whether the condition is temporary or permanent.	No change/not applicable	Temporary	Permanent
Reversibility Measure of the control over the effect of the applied condition.	No change/not applicable	Reversible	Irreversible
Cumulative Measure of whether the effect will be a single effect over time or a synergistic effect with other conditions.	No change/not applicable	Non-cumulative/single	Cumulative

5.2 INVESTIGATION AND PREPARATION STAGE: DAM AND POWER HOUSE

Activities during the investigation and preparation stage are surveys and geotechnical activities undertaken at the site. As the major part of Project locations are under the jurisdiction of the Forestry Department, the Project Proponent and his appointed contractors have sought and obtained permission site entry to carry out the geotechnical activities from the Department. Dialogues with affected parties, particularly the Sabah Forest Industries and also local communities have been initiated during this stage.

5.2.1 INVASIVE SITE INVESTIGATIONS: GEOLOGY

The geotechnical investigations consist primarily of drilling holes in the existing surface to: Obtain core samples of rock; to identify rock strata and faults; to establish soil profiles and conditions; and to identify groundwater conditions.

In addition, the investigations will also include exploratory adits, trial pits and trenches and identification of potential borrow areas and quarries.

Surveys generally require the clearing of vegetation along 'rentice' lines to provide 'line-of-sight' between survey points, and to allow access. The clearing is minimal and there is no incentive for anyone to clear more than necessary.

Drilling sites require heavy machinery needing oil, fuel and lubricants, which may be spilt if not handled properly. This will result in long term pollution of soil and water ways.

The impacts from these activities are generally minor and short-term. However, if the investigations for e.g. the transmission- lines are done on small holders' fields, the loss of agricultural production even from a small area may be serious for the affected family.

Impacts:

- If holes or pits are left open, they represent a hazard for humans and animals alike. Holes can also be filled with water that become stagnant and a favourable breeding place for disease vectors such as mosquitoes.
  - Mitigation: All pits and boreholes must be covered during the monitoring period and filled after use.
- Waste Generation and Management – 'Domestic' camp waste such as of plastic bags, containers, wrappers, papers and cans. If not disposed properly, these wastes has the potential to be a breeding area for pests and vectors (e.g. mosquitoes and flies), thus causing health problems. Glass and tin cans will for years be able to hurt wildlife or humans alike.
  - Mitigation: Training, monitoring and supervision of field workers. All wastes other than hazardous must be dug down or removed from the area to an approved dumping site.

- Oil, fuel and lubricant spills from transport, storage or handling in connection with drilling work.
  - Mitigation: Oil, fuel and lubricants must be provided in appropriate containers of a size that can be handled by the field crews. Proper equipment for handling and storing oil, fuel and lubricants must be provided: Winches, ropes, building material for shades and slides. Oil traps must be dug around all storage facilities, even at field camp level. Bunding shall be done wherever skid tanks are being used.
- There will be minor spillage of soil from drilling and digging of soil pits.
  - Mitigation: No mitigation is required.
- Minor damage to the habitat but as this habitat is likely later during construction or inundation to be totally removed or flooded, this impact is not of any significance.
  - Mitigation: No mitigation required.

For all impacts under this heading:

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	1	1	3
Overall significance	Moderate		

5.2.2 HYDRAULICS INVESTIGATIONS

Some hydraulic investigations such as flow measurements will take place. However, such investigations are non-invasive and will therefore have no impact on the surrounding environments.

5.2.3 DISCLOSURE AND COMMUNICATION

Prior to the final decision on the Project, affected communities and parties must be informed and their consent sought. Project impacts and risk have to be disclosed in a transparent and frank and timely manner so the dialog can be meaningful to all parties. If done right, local support can be achieved while if done wrongly or insufficiently, this may lead to political opposition.

The key words are free, prior and informed. Free of manipulation and political interests, freedom to select representatives, freedom to select options and alternatives. Timely disclosure prior to irreversible decisions being taken, enabling affected parties to consider, to plan, to discuss among themselves. And the disclosure must be meaningful, the information complete, all facts and options laid out in the open in a manner and language that can be understood by the affected parties.

The management will be fully in charge of the choice between success and failure on this point.

If done right, the impacts will be positive:

- Easy negotiation of rights and tenure.
- Local support for unforeseen events or emergencies.
- Local support for security and safety.
- Reliable access to local labour force and local supplies.
- Options for development of the Project site as an attraction.

If done wrongly, the impacts may be:

- Political opposition locally and beyond, forcing the Project Proponent into the defensive where much energy and funding will be needed in political or even legal arguments, which normally will only aggravate the situation.
- Heightened security concerns.
- Lack of support in emergencies.
- Tension between local communities and workers from outside.

For all impacts under this heading:

- Mitigation: Ensure all disclosure and communication is free, prior and informed.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

5.2.4 LAND USE PLANNING (CATCHMENT AREA MANAGEMENT, RIGHT OF WAY)

This Project will have an interest in the management of the catchment area for the reservoir in order to ensure sufficient supply of water in the reservoir and that the water that flows into the reservoir is of a quality that does not threaten the power generation facilities. If the hydroelectric power Project had been there at the time of the environmental impact assessment was written for the forestry concession in the area, then this might have caused the environmental conditions of Sabah Forest Industries to have been stricter.

The Project Proponent will therefore have to initiate dialogue with first of all the Sabah Forestry Department and the Sabah Forest Industries in order to establish modalities for introducing new aspects to the forestry management, i.e. providing environmental services in the form of water. The impacts and risk are very similar to the impacts and risk for disclosure and communication.

If done timely and in an informed manner, this may ensure the feasibility of the Project.

If done in a non-conducive way, or not at an appropriate schedule, the risk will be lengthy and politically difficult negotiations causing delays and additional cost.

There will be a need for imposing management restrictions in the wayleave area under the transmission- lines. Crops are likely to be restricted to those that do not reach a height of more than 6 feet (about two metres). This will affect all tree crops such as forest, rubber or oil palm.

The height restriction is valid for structures such as buildings too.

Impacts:

- Catchment area management: Restrictions to clearing and harvesting methodologies, silvicultural regimes. Such restriction may concern size of cleared area, intensity of clearance, restrictions to removing stumps and roots, requirement to crush debris, use of lighter machinery, use of different technologies, change of weeding and thinning regimes etc.
- Additional riparian reserves to cover also non-permanent water courses with surface area less than the present limits.
- Riparian reserves may be requested to be replaced by reserved strips along contours on long or steep slopes or where soils are considered particularly fragile.
- The existing system of riparian reserves in the Sabah Forest Industries concession (see **Map 6.6- 1 Existing Riparian Reserves**) must as an EIA requirement be extended to cover the areas within the catchment area which are planned to be under natural forest management. This includes compartments P02, P13, P18, P21, P25, P38, P39, P43, - P45, P48 - P65. The riparian reserves in these areas are currently part of the reduced impact logging requirements.
- The existing system of riparian reserves in the Sabah Forest Industries concession is extended into the state land and kampong areas.
  - Mitigation: Payment for ecological services (Water). While the water in principle is owned by the government, a payment schedule, where Sabah Forest Industries benefitted from producing water for the reservoir is not unthinkable. Such scheme, however will threaten the viability of the Project even if the charges are set very low.
  - Mitigation: Compensation may have to be paid for loss of user right in the state land and kampong areas.
- Right of way area: Restrictions of cropping choices.
  - Mitigation: Payment of compensation.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.2.5 RESETTLEMENT

No resettlement of entire communities are foreseen for this Project. There may be cases where adjustment of location of individual houses is recommendable due to safety distances from the transmission- lines. This issue must be communicated to potential affected families at the earliest. The extent and mitigation will only be known at the construction stage.

Impact:

- Social and political resentment.
  - Mitigation: Timely and complete information, full participation of affected communities and individuals in finding alternatives, options and final solutions including relocation sites and other forms of compensation.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

5.2.6 LAND ACQUISITION

There will be some need for land acquisition for the transmission- lines.

The Project area for the dam, reservoir, power station and related facilities all falls within the Sabah Forest Industries concession, which is in its right to request compensation for giving up this area. However, the entire East bank of the reservoir is deemed protection area and therefore outside the Sabah Forest Industries economic interests.

The impacts are thus:

- Loss of land to give way for transmission-line pylons.
  - Mitigation: Payment of compensation.
- Loss of concession rights for the Sabah Forest Industries.
  - Mitigation: The Sabah Forest Industries is not interested in being paid any compensation as their interest is to ensure, their production is stable. They therefore only want to maintain their productive area through being allocated a compensation area for lost production. The Sabah Forest Industries points at the Pangalubon state land as an option[48].

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

[48] *Based on meeting with Sabah Forest Industries on 8th June 2010. Refer to* ***Appendix 1.11****.*

5.2.7 TEMPORARY ACCESS

It may be necessary to create temporary access roads in order to bring in drilling equipment. Such access will be similar to logging tracks and have the same environmental impact.

- Erosion causing siltation of waterways.
  - Mitigation: Limit slopes to 10 degrees, make surface run-off diversions at strategic points. Repair and rehabilitate all places where crossings of waterways have been necessary but avoid such crossings whenever possible.
- Limited loss of habitat.
  - Mitigation: No mitigation required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	1
Overall significance	insignificant		

5.3 INVESTIGATION AND PREPARATION STAGE: TRANSMISSION-LINE

The investigation and preparation stage for the transmission-line will include some topographic, geological and soils investigations in order to settle the accurate alignment. During this work, there will be a need for social communication and disclosure of Project details to the public.

5.3.1 SELECTION OF OPTIONS

There have been a number of options for alignment tabled. The present proposal (**Figure 5.3.1**) avoids heavily populated areas and minimises impact on natural vegetation and habitat by following land use boundaries and transportation corridors.

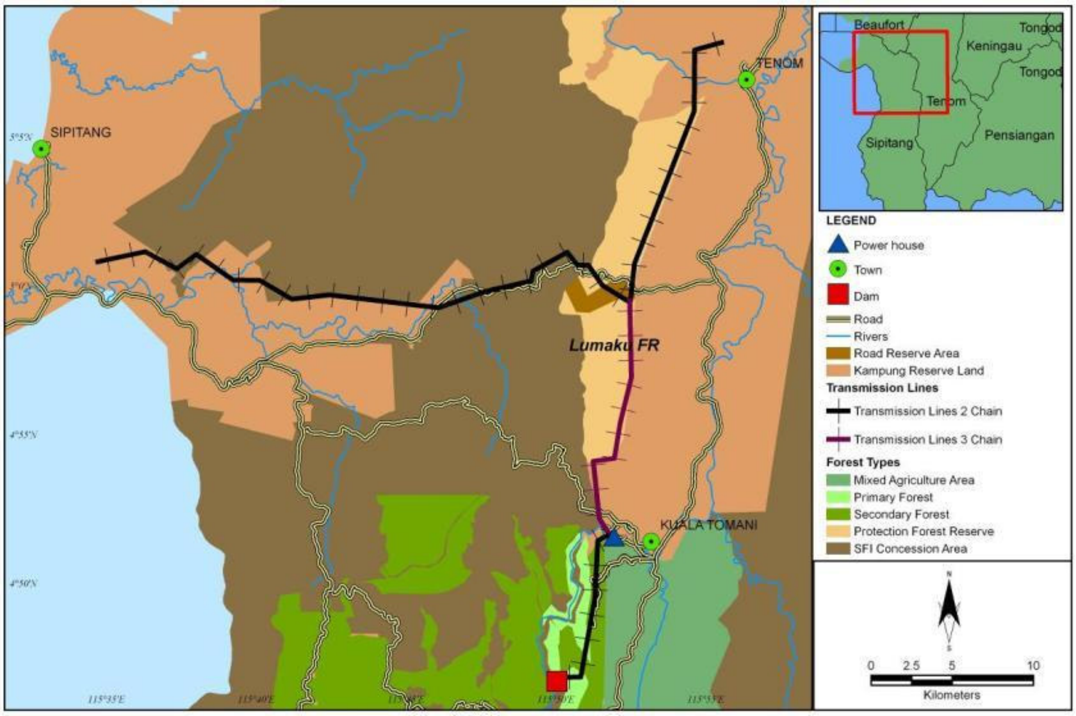

Figure 5.3.1 Proposed Transmission-line Route at 1st Stage

Only on the first section, the local line between the power station at the dam and the main power house will the alignment cut through a segment of primary forest, which has been designated as a protection area. This is bound to present an obstacle to wildlife moving or seeking refuge in the area.

Impact:

- Fragmentation of habitat: The line will cause fragmentation of the habitat in P08 on the stretch between the two powerhouses (see **Figure 4.6-21**). The habitat will in effect be cut in two. There is therefore not any significant impact expected for the wildlife or biodiversity outside this stretch.
- Aesthetics: Aesthetics impact will be minimal as the alignment does not go close to any major population centres, places of scenic value or roads apart from the corridor through the Gunung Lumaku Protection Forest. However, as this is already perceived as a transportation and communication corridor through the forest and the mountain, this is acceptable.
  - Mitigation: Where the transmission line runs parallel to the boundary between the Gunung Lumaku Forest Reserve and other land use areas, the alignment must be completely within the other land use area. A buffer of at least 20 metres from the boundary of the transmission line wayleave to the boundary of Gunung Lumaku Forest Reserve should be established, where possible.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	3
Overall significance	Insignificant		

5.3.2 TOPOGRAPHIC, GEOLOGICAL AND SOILS INVESTIGATIONS

The physical investigations will require clearing of lines of sight, access tracks, soil pits, drilling sites. They will in the larger picture be minor and insignificant but may for the individual land owner represent a fair part of his crop.

Impact:

- Localised destruction of crops.
  - Mitigation: Payment of compensation.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	1
Overall significance	Insignificant		

5.3.3 DISCLOSURE AND COMMUNICATION

As with all other disclosure and communication activities, there is a risk of failing to establish a conducive environment for the Project if things are not done well.

Impact:

- There is a risk of local or political resistance to the Project if the disclosure and communication is done in a top-down manner or if it is perceived by the target group to be dishonest.
  - Mitigation: Ensure all disclosure is timely, transparent, complete and without any form of manipulation. Ensure, the target group is free to present and choose realistic options instead of presenting completed and final solutions.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Significant		

5.4 CONSTRUCTION STAGE

5.4.1 PROCUREMENT

The Project will have consequential impacts upstream of its procurement lines. Building material such as rock, sand, cement and timbers will have to be procured and labour sourced.

When building material is procured from outside sources, there is a risk, they come from sources that have great negative environmental impact in places distant from the Project area. Similarly, sourcing of the especially foreign labour force may disrupt government planning and strategies.

Impact:

- Negative environmental and economic impacts (soil, water, habitat, ownership, royalties, taxes) from uncontrolled exploitation.
  - Mitigation: Introduce requirement for 'Green Procurement' i.e. a requirement to use only verifiable legal sources and whenever possible certified sources (timber).
- Social disturbances and unrest from uncontrolled influx of foreign labourers.
  - Mitigation: Use only government approved channels and quota for import of foreign labour. Ensure contractors provide all labour benefits to the work force as required by national legislation and that the employers implement a repatriation program at the end of the contract to ensure smooth and legal departure.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

5.4.2 TRANSFER AND MOBILIZATION OPERATIONS

During construction stage, it is very likely that some of the construction materials or machineries would be transported by sea vessels. The most likely point of arrival is at Kota Kinabalu Port but there is another smaller jetty at Sipitang – Sabah Port Jetty which is located nearer to the Project site. However the capacity of this particular jetty may need upgrading to ensure that it could be utilized as an unloading point for the sea vessels.

Construction vehicles can use the highway from Kota Kinabalu Port and travel south to utilise the highways from Kimanis to Keningau, or from Sipitang to Tenom. These two roads traverse across mountainous areas with steep gradients but climbing lanes are provided where necessary. They are public roads and usually are maintained periodically by JKR.

From the capacity analysis included in **Section 4.2**, it can be seen that with the exception of the highway from Beaufort to Sindumin, most of the highways and roads will still have adequate capacity to serve the existing and projected traffic before the commercial operation of the Project in late 2014. No significant traffic impact is expected during the construction stage except that the delivery trucks might deteriorate the road pavement if overloaded, which could be hazardous to other road users. Also, the circulating width of the Tomani-Tenom Roundabout is likely to be too tight to cater for the turning path of heavy vehicles.

Transfer operations involve the mobilisation of equipment, machinery and other materials to the Project site at the commencement of the construction stage, as required during the process of construction, and out of the Project site at the end of the construction stage. Such transfer might be necessary but to lesser extent during the operational stage of the Project. At this stage, information regarding the number of construction vehicles generated from the construction site is still not available.

Transfer operations are often associated with accidents if proper transfer procedures are not observed. The outcomes of such accidents are injuries or even casualties to the workers and other road users.

Impacts:

- Spillage or leakage of waste or hazardous substances during transport or as a result of accidents or break-downs.

  - Mitigation: Materials, especially hazardous material/waste, should not be received or dispatched in damaged and/or leaking conditions; All containers containing hazardous material/waste shall be inspected prior to loading to ensure that the seals are tight, the containers are in good, non-leaking condition, and labels and markings are in place, legible and complete.

  - Mitigation: Common regulations for transportation of hazardous materials also include:

    - ✓ The containers shall be compatible with their contents and be equivalent to regulatory specifications for the material being shipped.
    - ✓ Shipping placard shall be used as required by law for shipments on public roads.
    - ✓ Smoking should not be permitted during loading and unloading of hazardous materials like fuels, etc.
    - ✓ Appropriate spill containment and control supplies and equipment shall be provided at or in proximity to loading and unloading areas.
    - ✓ Containers shall be loaded in a manner which allows for easy access.
    - ✓ Tools or equipment which could damage containers shall not be used.
    - ✓ Incompatible materials shall be segregated.
    - ✓ Containers especially containing flammable material shall be loaded such that contact between containers during transit does not occur.

- Road destruction: Continued passage of high pressure loads may destroy the road network thereby endangering other traffic.
  - Mitigation: Operate strictly within the limitations of the road construction design. If this is found insufficient, the Project must reinforce vulnerable stretches of road and if the Project vehicles damage the road, the Project must also repair the road immediately the road is safe for other users.
- Accidents: The transportation to the Project sites – dam, powerhouse-transmission- lines – pass several settlements, schools and other centres. The increased heavy traffic will drastically increase the risk of accidents.
  - Mitigation: Plan transport to avoid peak hours including school peak hours. Impose strict penalties on top of police fines for speeding and other reckless driving. Contribute to traffic safety curricula in local schools.
  - Mitigation: General regulations for traffic safety include:
    - ✓ Lorries used for transporting construction materials, equipment, etc, shall be driven by qualified and experienced drivers.
    - ✓ Avoid overloading of lorries while transporting construction materials. Lorry load should be covered and fastened to avoid spillage, which may cause skidding and accident to other road users.
    - ✓ Transportation and site vehicles are to be maintained periodically and damaged parts of the vehicles replaced.
    - ✓ For the access using existing logging road, clear directional arrows shall be installed along the roads to remind drivers on what side of the road they should drive on.
    - ✓ All moving vehicles shall keep to their sides of the road. Where the driving side cannot be clearly defined as on logging roads, appropriate signalling shall be given by drivers to indicate the side of travel.
    - ✓ Broken-down transportation vehicles shall be moved to roadside with proper signage at the front and back to divert passing vehicles and lighting at night to warn other vehicles.
    - ✓ If any section of the public road towards the Project site is subjected to damage by the heavy transportation vehicles involved in the Project development, repair work should be done immediately by the contractor.
    - ✓ Proper signage showing entry to the Project site; shift between right and left hand driving; speed limits; compulsory use of lights, safety-belts and other safety measures; dangerous sections of the road (bends, slopes etc), entry and exit from community

areas shall be erected in appropriate places using descriptive pictures as well as text in Malay, Chinese and English.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Significant		

5.4.3 WORKSHOPS AND OTHER MECHANICAL SUPPORT FACILITIES

The two major negative impacts of the Project's workshops and other mechanical facilities are 1: Spillage of oils and fuels and 2: labour safety while the positive impact of job creation also exists.

Then there is the question of disposal of waste oil and machine parts.

Impacts:

- Oil or fuel spillage with consequential pollution of soils or waterways.
  - Mitigation: All fuel stations and workshops must be situated a minimum of 50 metres from waterways.
  - Mitigation: Skid tanks and the fuel depot shall be bunded to contain any spills. Bunding must be constructed of concrete, with concrete flooring and a sump to collect spillage and rainwater. The bunding shall be able to contain a minimal of 110% of total tank volume.
  - Mitigation: Contaminated soils shall be removed from the site and treated or disposed in approved off-site location in accordance with the requirements of the Environmental Quality (Scheduled Wastes) Regulations, 2005.
  - Mitigation: Waste oils must be collected and disposed off in accordance with local district or state regulations. Spent machine parts must be regularly collected and transported to re-cycling collectors or plants.
  - Mitigation: Scheduled Wastes must be sent for final disposal by a contractor approved by the Department Environment (DOE). Generation of any scheduled wastes shall be notified to the Director General of Department of Environment (DOE) in writing. The notification shall be completed in the form prescribed in the Second Schedule (Notification of Scheduled Wastes).
- Labour safety: The work with heavy machinery parts and heavy duty tools present a constant danger for the workers. Things may fall down, tools slip or break, jacked up machines topple.
  - Mitigation: All working areas must be surfaced with concrete, which must be kept clean and tidy. Appropriate lifting equipment must be provided

as well as other working tools, which must at all times be kept in proper working order. Personal safety equipment or clothing such as safety shoes, gloves and hard hats must be provided and their use enforced. No worker should work without regular supervisory or safety visits and all workers must be properly trained for their jobs. One worker must be assigned as work safety official and trained for this job. First aid equipment and communication equipment must be available and staff trained in its use.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Significant		

5.4.4 QUARRIES

Potential sites for quarry and areas for land disposal and borrow pits will be identified during the soil and geotechnical site investigation works. These areas shall be subjected to separate EIAs as stipulated in item nine (9) of the Second Schedule of the Environment Protection (Prescribed Activities) (Environmental Impact Assessment) Order 2005.

The impacts and mitigation measures listed below are thus general and based on Chemsain's general experience within this field.

Impacts:

- Erosion and Sedimentation. The operation of quarries, particularly during clearing, drilling and preparation of benches will cause entry of suspended particulates consisting primarily of eroded soils from denuded area of the quarry and fine rock particles from the drilling of the blast face into the waterways. This will lead to sedimentation and deterioration in the quality of receiving waters.
    - Mitigation: Quarries must maintain a 20-metre buffer zone to private lands.
    - Mitigation: Clearing of quarry site shall be restricted to necessary area of rock extraction.
    - Mitigation: Sedimentation ponds are recommended for the retention of eroded particles from the quarry. A typical sedimentation pond design is provided in **Figure 5.4.1**.
    - Proper drainage shall be established to channel the runoff to the sedimentation ponds before final discharge into the waterway.

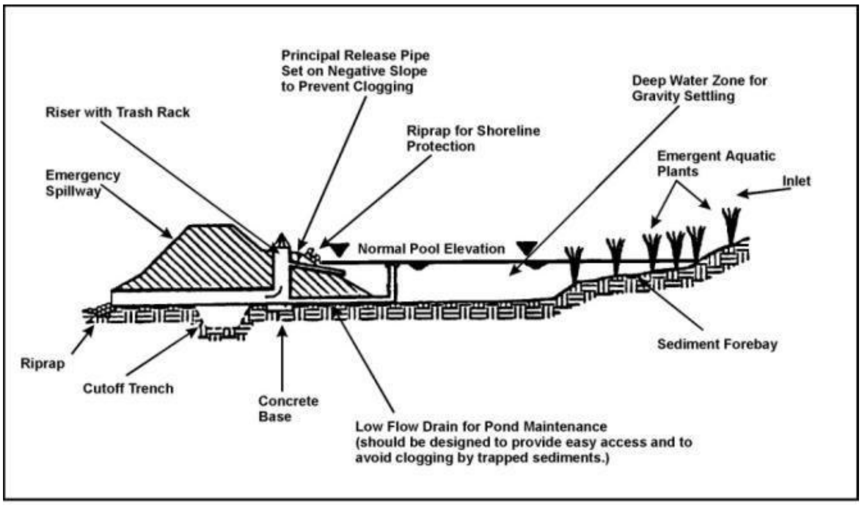

Figure 5.4.1 Typical Layout of Sedimentation Pond

Source: MASMA 2000

- Mitigation: Regular de-silting of the sedimentation ponds shall be carried out to ensure the efficiency of the ponds. Total Suspended Solids (TSS) content in the final discharge should be maintained at a level not exceeding 100 mg/l, i.e. Standard B of the Environmental Quality (Sewage) Regulations 2009.

- Blasting Vibration. Vibration can be generated within the ground by any dynamic sufficient energy. It will be composed of various wave types of differing characteristics and significance collectively known as seismic waves. These seismic waves will spread radially from the vibration source, decaying rapidly as distance increases.

  - Mitigation: Blasting Noise. Noise generated by blasting is related to air blast as large quantity of expanding gases dissipate the energy in the atmosphere thereby generating shock waves. Audible noise, being part of the pressure wave, occurs at the same time as the air-blast. It is of very short duration and depending upon distances involved can reach the peak action level, causing damage to structures as well as annoyance to humans. In Malaysia, no particular standard pertaining to noise level from blasting operation has been adopted. Typically, a stipulated limit of 120 dB(L) is recommended.

- Fly-rocks. Geology, deposit conditions, improper blasting design, or carelessness can cause fly-rock. Fly-rock is produced when there is too much explosives energy for the amount of burden, when stemming is inadequate, or when the explosives energy is too rapidly vented through a zone of weakness. Although fly-rock is an unlikely hazard to the surrounding, adopting a suitable blasting method is important.

  - Mitigation: In consideration of its impacts to surrounding environment, the quarry operation shall utilise an environmental friendly blast initiation system in its blasting operation. This will enable a multi-row blast pattern to be implemented in order to achieve a desired shot volume.

- Mitigation: The initiation system recommended for primary blasting is Non-el or electrical system with minimal holes per delay design. The use of millisecond delay intervals between adjacent holes in a single row will minimise ground vibrations, air blast, fly-rock and increase fragmentation. Good fragmentation is achieved when each charge is given sufficient time to break its quota of burden from the rock mass before the next charge detonates, the second and subsequent charges can then shoot to free additional face sequentially.
- Mitigation: A staggered/ rectangular drill pattern shall typically be utilised. This pattern is of the symmetric plough formation type. This usually results in a better control of the blast's progression, and thereby reduces the risk of fly-rock.
- Mitigation: Direction of rock motion as a result of blasting operation will be planned in order to ensure that should any fly-rock generated from the blasting operation, it will not endanger any adjacent interests. In this particular case, attention must be drawn to ensure that the direction of the rock motion must be away from the sensitive areas nearby the quarry operation area. Furthermore, works shall be done in a way that the rock face shall be shielded from the area of concern. In this case, the forest area and high hill shall be utilized for that purpose.
- Mitigation: Buffer zones shall be available to ensure that there is always sufficient distance between blasting activities and adjacent environment. The existing trees and vegetation within the buffer zone may allow the distance between quarrying activities and the open areas to be reduced. As the quarry operation site is naturally buffered by the natural forest area, this element shall be used to protect the operation from the adjacent interests.
- Mitigation: Competent personnel handling the blasting operation are an important factor to ensure that the operation is conducted in a professional manner. The person in charge which is the shotfirer shall have experience in blasting operation at sensitive areas and possess good knowledge in the latest technology in blasting operations. This competent person shall have the qualification in term of certificates from the Minerals and Geoscience Department and the Royal Malaysian Police.

- Noise from drilling.
- Noise from Crusher Plant. **Table 5.4-1** shows the typical noise level generated during the operation of a quarry plant.

Table 5.4-1 Noise Levels of Various Equipment of a Quarry Plant

Source	Noise Level, L_{eq} (dBA)	Distance From Source (m)
1st Screen	90 (5 min.)	15
2nd Screen	85 (5 min.)	15
Crusher	90 (5 min.)	6

- Workers safety: There is an inherent risk for workers' safety when working in a quarry. Heavy equipment, falling rocks, working at heights all contribute to the risk on top of the blasting, which is described above.
  - Mitigation: Provide and ensure the wearing of proper PPE such as hard hats, earmuffs or earplugs by personnel involved in blasting and near quarry. No workers to be exposed to noise exceeding 115 dB(A) and impulsive noise at or above 140 dB(A).
- Habitat: The quarry will remove a piece of the habitat completely.
  - Mitigation: Rehabilitation of quarry the site with species indigenous to the area. This will include re-covering the area with soil suitable for forest restoration.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	2
Overall significance	Significant		

5.4.5 CONCRETE PRODUCTION

Batching plants are subject to individual approval by the Department of Environment. A detailed site plan for the batching plant(s) must therefore be developed and submitted for approval.

Proper planning, design, and construction of temporary batch plants should be implemented to minimize potential water quality, air pollution, and noise impacts associated with temporary batch plants.

Impacts:

- Water quality may be affected negatively by storm water containing cement, fly ash and other material draining into the waterways.
- Dust and noise can be a problem if the plant is not shielded properly and through careless operation.
  - Mitigation: Batching plants should be located minimum 50 metres away from watercourses, drainage courses, and drain inlets. Batching plants should be located where it minimizes the potential for storm water runoff onto the site.
  - Runoff shall be directed from the paved or unpaved portion of the batch plant into a sump and pipe to a lined washout area or dewatering tank.

- Storm water and non-storm water runoff from unpaved portions of batch plant facility shall be directed to catchment ponds or tanks.
- Concrete may not be disposed of into drain inlets, the storm water drainage system, or watercourses.
- Equipment washing should occur in a designated washing areas.
- All dry material transfer points should be ducted through a fabric or cartridge type filter unless there are no visible emissions from the transfer point.
- Bulk storage silos, including auxiliary bulk storage trailers, shall be equipped with fabric or cartridge type filter(s).
- Silos and auxiliary bulk storage trailers shall be equipped with dust-tight service hatches.
- The fabric dust collection system should be capable of controlling 99 percent of the particulate matter.
- Fabric dust collectors (except for vent filters) shall be equipped with an operational pressure differential gauge to measure the pressure drop across the filters.
- All transfer points shall be equipped with a wet suppression system to control fugitive particulate emissions unless there are no visible emissions.
- All conveyors should be covered, unless the material being transferred results in no visible emissions.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	2
Overall significance	Moderate		

5.4.6 ROAD BUILDING

A six-meter wide access road will be built connecting the existing road system in the rubber estate near Tomani to the dam site. 4.7 km will be through primary forest and 6.17 km through secondary forest (**Figure 5.4.2**). This road construction will result in the loss of approximately 6.5 ha vegetated land. There will as with all road constructions be some degree of erosion or some of the cleared material will be washed with the run-off rain water into Padas River.

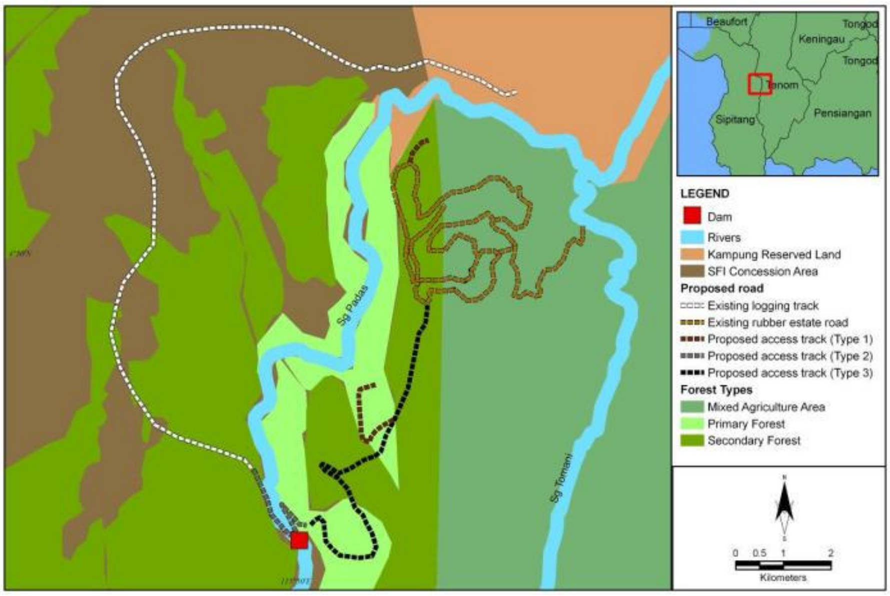

Figure 5.4.2 Proposed Roads to Access the Dam Site

The general opening up of the area and frequent travel to the area from outside may cause the spreading of invasive species into the catchment. Weed invasions pose a major threat to the ecosystems. They threaten both individual native species and communities of native plants and animals, and they alter important ecological processes.

Impact:

- Surface erosion leading to increased siltation of Padas River with the consequential impact that aquatic wildlife will suffer and human settlements down river will find it even harder to utilise the river for domestic or fisheries purposes.
  - Mitigation: Limit slope to max 10% and seal fragile road segments (slopes, tight curves, fragile soils). Ensure proper drainage on both sides of the road as well as on cut hill sides, which also must be re-planted or otherwise protected. Bridges or culverts shall be installed at all crossings of potential waterways so no impounded water areas are created. Pushing of earth spoils over road shoulder and into waterways shall be totally prohibited. During the construction of the internal connecting road between the dam and the powerhouse, earth spoil shall be carted immediately after cutting and stored at designated spoil areas. Transportation of heavy loads during rains must be limited.
- Dust generation during dry spells are not only a nuisance and health risk to people and animals alike but will also impede growth of the vegetation near the roads and will pose a threat to visibility and thus safety during use.
  - Mitigation: Seal particular dusty segments of the road and apply water on the surface of non-sealed segments to dampen the dust generation. Impose a regulation that all vehicles must use headlights at all times.

- Invasive species. Invasive species are not only vegetation that come along the cleared roads but also domesticated species such as amenity plants, fruit trees, spices or domestic animals such as dogs, cats, chicken, pigeons, pests such as rats. All these may threaten the natural balances of the environment.
  - Mitigation: In cooperation with Sabah Forest Industries and the local communities monitor the influx of invasive species and implement eradication measures if found necessary. Impose restrictions on pets and exotic plants for the work force.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	2
Overall significance	Moderate		

5.4.7 CAMP AND SERVICE INSTALLATIONS

The construction and operation of camps, offices and service installations such as shops, canteens, entertainment centres, health centres and educational or training facilities will all require land clearing and levelling. The facilities will need energy for electricity and cooking, water for all sorts of purposes. They will at the same time generate human and domestic wastes, they may cause the spread of diseases, and the workers living there may contribute to environmental damage by uncontrolled hunting or fishing activities.

Impacts:

- Site selection. There is a risk that polluted water and general rubbish may enter the waterways.
  - Mitigation: Camps and other facilities shall be placed not less than 30 metres from natural watercourses to avoid any contamination of these waters. The camps and installations shall be surrounded by a ditch functioning as a trap for unplanned run-off waters and spillage.
- Site clearing and levelling. As for road construction, there is a risk that spoils will enter the river system or that surface run-off will create sheet erosion, which again will cause siltation of the waterways.
  - Mitigation: Ensure proper drainage on all sides of the clearings and installations as well as on cut hill sides and major openings, which also must be re-planted or otherwise protected. Pushing of earth spoils over the edge of the clearing and into waterways shall be totally prohibited. During the construction of the camps and installations, earth spoil shall be carted away immediately after cutting and stored at designated spoil areas.
- Waste: Substantial wastes will be generated from the workers' camp/ residential area. The wastewater consists of greywater from the food preparation area at the residential facilities, workers' quarters and canteen which is often loaded with oil and grease as well as organic matter. Entry of untreated wastewater and raw

sewage into the waterways will adversely affect the quality of receiving waters, hence the health of those who obtain water directly from the waterways.

- Mitigation: All households and work places must be equipped with flush-toilet facilities and connected to waste-water treatment facility such as septic tanks. Solid household wastes, which cannot be recycled shall be sorted into biodegradable waste, which shall be deposited for composting in a safe area and wastes that have to be disposed of in accordance with district and state requirements. There must be a household and office collection system for waste. Recycling shall be promoted by the Project Proponent facilitating or arranging a reception facility.

- Irresponsible hunting, fishing and other collection of 'environmental services and products' by the large numbers of workers engaged in the construction of the Project may lead to depletion of wildlife and ecosystems.

  - Mitigation: Workers must receive environmental education as well as education in the laws of the state – assuming there will be a large number of foreigners. Regulations must be strictly enforced, also when it comes to procuring bush-meat from local hunters offering such meat for sale.

- Use of energy. The camps and other installations will resemble a smaller township and consume energy, which has an impact at the global scale, contributing to air pollution and climatic changes.

  - Mitigation: Small generator units shall be avoided and replaced with central, high efficiency power generation units. Alternatives to diesel must be considered. Appropriate applications for installation of such units must be made to the Department of Environment.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Moderate		

5.4.8 TUNNELLING FOR DIVERSION TUNNEL HEAD RACE TUNNEL AND PENSTOCK

The construction of diversion and other tunnels are mostly done in a confined space, i.e. apart from the issue of depositing the excavation material, then the likelihood of environmental damage is negligent. The major issue for this activity is workers' safety. Further details can be referred to in **Section 3.5.3**.

For the most parts, the diversion tunnels will be at acute angles or parallel to the strike direction of the bedding. This is not a favourable orientation and rock falls due to daylighting bedding structures in combination with conjugate joints may occur. In addition, a mixed tunnel face may be encountered at contacts between the Temburong and Crocker, which can cause excavation problems. The tunnel crosses the Crocker and the Temburong and back to the Crocker at the power station area. See **Map 4.3- 2 Geological**

Formation of The Project Area. The excavation will be in slightly weathered or fresh rock, and there will be some problems of flakiness when shale formation is encountered.

Impact:

- Excavated material may end up in the waterways if not disposed of properly causing siltation and environmental destruction downstream.
  - Mitigation: As for road building with addition of the following for the disposal site: Located at least 30 metres from the nearest waterway, proper soil compaction works and slope gradient (1:2) to the appropriate density with proper perimeter drainage.
- Labour safety: Rocks may fall during excavation.
  - Mitigation: Weak areas must be protected. Training and awareness raising among workers. First aid training among workers, safety supervisory visits, appointment of a safety official among workers, who shall receive appropriate training. Availability of first aid kits and communication facilities.
- Labour safety: Tunnel excavation/Drilling involves the use of heavy machinery in confined spaces, a work that inherently involves a risk of accidents.
  - Mitigation: This risk can almost be eliminated with proper training, good maintenance of machinery and by provision of good personal safety clothing.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	1
Overall significance	Moderate		

5.4.9 COFFER DAM CONSTRUCTION

At the time of this report production, a plan decision has not yet been made with regards to whether or how cofferdams should be built.

It is assumed a 35-metre tall coffer dam will be built between the dam site and the intake for the bypass tunnels and a smaller one, approximately 15 metres tall between the dam construction site and the outlet from the diversion tunnels.

The dams may be roller compacted concrete dams but they may also be earth or rock-filled. A final decision has not yet been made.

In any case, they will need clearance of vegetation and some removal of upper soil layers causing soils to enter the waterways. The cofferdam site is integrated into the main dam construction site, so the incremental impact of the cofferdam is insignificant.

After use, the upstream coffer dam is likely just to be left under water in the reservoir while the downstream cofferdam will be removed.

The upstream cofferdam may by time disintegrate and join the sedimentation on the bottom of the lake depending on the building technique used. If it is an RCC cofferdam, it is likely to remain as an underwater wall on the lake bottom. In either case, no harm is done to the environment.

The demolition of the downstream cofferdam will temporarily create additional loading of suspended solids in the bypassed channel. It will, however be short-lived as it will be flushed away with spillage and the environmental (compensation) flow.

Impacts:

- Increased load of suspended solids from construction of cofferdams.
  - Mitigation: As for the main dam.
- Increased load of suspended solids from demolition of the downstream cofferdam.
  - Local drainage and silt traps must be established around the demolition site. The demolition work shall progress from one point and not spread over the entire area at once.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall Significance	Significant		

5.4.10 RIVER DIVERSION

Figure 5.4.3 shows the principles and water flow at the river diversion.

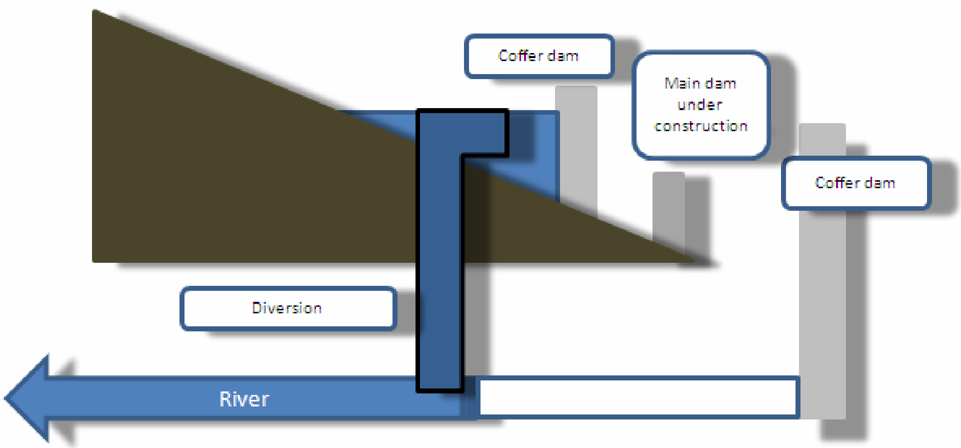

Figure 5.4.3 River Diversion

5.4.10.1 *RIVER FLOW AND WATER QUALITY*

During the construction stage, flows will need to be diverted around the construction site. As long as the diversion channels are sufficiently sized to maintain natural flows during the construction stage, impacts to hydraulic variations or water quality will be minimal. Blocking passage of the river will have some impacts on wildlife and humans alike.

The diversion will last until the dam is completed – after about 3 years - and the reservoir shall be filled. At that time the diversion will be blocked but a smaller compensation flow maintained to keep the river alive.

Impacts:

- If the diversion tunnels are dimensioned too narrow to cater for full flow of the river, flooding will occur upstream of the inlet endangering the upper cofferdam.
- If the diversion tunnels are dimensioned too narrow to cater for full flow of the river, they may implode when they are filled with rushing water.
- River flow volume will be totally interrupted at the construction site itself but will be normal downstream of the diversion tunnel outlets.
- No significant impact is foreseen on river flow and quality from river diversion.
- Restrictions to fish movements may occur as the fishes are not likely to pass upstream in the tunnels. This will therefore be the beginning of the total blocking of fish movement that becomes effective when the diversion tunnels are blocked and the reservoir is being filled.
- There will be restrictions to human transportation on the river as the passage will be blocked for all sorts of boats. There is, however on that stretch of the river not much human traffic other than the occasional local fishing.
  - Mitigation: It must be ensured, the tunnels are dimensioned to cater for full river flow.
  - Mitigation: No mitigation for fish movement is realistic.
  - Mitigation: Mooring facilities must be provided on either side of the construction site for local boats a road connecting the two points must be made.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	1
Overall significance	Insignificant		

5.4.11 DAM CONSTRUCTION

5.4.11.1 WORKERS' SAFETY

Construction work in general is a high-risk related job. This may be due to ignorance or lack of concern for safety of workers on the workers' part or the employer's part. As such, it is necessary that both parties strictly adhere to safety regulations and procedures.

Accidents can have several effects, including death, permanent disability, temporary disability, minor injury and psychological disturbances. The lack of safety gear or equipment, awareness and experiences could contribute to hazard at the work place as well as to the general public. The following are health-related risk hazards that are common in construction sites:

- Manual handling – lifting, carrying, pulling, etc. causing back pains and muscular-skeletal disorder.
- Heat stress – due to working outdoors in the sun. This may lead to dehydration.
- Hearing impairment and industrial deafness – due to use of noisy machinery and equipment.
- Respiratory irritation – due to inhalation of dusts particularly in this case.

The following are safety-related hazards at construction sites:

- Movement and use of construction vehicles – risk of overrun by trucks, lorries, etc. and risks during loading/unloading of materials.
- Risk of falling from heights – this Project involves construction at high and undulating terrain.
- Risk of falling objects – the construction of dam and its ancillary facilities might involve frequent lifting of heavy construction materials, which if not properly fastened, may result in injuries and more seriously, death.
  - Mitigation: Safety regulations and procedures must be observed at all times. All safety rules and regulations as stipulated by the Occupational Safety and Health Department shall be observed. The relevant rules include the following:
    - ✓ Formulation of Safety and Health Policy – this will be the responsibility of the Contractor. The policy will form the basis of rules and regulations. These are to be made available at the Project site office.
    - ✓ The Project Proponent and Contractor shall inform the workers of their responsibilities and roles in maintaining safety at the Project site.
    - ✓ Appointment of adequate number of competent safety officers – to be employed exclusively for the Project. The incumbent will be in charge of health and safety and will ensure all health and safety regulations are observed. Appointment of competent Safety and Health Officers shall comply with Occupational Safety and Health (Safety and Health Officer) Regulations, 1997.
    - ✓ Establishment of Safety and Health Committee. A Safety and Health Committee will review the measures taken to ensure the safety and health of all workers and also to investigate relevant issues that may arise.
    - ✓ Systematic notification of accidents, dangerous occurrence, occupational poisoning and occupational diseases.

- ✓ Incorporate safety procedures and regulations into contract agreement with contractors.
- ✓ Workers shall be provided with suitable personal protective equipment (PPE) such as gloves, hard hats, safety boots, earmuffs, etc. Those working above ground (above 2 m) are to wear half or full harness with lifeline to prevent falling.
- ✓ Workers exposed to dust are to be provided with masks or respirators.
- ✓ Keep and maintain on site, a clinic with sufficient supply of medicines and medical equipment (i.e. ambulance) for first aid and emergency purposes on site.
- ✓ Provide assistance, ambulances and medical services for workers to nearby medical facility for serious medical cases wherever and whenever required.
- ✓ Provide telecommunication facilities for workers particularly for use during emergency.
- ✓ Provide Fire Department-approved fire extinguishers of the 10 kg dry powder type or pressurised carbon dioxide. The recommended number is 2 for every fire-sensitive location such as fuel depot/skid tank areas, workers quarters, workshop and 1 for non-sensitive areas such as site office and guard house.
- ✓ Construction Safety and Health programmes (such as those provided by the Construction Industry Development Board-CIBD) should be provided for workers. This is to ensure that they are aware of the inherent risks at construction sites and are well prepared to deal with emergency situations.
- ✓ Safety barriers are to be provided on dangerous areas such as steep slopes under development, dug pits, etc. High visibility reflective stickers and warning signs should also be set up.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	2
Overall significance	Moderate		

5.4.11.2 SOIL AND WATER

Clearing of vegetation from the dam and ancillary sites and the subsequent earthworks will result in increased risk of soil erosion and slope instability.

Impacts:

- Site clearing at the dam site and the proposed area for the ancillary facilities will expose a substantial area of land to rainfall and runoff, which will result in erosion and loss of topsoil thereby contributing to an increased load of suspended solids in the river and associated sedimentation.

- Mitigation measures include:
  - ✓ The sites that are to be cleared must have sedimentation ponds constructed[49] at the low points. These will enable settling of larger sediment prior to discharge to the nearby drainage or waterway systems. Drainage paths need to have silt fences, or similar arrangements to slow flow and trap sediment. Formal drains need to be well designed and constructed in materials that will endure for the duration of the Project. These drains will also collect runoff from future structures such as housing, sheds, etc.
  - ✓ Site clearing and earthworks should not be carried out during excessively wet and rainy periods. The rainfall pattern in the Project area is not entirely predictable into wet and dry seasons as wet and dry spells are known to happen in any month of the year. The planning will therefore have to follow the actual rainfall pattern in any particular month.
  - ✓ Following construction of the dam, remaining cleared areas will require restoration of vegetative cover to prevent further erosion and sedimentation of the reservoir and downstream river.
  - ✓ Areas of steep slopes and unstable terrain should be terraced, stabilized, strengthened and re-vegetated to avoid risk of erosion and slope failure during and after the construction stage.
  - ✓ Soil erosion at construction sites can be minimized using soil protection such as terracing, plastic sheeting and installing silt traps at strategic locations.

- Aquatic flora. Deterioration of water quality due to increased total suspended solid (TSS) might affect the aquatic flora once construction has begun. Decrease in quality and availability of light due to increase in TSS and turbidity is expected particularly at the construction site for the dam and powerhouse. Phytoplankton composition and primary productivity will be affected negatively due to increase in turbidity/reduced in water transparency, which is already high at present. The silt from sediment loading will smother the benthic environments including substrates (stone, sand, etc.) which potentially reduce the periphyton biomass and diversity. This in turn will affect fish populations and subsequently the livelihoods and health of villagers dependent on fishing.
  - Mitigation: As above.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Significant		

[49] *The locations of the sedimentation ponds cannot be determined at this stage due to lack of information such as detailed topographical survey plan, etc. A detailed ESCP shall need to be prepared at a later stage and submitted to Department of Irrigation and Drainage (DID) for approval.*

5.4.11.3 AIR

Dust is expected to be generated during the construction stage, during the clearing of the Project area and any other earthworks operations required for the construction of the dam and access roads. Stockpiles of topsoil, uncovered loads on construction vehicles and unprotected cleared areas are other potential dust sources. In addition, dust could be generated during unsealed road use by construction traffic. Dust emissions often vary substantially from day to day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions.

Construction consists of a series of different operations, each with its own duration and potential for dust generation. In other words, emissions from any single construction site can be expected (i) to have a definable beginning and an end; and (ii) to vary substantially over different stages of the construction process. This is in contrast to most other fugitive dust sources, where emissions are either relatively steady or follow a discernable annual cycle. Furthermore, there is often a need to estimate area wide construction emissions, without regard to the actual plans of any individual construction Project. For these reasons it is very difficult to estimate the potential dust emissions from the sources. However, it can be said that the quantity of dust emissions from construction operations are i) proportional to the area of land being worked and to the level of construction activity; ii) positively correlated with the silt content of the soil; iii) dependant on the speed and weight of the average vehicle; and iv) negatively correlated with the soil moisture content.

Air pollution from open burning of biomass and the inappropriate disposal of other waste may happen. However the main pollutant of concern is total suspended particulate (TSP). Although the dam will seem to occupy a huge area, the area where construction activity is conducted at any one time is conservatively estimated only at about 30 hectares.

Based on a construction period of 18 to 24 months and the main construction area of 30 hectares, the amount of dust emitted is = 2.69 t/month/ha * 24 month * 30 ha = 1,936.8 t, where the factor 2.69 t/month/ha is the approximate emission factor for construction activity operations (US EPA, 1995).

The assumption is made there are 26 working days in a month, and construction activity is active during day time and last approximately 10 hours a day, from 7.00 a.m. to 5.00 p.m. The 1,936.8 tons reduces to an emission rate of 86.2 g/s (worst case) when there are no control measures. This emission rate has been used for modelling a prediction of the total suspended particulate (TSP) concentration in ambient air. The air quality modelling is further described in **Appendix 2-2: Climate and Air**.

Impacts:

- In the event when there is no dust control measures to reduce dust emissions during the construction stage, the increase in TSP concentration can be as much as 1,000 µg/m^3 near the Project site for the 24-hour average concentration. This is well above the guideline of 260 µg/m^3.

  On a long term basis, if there are no control measures, the long term average TSP concentration increases by 100 µg/m^3 near the Project site and decreases to 3 µg/m^3 about three kilometres away. The 100 µg/m^3 level exceeds the guideline level for long term; i.e. 90 µg/m^3 in areas near the Project site.

As the construction stage of the Project will be over a period of 12 to 24 months, the impact of TSP pollution on ambient air is minimal once construction activity ceases.

- Mitigation measures include:
  - ✓ Existing vegetation at the Project site especially on undeveloped areas are maintained as much as possible to act as natural barriers.
  - ✓ Vehicles transporting construction and earth materials must have their loads covered using tarpaulin or canvas sheet when utilizing the public road to prevent spillage of materials that can become a source of dust pollution.
  - ✓ Topsoil stockpiles should be kept covered or have a suitable dust palliative applied.
  - ✓ A suitable dust palliative should be applied to unsealed roads if dust rises above unacceptable levels.
  - ✓ Road sections passing schools and villages must be sprayed with water or other dust suppression systems during dry periods.

- Complete burning of biomass or biological waste will produce emissions of CO_2 at levels similar to the level after natural decomposition.
  - Mitigation: All un-planned and incomplete burning must be totally banned. This will include burning of refuse other than completely dry wooden building materials. Burning of biomass from clearings must only take place after approval is given by the Department of Environment and after ensuring the biomass is completely dry and that there is no other option such as e.g. natural composting.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

5.4.11.4 VEGETATION

Biodiversity and habitat will be lost at the construction site as it will be totally cleared.

Impacts:

- Loss of habitat of about 30 ha. The vegetation on both sides of the river is currently primary Dipterocarp forest. On the East bank the vegetation is part of the protected P08 while the forest on the West bank of the river is part of compartment P07, which is planned for conversion to industrial tree plantations. While the loss locally is significant, this loss of habitat is in the larger picture of biodiversity insignificant.

- Mitigation: No direct mitigation is possible other than efforts to minimise clearings and to offset biomass and habitat losses by establishment and/or protection of similar areas elsewhere. This will require that the Project Proponent either gets authority over an area or enters into an agreement with e.g. the Sabah Forest Industries. The Government Authorities such as the Forestry department and the Environment Protection Department must in any case be involved as active partners.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.4.12 BLASTING

Blasting of the hard rock is inevitable. Operations in quarries require the blasting of rocks which will become the raw material for the construction of the proposed dam and the ancillary structures. Foundation works at the dam site also requires blasting of rocks. Blasting is inherently high risk and needs to be handled with care.

This activity generates extreme noise, potential fly rocks and ground vibrations. It poses a great risk to the safety of the workers, nearby residents and property. The noise and vibration may be a nuisance to the residents. However, the impact is only temporary.

As mentioned earlier under quarry operation, **Section 5.4.4**, a separate EIA report will be required for submission and approval from the Environment Protection Department before the quarry activities can begin.

Impacts:

- Impacts include physical accidents due to fly-rocks, fire, direct explosions, landslides as well as noise hazard and air pollution.
    - Mitigation measures are mentioned under Quarry operations and include:
        - ✓ Explosive storage magazine should be clean, dry, well-ventilated, reasonably cool, with bullet and fire resistant shelters. A safe distance must be maintained between the magazine and settlements as well as other installation of the Project. Blasting caps should never be stored in the same magazine with other explosives.
        - ✓ Storage of explosives shall be as per requirements of the Police Department and Explosive (Amendment) Act 2007.
        - ✓ Explosives shall only be handled by authorized and competent personnel.
        - ✓ Signboard shall be erected at strategic places to inform the workers and public about blasting session. Workers and public shall be informed prior to any blasting session.

- ✓ Siren shall be sounded prior to blasting as a warning of upcoming blasting at the quarry site.
- ✓ General workers are to be evacuated from quarry site during blasting. Only blasting personnel are allowed.
- ✓ Fly-rock impact zone of 50 m shall be totally evacuated during blasting.
- ✓ No visitors or outsiders are allowed to enter the quarry site during blasting sessions.

- Blasting activities at quarries also produce dust and minor gaseous emission consisting mainly of sulphur dioxide, nitrogen dioxide and carbon monoxide. While these gasses are toxic pollutants the effect of this pollution is only temporary.

  Mitigation is not required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Moderate		

5.4.13 POWER HOUSE CONSTRUCTION

Two power installations will be built: A main powerhouse approximately 10 km downstream of the dam and a secondary power unit at the dam itself to utilise the environmental or compensation flow.

The main powerhouse will be constructed near the Kg. Tomani settlement and mitigation shall therefore be directed towards shielding the Tomani residents from negative impacts and nuisances. Both powerhouses will require substantial earthworks and impacts and mitigation will be similar as for dam, road and tunnel construction.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Moderate		

5.4.14 DE-COMMISSIONING OF TEMPORARY SITE INSTALLATIONS

Most site installations, in particular, the contractor's camp and the labour camp will be decommissioned at the end of the construction stage of the Project. Only some workers' settlements, offices and probably workshop might be retained for use of on-going dam maintenance works during the operational stage of the dam. Besides, it is very likely that the aggregate crushing and processing plants will be decommissioned. The associated major environmental impacts are the large amount of construction wastes generated and the transportation of decommissioned parts to designated places, and construction wastes to proper disposal facilities.

Impacts:

- Large amounts of construction waste will be generated when the construction is over and camps etc. will be broken down.
- Discarded machine parts, waste oil and grease from workshops will have accumulated.
- Sewage and other waste installations will be rendered useless after decommissioning of the camps.
- The landscape will be denuded and scarred by temporary roads, drainage etc.
  - Mitigation: Contractors shall be obliged by their contracts to remove all leftovers from their operations to sites approved by the authorities. The contractor must therefore a minimum of six months in advance present a detailed removal schedule including quantities to the appropriate district authorities and the Environment Protection Department for approval.
  - Mitigation: In-ground installations such as septic tanks, water piping, electric wiring must be removed from the site too. Contracts must also include landscaping and re-planting all cleared areas.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Moderate		

5.4.15 TRANSMISSION-LINE CONSTRUCTION

5.4.15.1 LAND USE

The initial clearance of a Right-of-Way (ROW) for the transmission-line will have the general effect of producing a continuous narrow corridor through the existing natural vegetation or crops from which all tall-growing species (>2 metres) will be reduced to stumps by cutting. It will have the characteristics of a linear forest opening in forested areas.

During the construction stage, most serious impact would be when the whole ROW for the transmission-line and the access roads is clear-felled. This is necessary in order to string the lines.

As far as agricultural crops are concerned, the taller ones like oil palm, tall coconut varieties, and some fruit trees (e.g. durian) will have to be permanently removed from the ROW.

Agricultural activities will suffer a significant adverse impact, particularly in areas where tall perennial cash crops are already established. These crops such as oil palm, rubber, tall coconut varieties, sago, and some fruit trees (e.g. durian) will have to be permanently removed from the ROW. This will result in a total loss of the crops affected. Even in cases where the crops do not have to be eliminated, the existing agricultural activities in the ROW will need to be temporarily halted or restricted during construction. The proposed mode of construction means that crops and vegetation that are of short stature may mostly be retained; where they have to be cleared during the construction stage, they may be replanted afterwards. In any case, the removal may be expected to be met with requests for compensation from the farmers and companies concerned.

The land at the actual sites of the towers may have to be acquired. The land value varies considerably according to the locality and the category of land tenure.

The currently proposed alignment follows boundaries between different land uses such as forest and agriculture. There will therefore always be a choice whether to align the right-of-way on the boundary, i.e. 50% in either land use category or to align the right-of-way in only one of the land use categories.

Chemsain supports the principle of aligning the right-of-way in the most disturbed areas and the principle of protecting small holders against drastic changes of their livelihoods. Chemsain therefore assumes the lines primarily are in the different land use classes in the following priority:

1. Industrial tree plantation areas
2. Oil palm or rubber plantations
3. Natural forest management areas
4. Protection forest areas

Table 5.4-2 shows the areas affected by the right-of-way following above criteria.

Table 5.4-2 Land Use Under the Transmission Lines (Length (Km) / area (Ha))

Sector	Protection forest	Natural Forest	Industrial Tree Plantation	Oil Palm	Rubber	Total Length / Area
Secondary power house - Main power house	0 km 0 ha	1.9 km 7.60 ha	-	-	9.6 km 38.40 ha	11.50 km 46.00 ha
Main power House - Kg Bamban (16.01 km Double line)	0 km 0 ha	-	-	32.02 km 128.08 ha	-	16.01 km 128.08 ha
Kg Bamban - Tenom	0 km 0 ha	-	-	17.87 km 71.48 ha	-	17.87 km 71.48 ha
Kg Bamban - Sipitang	0 km 0 ha	8.83 Km 35.32 ha	5.45 km 21.80 ha	1.93 km 7.72 ha	20.55 km 82.20 ha	36.76 km 147.04 ha
Total	0 km 0 ha	10.73 km 42.92 ha	5.45 km 21.80 ha	51.82 km 207.28 ha	30.15 km 120.60 ha	98.15 km 392.60 ha

*Note: Table similar to **Table 4.7-1**.*
Note: Slight variations in line lengths with other tables is due to different map sources in use

Impacts:

- Land will have to be acquired for the pylons, sub stations and access roads.
- Limitations will be imposed on land use in the right-of-way area. Height of crops will be limited to 2 metres tall.

- Mitigation: Compensation will have to be paid.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	3
Overall significance	Moderate		

5.4.15.2 AESTHETICS

The transmission-line will not be particularly visible from public roads or inhabited areas, except where it follows the road through the Gunung Lumaku Forest. The perception in this area, however, will be that this is a transportation and communication corridor and the alignment is therefore not expected to meet any resentment.

- Mitigation: No mitigation required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Insignificant		

5.4.15.3 SOILS

Soil erosion from land clearing may affect the natural environment and its visual landscape. However, the cleared land and exposed earth ensuing from the removal of vegetation may become an eyesore for the adjacent villagers. The cleared land is also subjected to wind, rain and sunshine that cause soil erosion. The loose soil particles, without the protection of vegetation cover, may be churned up by the construction vehicles moving in the Project site as well as wind forces, causing suspended particulate and dust in the air thus affecting its air quality.

Impact:

- Some level of soil exposure and subsequent erosion may happen around pylons and at access tracks.
  - Mitigation: Mitigation will as for other road construction include limitation of gradients to less than 10%, re-establish water-courses that have been disturbed, and re-establish vegetation.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	2
Overall significance	Moderate		

5.4.15.4 VEGETATION

The clearing for the transmission-line will mainly be in the man-made landscape of oil palm, rubber or industrial tree plantation. Fragmentation will be minimal, and there are no major biodiversity areas at stake.

The alignment does go through the Gunung Lumaku Protection Forest but follows in broad terms an existing transportation corridor.

Only exception is the first leg of the line between the auxiliary and the main power stations. This line goes partly through SFI compartment P08, which is laid out as protection area.

Impact:

- Loss of habitat and fragmentation in protection area.
  - Mitigation: Where the alignment follows a boundary between natural forest and any other land use, the alignment shall not cut into the natural forest area.
- Invasive species may take over in the cleared areas of the Right-of-Way and spread into neighbouring lands.
  - The ROW management must include clearing of invasive species even outside the ROW wherever the species occurrence without any reasonable doubt can be attributed to have spread from the ROW.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	3
Overall significance	Moderate		

5.4.15.5 FAUNA

With the present proposal for line alignment, and the low level of wildlife in the area, there is little risk of any significant impact on wildlife from construction work.

The transmission-line alignment is currently proposed to be where disturbance will be felt as little as possible. Clearing of the Right-of-Way will be along the boundaries of vegetations and will therefore not add to fragmentation of contagious natural forest areas.

- Mitigation: Mitigation will not be required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	1
Overall significance	Insignificant		

5.5 IMPOUNDMENT STAGE

5.5.1 CLOSING OF DIVERSION TUNNELS

When the main dam construction is completed, the diversion tunnels will be blocked and the river immediately below the dam would be dry if nothing is done. A mitigation measure of a compensation flow of 16 m^3/s, which is equivalent to the mean flow naturally existing at least 10% of the time (90% exceedance flow), is already incorporated in Project planning in order to maintain the river between the dam and power station (the bypassed channel) alive. The energy value of this ‘compensation flow’ or ‘environmental flow’ is lost to commercial marketing but has by the dam designers been utilised for power generation for internal Project use. Downstream of the confluence with Tomani River, the effect of partial blocking the river will be less pronounced.

The compensation flow represents the 90% exceedance flow calculated on the basis of annual mean runoff. Hydrological modelling carried out by DHI estimates that it may take between 11 and 84 days in wet and dry years respectively to fill the reservoir to minimum operational level if the 10% low flow is released as compensation flow.

It is estimated that 5.9 km^2 or 590 ha of land comprising the valleys and rivers of Maligan, Ketanun and Padas will be flooded.

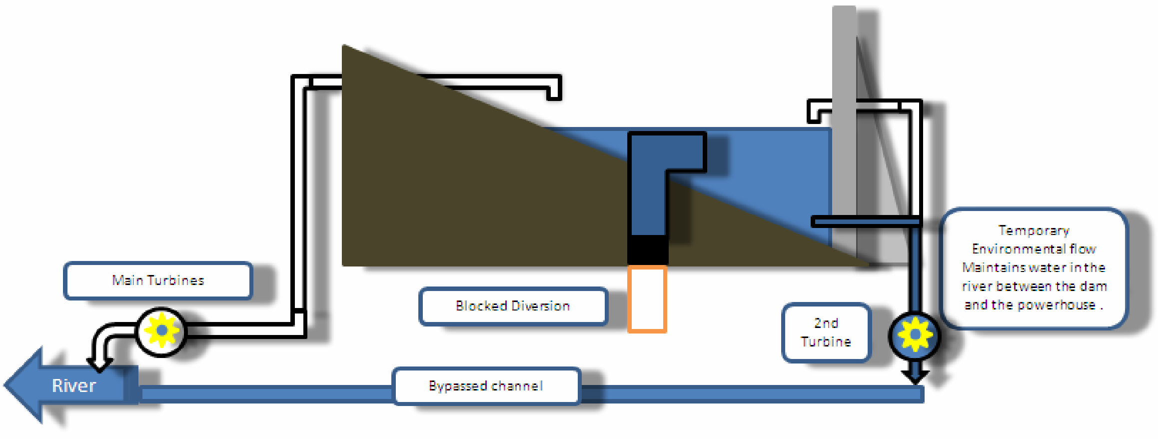

Figure 5.5.1 Water Flow: Reservoir Filling

5.5.1.1 *TERRESTRIAL VEGETATION*

Loss of biodiversity

590 hectares of habitat and biodiversity will be totally lost in the reservoir area during impoundment.

The habitat is as mentioned earlier mostly undisturbed dipterocarp forest (**Figure 5.5.2**), a forest type, which is common but under constant threat. However, there are several virgin forest reserves in the area established in order to conserve the local gene pool.

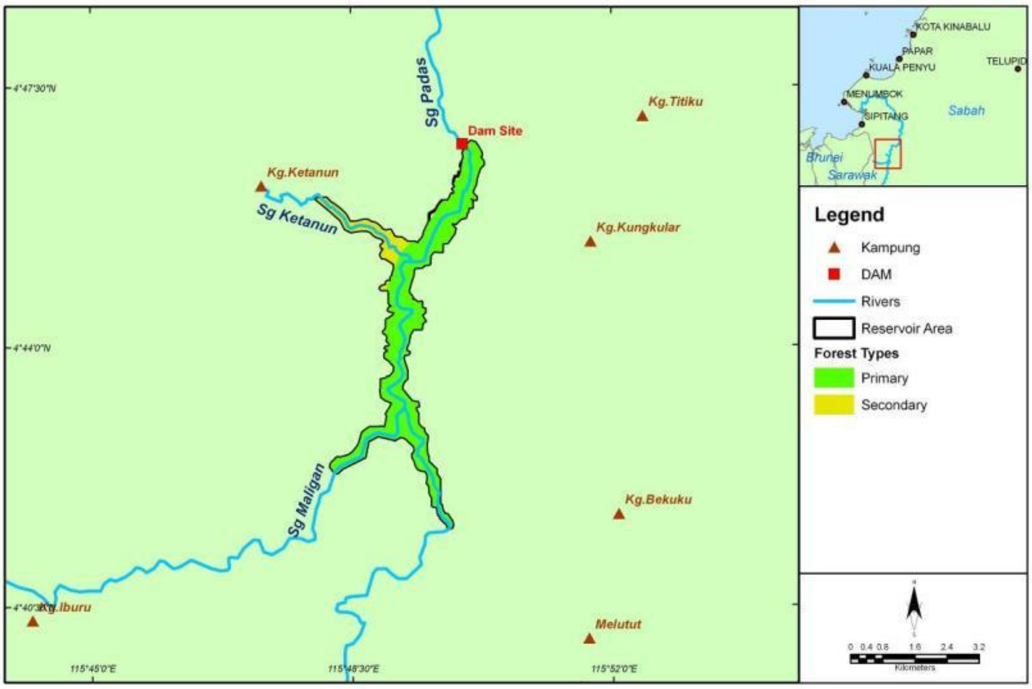

Figure 5.5.2 Vegetated Area within the Reservoir Area

Impact:

- Loss of 590 ha mostly undisturbed dipterocarp forest.
  - Mitigation: A similar area should be protected locally or elsewhere.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

<u>Biomass loss</u>

The vegetation within the future reservoir area is predominantly primary forest (507 ha), with a small area of the reservoir (14%, 83 ha) being secondary forest. A total area of 590 ha will be lost within the reservoir area (**Figure 5.5.2**).

The Consultant's inventory in the reservoir area suggests there may be only as little as 98 t/ha. The standard normally adopted by the Intergovernmental panel on Climate Change is 350 tons per ha.

Assuming an average above ground dry weight biomass of 100 t/ha, **Table 5.5-1** shows total loss of biomass from 590 ha if no salvage operation is carried out.

Table 5.5-1 Loss of Biomass and Emission of Greenhouse Gasses Assuming No Salvage

Carbon release

Forest type	Dipterocarp forest		
Reservoir Area ha	590.00		
Boundary (Shore) line(m)	30,000.00		
With of buffer (shore) band to be cleared (m)	130.00	Shore line band area (ha):	390
Area not cleared	200.00		
Above ground Tons Dry Weight Biomass / ha	100.00	cf. Chemsain inventories	
Carbon : dry weight biomass Ratio	0.50		
salvageable proportion (%)	0%		
Of the wasted material in the cleared area:			
Proportion cleared and piled for decomposition (%)	90%	years for decomposition:	10
Proportion left standing for inundation (%)	10%	years for decomposition:	20
Of the wasted material in the inundated area:			
Proportion cleared and piled for decomposition (%)	0%	years for decomposition:	10
Proportion left standing for inundation (%)	100%	years for decomposition:	20

Biomass stored in the vegetation	59,000	Tons
Salvagable biomass, all areas	-	Tons
Carbon stored in the non salvagable biomass, all areas	59,000	Tons
Carbon stored in the non salvagable biomass, cleared area	39,000	Tons
Carbon stored in the non salvagable biomass, inundated area	20,000	Tons

Impact:

- 59,000 tons of biomass or about 85,000 m^3 will be lost.
- A total of 49,000 tons of carbon (**Table 5.5-2**) will be emitted as greenhouse gasses. Half of this from decomposition of waste in the forest, half through processed products. Emission of CO_2 equivalents through methane from anaerobic decomposition will be 314,000 tons while CO_2 emission from aerobic decomposition will be 140,000 tons. See **Appendix 1-1: Climate and Air** for calculation details.

Table 5.5-2: Annual Carbon Release

CO_2 equivalent release, years 1-2:	48,693	tonnes per year
CO_2 equivalent release, years 3-10:	21,652	tonnes per year
CO_2 equivalent release, years 11-20:	18,434	tonnes per year
Total CO_2 equivalent release:	454,942	tonnes per year

- Mitigation: Salvage of commercial timber and clearing of remaining vegetation.
- Mitigation: Removal of as much as possible of the biomass prior to inundation. A biomass removal plan is presented in **Section 6.7.3**.
- Mitigation: Offset plantation of a suitable area for high carbon sequestration. Since the emission is in the form of methane and carbon sequestration to forest plantations is from carbon dioxide, an area of

more than 20 times the reservoir, i.e. 12,000 hectares, will be needed to offset the emission.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

Loss of Significant Species

The clearing of forest habitat results in the loss of plant resources, some of which have been locally identified of their conservation and commercial importance. These species as listed in **Table 5.5-3** were observed in the future reservoir area, and their estimated densities have been derived from the field surveys conducted for the present SEIA study.

Table 5.5-3 Species of Conservation Significance and Their Density within the Reservoir Area

No.	Species	Conservation significance	Average Density	Estimated Loss (Individuals)
1.	*Podocarpus* *(Kayu Cina)*	Sabah Wildlife Conservation Enactment 1997 Part (II) Section 54 (1) (b) Protected Plants	42/ha	24780
2.	*Aquilaria malaccensis* (Gaharu)	CITES (Convention on International Trade in Endangered Species); Vulnerable, IUCN Red List	11/ha	6490
3.	*Dipterocarpus* spp.	Critically Endangered, IUCN Red List	25/ha	14750
4.	*Parashorea malaanonan (Urat Mata)*	Critically Endangered, IUCN Red List	8/ha	4750
5.	*Shorea inappendiculata (Selangan Batu)*	Critically Endangered, IUCN Red List	25/ha	14750
6.	*Shorea pauciflora (Nemesu)*	Endangered, IUCN Red List	58/ha	34220
7.	*Shorea argentifolia (Meranti Binatoh)*	Endangered, IUCN Red List	13/ha	7670
8	*Durio spp.* *(Durian)*	Vulnerable, IUCN Red List	8/ha	4720

Other commercially important species found within the reservoir area would also be lost due to inundation of the area. These species are as listed in **Table 5.5-4** below. The average density for all these species of commercial significance according to the average density data from survey plots are as shown on **Table 5.5-4**.

Table 5.5-4 Commercially Important Species within the reservoir Site

Species	Average individual per ha	Estimated Loss (Individuals)
Agathis borneensis	29	17110
Artocarpus spp.	17	10030
Calophyllum obliquinervium	47	27730
Durio spp.	8	4720
Dillenia spp.	42	24780
Dipterocarpus spp.	25	14750
Gluta spp.	17	10030
Mangifera foetida	17	10030
Parkia speciosa	21	12390
Podocarpus imbricatus	42	24780
Shorea curtisii	13	7670
Shorea pauciflora	58	34220
Vatica spp.	31	18290

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Significant		

5.5.1.2 AQUATIC FLORA

The increase in water level at the upper part of the dam will create a reservoir and river bank, which will be submerged due to the water level rise. The adverse impact of losses of riverine habitat cannot be adequately quantified in this study. The phytoplankton and periphyton composition of the part of Sg. Padas to be inundated by the reservoir will change from lotic composition to lentic composition. The implication is species adapted to a lake environment will occupy the reservoir.

Significant water level rise will cause thermal stratification in the water column. A thermocline is expected at 10 m depth based on the model on hydrological and water quality analyses (*Frachissie et al. 2009*). Oxygen depletion is likely to occur at the lower part of the water column. Impact: Oxygen depletion due to decomposition of biomass within the reservoir resulting in fish decline.

- Mitigation: Remove biomass from the reservoir before inundation to avoid adding to the problem of low levels of dissolved oxygen in benthic environments. A biomass removal plan is presented in **Section 6.7.3**.
- Mitigation: A measure of mitigation is built into the design of the water intakes to the powerhouses. The low position of the water intakes are under most reservoir conditions placed in the anaerobic stratum and will therefore to some degree create renewal of water in this stratum.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	1	1	3
Overall significance	Moderate		

5.5.1.3 TERRESTRIAL FAUNA

There are no caves or other natural structures found in the area that would contain a sizeable colony of birds or mammals in the flooded area during the ecology field survey.

The inundation of approximately 5.9 km^2 or 590 hectares will result in the loss of wildlife habitat therefore forcing wildlife to seek refuge to higher grounds. Those that move to adjacent habitat but cannot colonise it will eventually perish due to starvation and exposure to inclement weather. Slow moving individuals or animals that cling to their home range and refuse to move may be trapped and eventually die if they are not removed or rescued. Injury and death to arboreal animals occur when the trees they use are felled while ground dwelling animals may be crushed by falling trees. Immature animals and animals that are injured and weak are particularly prone because they have limited ability to move away from the source of disturbance or escape predators. Soil dwelling organisms, mainly invertebrates, will also perish during earthwork.

Of the totally protected species, birds will fly off and may not be affected by the flood water. Totally protected mammals such as Giant Squirrels and primates are also at home in the tree canopy and are found in both the flooded and non-flooded area. As no islands are expected to be created, these species will be safe too.

- Mitigation: Clearing methodology: Reduce the impact on the lowland that will be inundated by starting work at the lowest elevation near the river bank and proceeding towards the higher ground. This will allow time for as many species and individuals as possible to move to higher ground above the watermark where they can establish new homes. Clearing of land in a manner so as to create a forest island should not be done because it does not leave corridor for wildlife to flee from disturbance. Any injured animals or birds found should be given proper veterinary care and then released into the adjacent forest or surrendered to the Wildlife Department.
- Mitigation: Gate/Guard house should be erected at the entrance of the access road to regulate entry into the Project area. No unauthorised access by outsiders should be allowed during this stage especially hunters.
- Mitigation: Construction workers must not be allowed to bring in firearm or to hunt. This must be strictly enforced at all times. Stern action must be taken against those who defy.
- Mitigation: Clear signboard should be erected at road entrance to warn hunters from entering the Project area.
- Mitigation: All workers should be made aware of the law governing wildlife hunting.

- Mitigation: The Wildlife Department should be notified immediately if a situation warrants wildlife rescue operation such as when animals are found abandoned or isolated without ability to move into safer areas.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	1
Overall significance	Moderate		

5.5.1.4 FISH FAUNA

The biology and ecology of fish in Padas River is strongly linked to the annual hydrological regime. Aspects of the natural flow regime including magnitude, frequency, timing, duration and rate of change and the predictability of flow events are thought to be linked to critical components of the life history strategies of many riverine fishes, including spawning and recruitment (King et al., 2008).

However, once impoundment of the dam starts, this annual hydrological regime would be greatly affected. Therefore, major impacts will be expected to take place during the impoundment stage. Impounding the water following the completion of dam construction may take 5 months before the dam can be operational depending on the amount of rainfall. Different impacts will be felt on the aquatic fauna in the area downstream of the dam and in the reservoir.

The Upper Padas Hydroelectric project will not have any impact on the aquatic fauna upstream of the reservoir.

Reservoir Area

As the reservoir is being formed through the impoundment process, fish species will gradually start to change. All species from the family Balitoridae and some species from the family Cyprinidae such as *Tor sp.* that are well adapted to swift flowing waters will either move upstream or into the smaller tributaries and some will die due to unsuitable new habitat.

The reduced water velocity in the reservoir will encourage the deposition of suspended solids especially around the areas of the inflowing water supply. The water will be more transparent, thus encouraging the growth of phytoplankton in the newly developed lacustrine environment. Enhanced primary productivity in the lacustrine environment will lead to rapid increase in selected fish species, particularly planktivorous and herbivorous species. These species will be preyed upon by carnivorous species particularly *Mystus spp.* Movement of fish from the reservoir to the downstream areas or the other way will in practice be blocked. The way of releasing the environmental flow is not yet designed but will initially have to be close to the bottom level of the reservoir, e.g. at a semi-blocked diversion tunnel or a separate structure in the dam itself till the reservoir level reaches the permanent intake level at about 430 m a.s.l.

Downstream Area (between the dam/outlet of the secondary powerhouse and the main powerhouse)

In the downstream area between the dam and the power house, there will be a reduction in water flow and volume depending on the impoundment stages. This will lead to a reduction in the depth of the water and many rapids area will become very shallow or dry. Some of the exposed sand banks may be colonized by earthworms during this period when there will be minimum flushing effects even during the rainy period.

During the impoundment stage and later operation, fish in the river between the dam and powerhouse will experience less of the natural flow variability. The quantity of the water will also be very much reduced. As there are strong evidence linking environmental flood to fish spawning and recruitment (King et al., 2008), this may result in less spawning and recruitment taking place at this stretch of the river.

Downstream Area Below the Main Powerhouse

In the downstream area below the power house, there will also be a reduction in water flow and volume depending on the impoundment stages. This will lead to a reduction in the depth of the water. After the confluence of the Tomani and the Telekosang rovers, this effect may be less pronounced although still present. The two rivers will maintain river width most of the time but the river will still be shallow. The drainage area of Tomani and Telekosang is almost equal to that of the Project catchment.

Fish in the river below the main powerhouse will experience less of the natural flow variability. During the impoundment stage, fish in the river between the dam and powerhouse will experience less of the natural flow variability. The quantity of the water will also be very much reduced.

Depending on the species and size of fish, reduction in water depth may impair localized movement of fish. However, most species including medium sized *Tor spp*. are able to swim at ease at minimum depth of 20 to 30 cm. However, reduction in water volume and flow will lead to congregation of larger sized fish at certain parts of the river, mainly at the pool areas. Without proper regulation and enforcement by the relevant authorities, they are vulnerable to overexploitation.

Water flowing downstream will have reduced suspended solids and leaf litter. Rivers in the higher order are strongly influenced by riparian vegetation (Vannote et al., 1980) and although primary production is low because of shading, vegetation provides large amounts of allochtonous detritus which are food web base for stream invertebrates and subsequently fish (Cummins et al., 1973).

- Mitigation: The compensation flow is the mitigation measure. It is important that this flow is maintained at all times at the planned rate of not less than 16 m^3/sec.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.5.2 REMOVAL OF COFFER DAMS

The cofferdam diverting the water from the river into the diversion tunnel is likely just to be left under water when the diversion tunnel is blocked. If the coffer dam is an RCC dam, it will just stand as an underwater wall with no significant impact to the environment.

If the cofferdam is an earth structure it will disintegrate under the water and join the sediment that eventually will build up. This will add slightly to the Project risk of sedimentation but will have no significant impact in the environment.

The cofferdam below the dam will be physically removed and this activity is bound to create a temporary, significant increase in the level of suspended solids of the downstream river system. This will be accentuated by the removal of the powerhouse cofferdam at the same time.

Impact:

- Sedimentation of the reservoir from the upstream cofferdam.
- Temporary increased levels of suspended solids in the downstream river system.
  - Mitigation: General caution and work discipline when removing cofferdams in order to avoid digging, excavating and driving all over the place
  - Avoidance of clearing earth during rainy periods.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	2	3
Overall significance	Moderate		

5.5.3 RELEASING COMPENSATION FLOW

The reduced flow in the river will be similar to what statistically is the minimum ‘guaranteed’ flow at least 10% of the time (90% exceedance flow).

The current design has not yet determined how the environmental flow will be maintained during reservoir filling. It will, however happen in two stages. First through a dedicated low elevation outlet (built into the now blocked diversion tunnel or as a separate facility built into the dam structure) while the reservoir rises to the level where the water can be released through the permanent outlet at elevation 430 m a.s.l. that will be used for generation of power in the secondary powerhouse.

During the reservoir filling period, of about three quarters of a year, methane is not yet expected to have built up in the lake, but the suspended solids will, due to the reduction of flow have settled in the upper reaches of the reservoir – remembering that the ‘upper reaches’ during this period will be a moving target starting at the dam moving towards the final upper reaches over the filling period.

The released environmental flow will therefore be relatively cleaner than the present river water during reservoir filling.

Impacts:

- The low flow will force the river to recede from the banks to the middle of the riverbed, thus giving up some previous riverbed to dry land habitat. This will change the hydrologic conditions of the previous banks and the vegetation will change to less water demanding types.
    - Mitigation: No mitigation is required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Insignificant		

5.6 OPERATION STAGE

5.6.1 INTRODUCTION

The operation of a hydroelectric dam is one continuous flow rather than a series of activities. The operation may thus be seen as a fluid state. Water flows through a reservoir, where its resident time has been delayed compared to the natural river state, passes through either the compensation flow and secondary turbines or through the great headrace tunnel and penstock, through the main turbines before it is released and combined with the compensation flow to re-establish flow of the natural river.

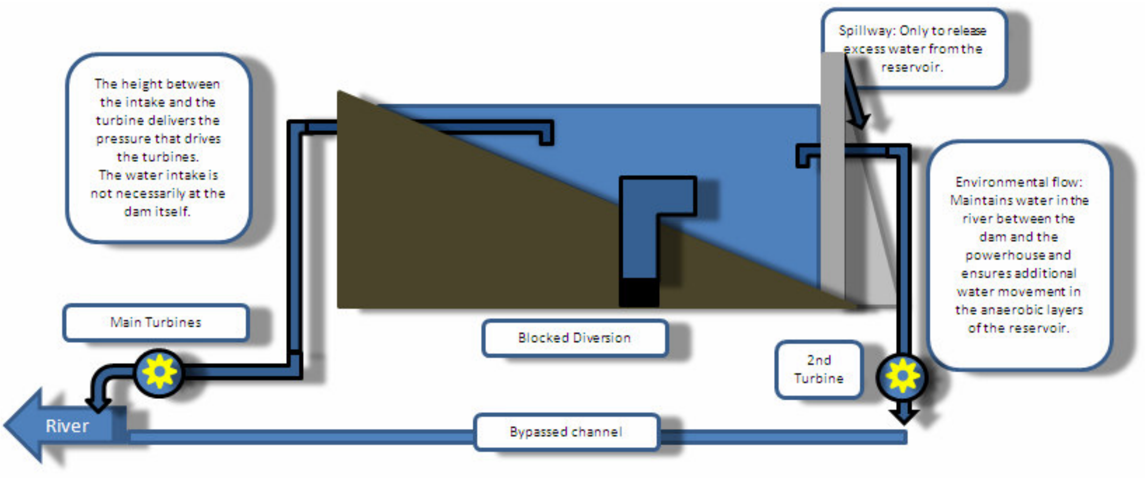

Figure 5.6.1 Water Flow: Operation Stage

Most impacts have already happened during the construction and impoundment: Loss of land, loss of habitat, loss of biodiversity, erosion increased turbidity, negative social impact of influx of a large labour force, and wastes.

In terms of human environment, the Project is not expected to generate any significant traffic or cause any air or noise effects. The major impact may be the induction of natural fear of a dam breach for the communities downstream of the dam.

There will be a need for a concerted environmental effort in the catchment area in order to ensure a supply of sufficient quantities and quality of water to support the Project. This point is further dealt with in the proposed catchment area management plan.

During the operation stage the big questions are: What happens in the deep of the lake? What happens when a great mass of compressed water is released and momentarily decompressed? What happens between the dam and the powerhouse in the 9 km of the Padas river, which is reduced to the compensation flow? What happens when relatively clear water is released to form a river?

5.6.2 ENVIRONMENTAL BASEFLOW

The Upper Padas hydropower Project is a diversion-type hydropower facility which will leave a reach of river between dam and hydropower station outlet dewatered (i.e. aside from compensation flows released from the dam and local inflows from tributaries along that reach). At issue is the setting of the compensation flow to be released from the dam to “re-water” the reach between the dam and power station discharge.

SWECO in its feasibility study[50] suggest a figure of 3 m^3/s while recent advice for a hydropower dam assessment in Sabah (pers com Scott Wilson and Partners, 2007) suggested adoption of either the 10% or 20% natural (pre-dam) low flow condition as a minimum baseflow . DID Sabah in its draft guidelines[51] recommend the environmental baseflow as “10 percentile low flow of the driest month”.

The 10% natural flow condition, derived from the hydrological modelling based on 20 years of simulated runoff at the Dam Site was estimated at 16 m^3/s. For the purpose of this study, two different environmental baseflow releases have been investigated in the reservoir operation modelling:

- 3 m^3/s as recommended in the feasibility study.
- 16 m^3/s calculated as the 10 percentile low flow (90% exceedance flow) at the dam site.

It is generally accepted internationally that river systems will suffer irreversible damage if the flow over a longer period drops to below the 90% exceedance flow calculated on the annual mean (Orth, D.J and O.E.Maughan. 1981; Wentworth, R. 2008). Above this level, species diversity can be maintained even though the volume of aquatic life will drop proportionally. Other thresholds, such as the lowest 7 day period over 10 years have been tested but found unsuitable. The international experience corresponds with that of Chemsain’s consultants locally. It is noted that the Department of Irrigation and Drainage of Sabah has approved the 90% exceedance flow.

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[50] *Feasibility Study on Upper Padas River Hydropower Project – Final Report”, SWECO International, November 2000.*

[51] *Draft guidelines for the assessment of sustainable level of water uses, DID Sabah.*

To maintain the dewatered channel healthy Chemsain's recommendation is thus the 90% exceedance flow based on the annual mean runoff, i.e. 16 m^3/s.

5.6.3 DAM

The main impact of the dam during operation is the very reason for building it: To raise the water level of the river so there is a head that may be utilised for power generation. In principle, the flow of the river before the reservoir and after the power station is as it has always been except that seasonal variations are evened out. There are no major activities surrounding the dam, so there is no significant environmental impact apart from the creation of the reservoir.

5.6.3.1 SPILLWAY OPERATION

Occasionally, when there is too much water in the reservoir, it will be released over the spillway, creating a tall waterfall. The spillway is designed to break the falling water just before it hits the riverbed below, thus controlling erosion, which would otherwise undermine the entire structure of the dam.

Impact:

- Fishes that go over the edge will have little chance of surviving but this will not be at a level that threatens any fish population.
- The water will be aerated on its way down the spillway and when hitting the flip bucket, a cloud of mist may be created. If this becomes a frequent event, the surrounding vegetation habitat will change to types that thrive in misty conditions.
  - Mitigation: Mitigation is built into the standard design of the spillway and flip bucket.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.6.3.2 RISK OF DAM BREACH / FAILURE

The proposed Upper Padas dam structure is provisionally a roller compact concrete dam (RCC). RCC dams have demonstrated a high degree of reliability and a longer life compared to other types of dam structure. This includes increased structural stability and a reduction in seepage through or under the structure. The concrete used is not susceptible to internal erosion or failure due to overtopping. No RCC has yet failed worldwide.

A recent risk assessment of dams (Chauhan and Bowles, 2003[52]) provides an indicative risk of failure of an RCC dam to be 7×10^{-5} per year, or once in 10,000+ years. This estimate is site specific; factors such as higher risk of earthquake, poor construction techniques and terrorist / deliberate dam destruction are variable. Nevertheless, the

[52] *Proceedings of the Australian Committee on Large Dams Risk Workshop, Launceston, Tasmania, Australia. October 2003. Dam Safety Risk Assessment with Uncertainty Analysis. Sanjay S. Chauhan and David S. Bowles.*

likelihood of dam failure is expected to be very rare. Furthermore, the likelihood of a sudden and rapid failure of a large portion of the dam is expected to be even rarer.

The most likely form of dam failure (although still unlikely) is one where a specific feature of the structure fails, while the overall integrity of the dam is maintained. The consequences upon downstream flooding in such instances are generally not severe and are considered to be an aspect of structural design. These include:

- Underestimation of Probable Maximum Precipitation and Probable Maximum Design Flood.
- Erosion and leakage through foundations.
- Capacity of spillways.
- Gated spillways, and their appropriate operation and sensitivity to debris blockage.
- Damage to spillway.

The timing of the flood wave from a catastrophic dam failure is initially dependent upon the nature and timing of the dam failure mechanism. The propagation speed would be relatively uniform in the upper and mid reaches of Padas River, but would slow as it reaches the flatter, wider floodplain areas due to the change in gradient and the storage effects of floodplain inundation.

Inundation of the floodplains would continue for several days following arrival of the flood wave front. Damage from a catastrophic dam failure could potentially be disastrous for riverside communities within the 70 km distance from the Upper Padas dam down to Tenom (Tenom will be reached by the wave front in approximately 6.5 hrs). Continuing on downstream, attenuation effects would progressively reduce the force and destructiveness of the flood wave occurring. Note that the wave front will eventually reach Beaufort in 11.25 hrs with attenuated and delayed peak discharges.

Impact:

- Structural failures, which may be anything from a broken pipe to the unthinkable total dam failure and its catastrophic consequences.
  - Mitigation: Creation of an emergency response organisation and emergency response plan. Such plan is included in **Appendix 2-12: Emergency Response Plan**.
  - Mitigation: Disclosure of all risks and communication with all potentially affected groups.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	3	3	3
Overall significance	Significant		

5.6.4 RESERVOIR

5.6.4.1 *ACCESS*

Increased encroachment, extraction of timber etc. may occur due to improved access to areas of primary forest surrounding the site. However, the probability would be low as the areas of primary forest around the dam area are very steep. Vegetation survey conducted in the area shows that the proposed site contains nearly 13 species with commercial and economical value. Therefore, the vegetation adjacent to the Project site is expected to contain similar significant species.

Impact:

- The improved access area would make it easier for irresponsible parties to enter the forest reserve area and to conduct any illegal timber extraction. Illegal timber extraction or other forest product may *i.a.* result in: Habitat degradation or loss; Erosion; Reduced biodiversity; Introduction of weeds.
  - Mitigation: Limitation of access points to one gated entry.
  - Mitigation: Monitoring through patrolling, check points.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	3
Overall significance	Moderate		

5.6.4.2 *IMPACT ON DOWNSTREAM WATER LEVELS AND FLOWS*

Numerical modelling was carried out in order to simulate various dam operations and the resulting reservoir water level variations and the effect of this operation on the downstream flows and water levels. The purpose of the model is to simulate the hydraulic response of the reservoir inflow and hydropower operations (refer **Appendix 1.4** and **2.5** for full details on the numerical model setup).

From an environmental perspective, over and above the adopted environmental baseflow, the natural flow conditions should be mimicked to a degree in the operational discharge rules so as to limit impacts in the dewatered reach of the river. From a power optimisation perspective, minimising the environmental flows during dry periods would be preferable. The overall reservoir operation strategy investigated in this study has, with some modifications, been derived from[50] (refer **Section 7.3**):

1. For water levels between Lower Storage Level (LSL) and Upper Storage Level (USL): Normal operations, with
   - Discharges (power production and environmental releases) equal to the "dependable" discharge (estimated at 51 m^3/s)[53].

[53] *The "dependable" discharge at N% reliability is defined as the discharge that can be maintained during N% of the operation time. With an USL of 470 meter the 95% dependable discharge was estimated at 51 m^3/s, refer /50/*

- Turbined discharges varying from "dependable" discharge to the turbines maximum capacity.

2. For water levels below LSL: Gradually varying between the environmental release (i.e. the 10% low flow or 3 m^3/s) to a release equal to the inflow.
3. For water levels above the USL: Total inflow is released.

In addition, two alternative reservoir operation strategies were considered with fixed and variable discharges at the turbines. The operation rules investigated in the reservoir operation simulations are summarised in **Table 5.6-1** (fixed turbine discharge) and **Table 5.6-2** (variable turbine discharge) with the reservoir operations simulations summarised in **Table 5.6-3**.

Table 5.6-1 Fixed Turbine Discharge

Reservoir level	Turbines	Spillway + env. flow
H > 470 m	Q = 70 m^3/s;	Q out = Q in
430 < H < 470 m	51 m^3/s minus environmental flow	Environmental flow (3 m^3/s or 16 m^3/s)
Inflow- env. flow > 0	Inflow minus env. flow	Environmental flow
Inflow- env. flow < 0	0	Q out = Q in

Table 5.6-2 Variable Turbine Discharge

Reservoir level		Turbines	Spillway + env. flow
H-reservoir > 470 m		Q = 70 m^3/s;	Q out = Q in
H-reservoir > 430 m	470	70	Environmental flow
	465	50	
	460	48	
	445	42.5	
	439	39.5	
	430	17 – env. flow	
Inflow – env. flow > 0		Inflow – env. flow	Environmental flow
Inflow – env. flow < 0		0	Q out = Q in

Table 5.6-3 Reservoir operation simulations

Model set-up ID	Environmental Flow (m^3/s)	Turbine discharge (T) (m^3/s)
Mod 1-1	3	Fixed at 48 (51 m^3/s minus 3 m^3/s)
Mod 1-2	3	Variable as per **Table 5.6-2**
Mod 2-1	9.4	Fixed at 42 (51 m^3/s minus 9 m^3/s)
Mod 2-2	9.4	Variable as per **Table 5.6-2**

All reservoir operations simulations cover the period from 1 January 1989 to 31 December 2008 (i.e. 20 years of simulation).

Results for the baseline and operation stage simulations are presented in the following in terms of time series plots, flow frequency tables and curves as well as bar charts (average monthly) of discharges and water levels[54] extracted at various locations namely upstream and downstream of the proposed reservoir, Kemabong, Tenom and Beaufort.

5.6.4.3 UPSTREAM OF RESERVOIR

Reservoir level frequency curves are shown in **Figure 5.6.2** and tabulated in **Table 5.6-5**. For the 4 mods investigated it can be seen that the full reservoir level (> 469 m) can be maintained from 20 to 30 % of the time. It is noted that mods 1-1 and 2-1 are almost similar as they are both considering a fixed turbine discharge at 51 m^3/s (**Figure 5.6.3**). In Mods 1-2 and 2-2, because the turbine discharge is a function of the reservoir level (except for reservoir levels below 439 m), a higher variability in reservoir levels can be noticed (refer **Figure 5.6.4**).

For all scenarios, the reservoir level can reach the MOL, with the longest period occurring during the 1998 drought event. With variable turbine discharges, low reservoir levels (i.e. near MOL) are less frequent and less prolonged in comparison with fixed turbine discharges (**Figure 5.6.5**).

For all scenarios, spilling (i.e. flow > environmental flow) to the de-watered channel will occur frequently (**Table 5.6-4**). For Mod 1-1, spilling will occur 37.6% of the time (about 4.6 months per year), while for Mod 2-1, spilling will occur 25.5% of the time (about 3.1 months per year). With variable turbine discharges however, spilling is less frequent and less prolonged with spilling occurring 9.8 % of the time (about 1.2 months per year) for mod 2-2 (**Figure 5.6.6**).

Table 5.6-4 Spilling Duration at Reservoir

Level Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
Duration of Spilling (%)	-	37.6	19.8	25.5	9.8
Maximum duration of Spilling (days)	-	115	38	36	29
Average duration of Spilling (days)	-	8	2	3	1

[54] *Upstream of the proposed reservoir only.*

Table 5.6-5 Reservoir Level Frequency

Level Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
1 percentile level	-	430.0	434.1	430.0	430.0
10 percentile level	-	448.1	448.2	444.3	435.3
20 percentile level	-	458.9	455.9	455.6	442.2
30 percentile level	-	464.9	460.7	461.3	448.8
40 percentile level	-	468.1	463.4	464.8	454.0
50 percentile level	-	469.6	465.4	467.2	458.6
60 percentile level	-	470.0	467.0	468.8	462.7
70 percentile level	-	470.0	468.5	469.9	465.5
80 percentile level	-	470.0	469.8	470.0	468.1
90 percentile level	-	470.0	470.0	470.0	470.0
95 percentile level	-	470.0	470.0	470.0	470.0
99 percentile level	-	470.0	470.0	470.0	470.0
Average	-	464.0	462.2	462.2	455.5
Maximum	-	470.6	470.9	470.9	470.9
Minimum	-	430.0	431.4	430.0	430.0

Figure 5.6.2 Reservoir Level Frequency Curves

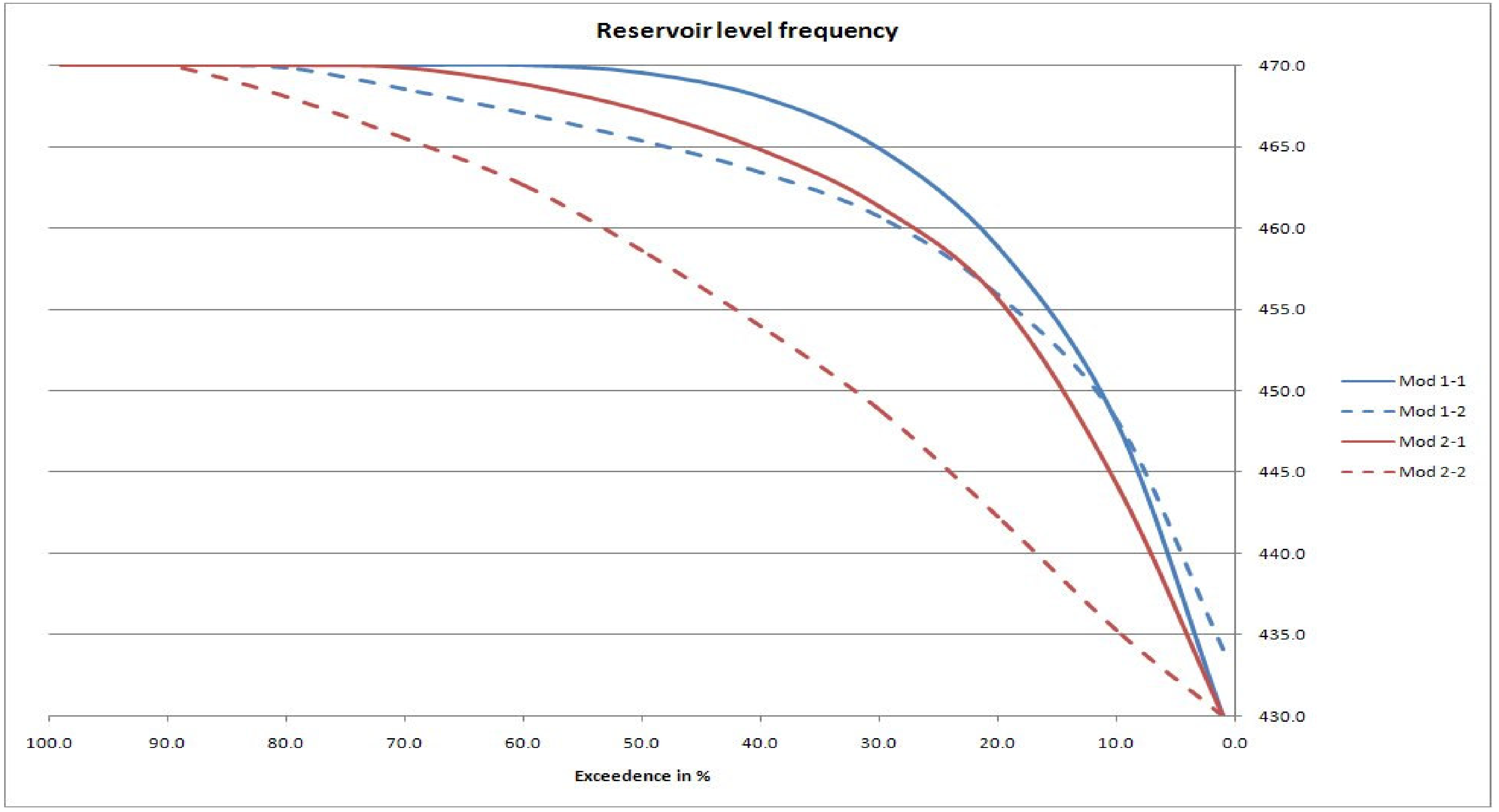


Figure 5.6.3 Simulated Reservoir Water Levels for Mod 1-1 (blue) and Mod 2-1 (red)

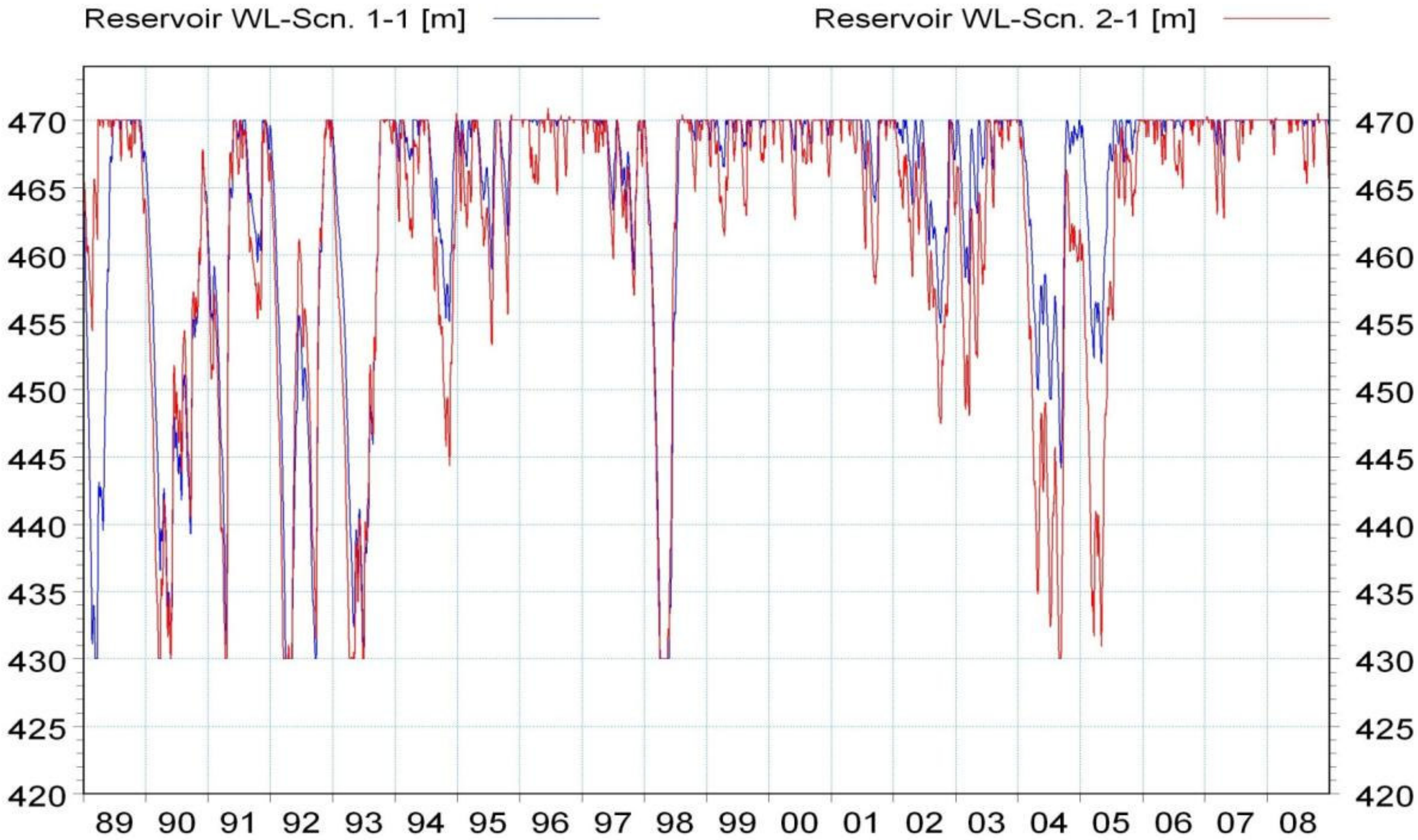


Figure 5.6.4 Simulated Reservoir Water Levels for Mod 1-2 (blue) and Mod 2-2 (red)

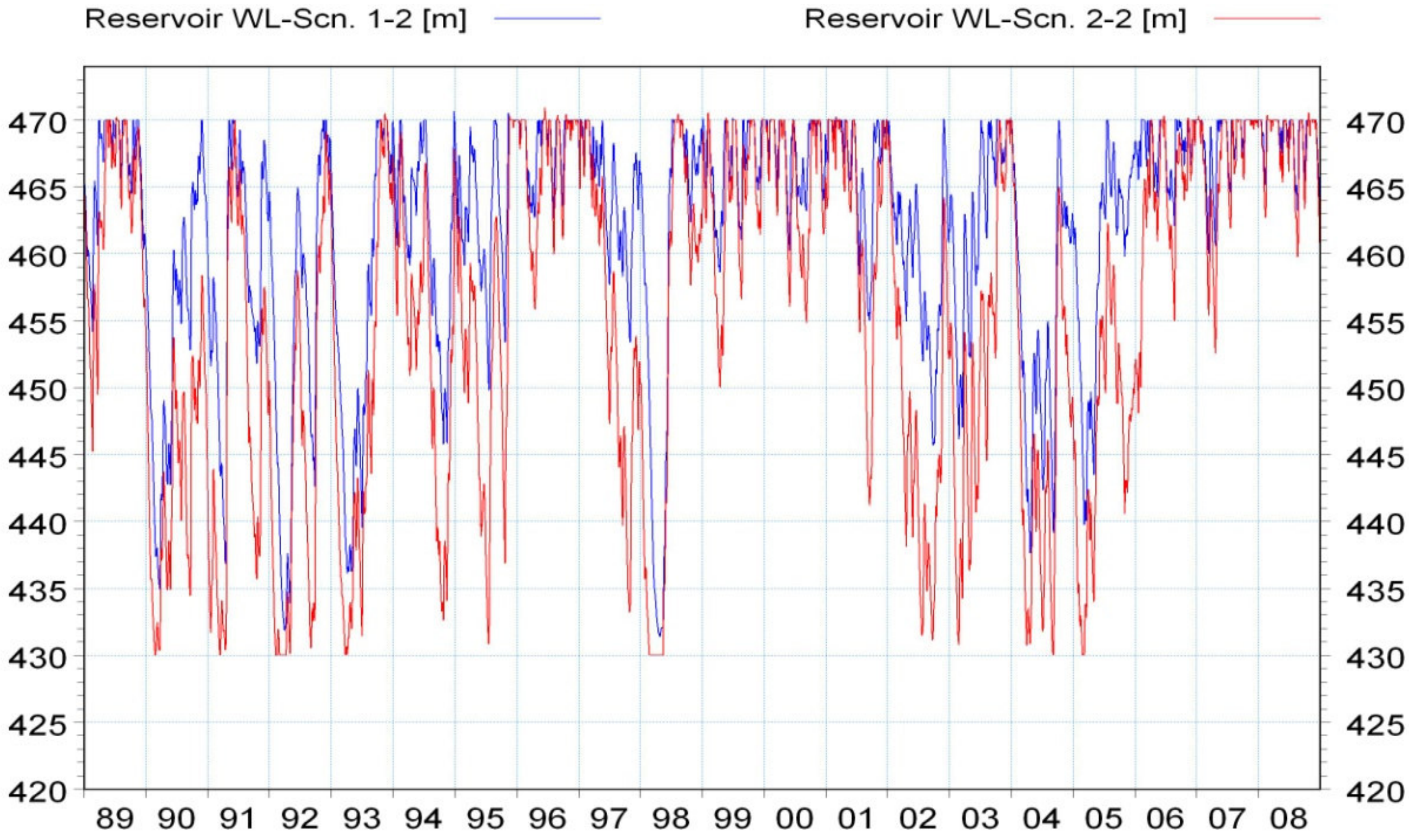


Figure 5.6.5 Simulated Reservoir Water Levels for Mod 2-1 (blue) and Mod 2-2 (red)

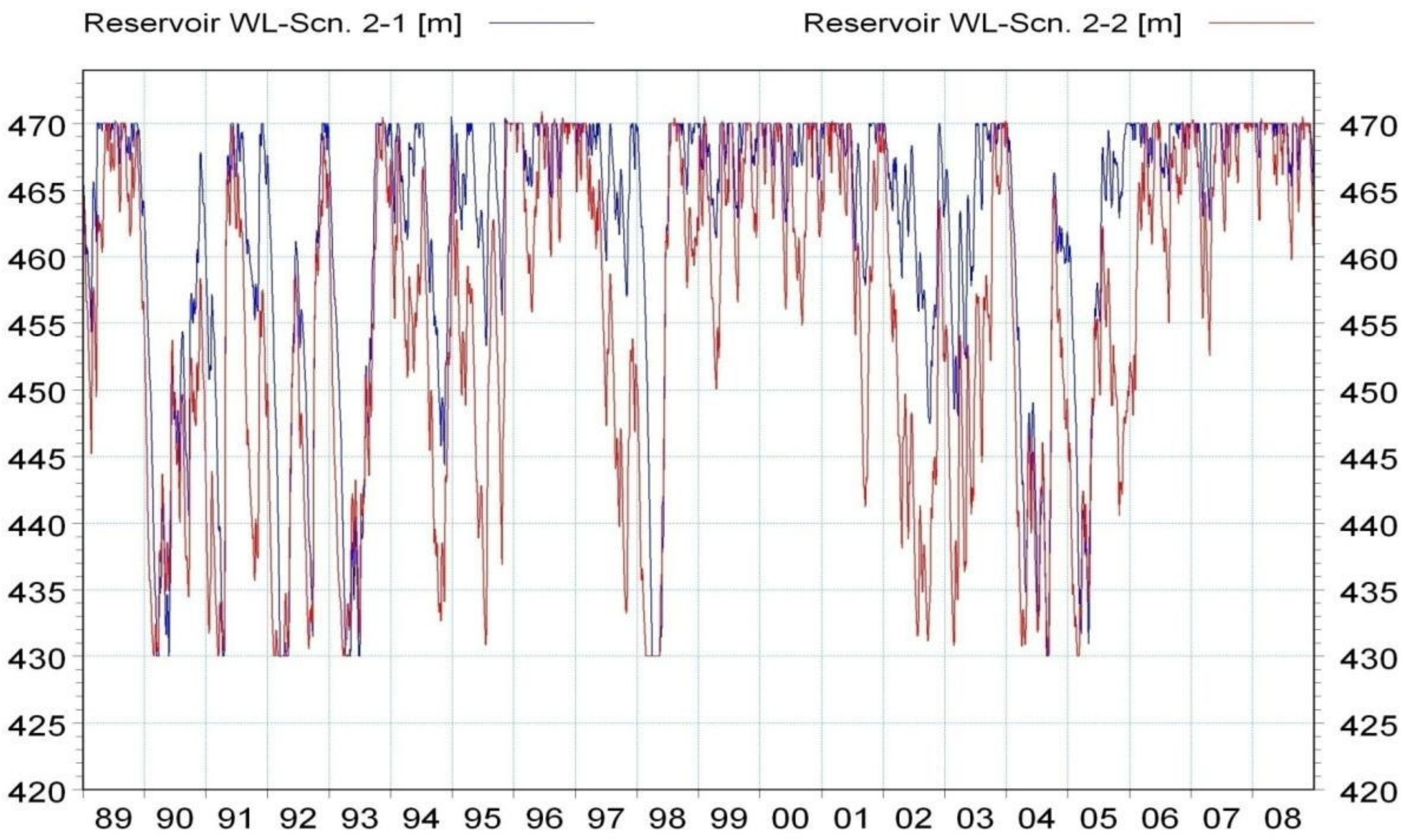
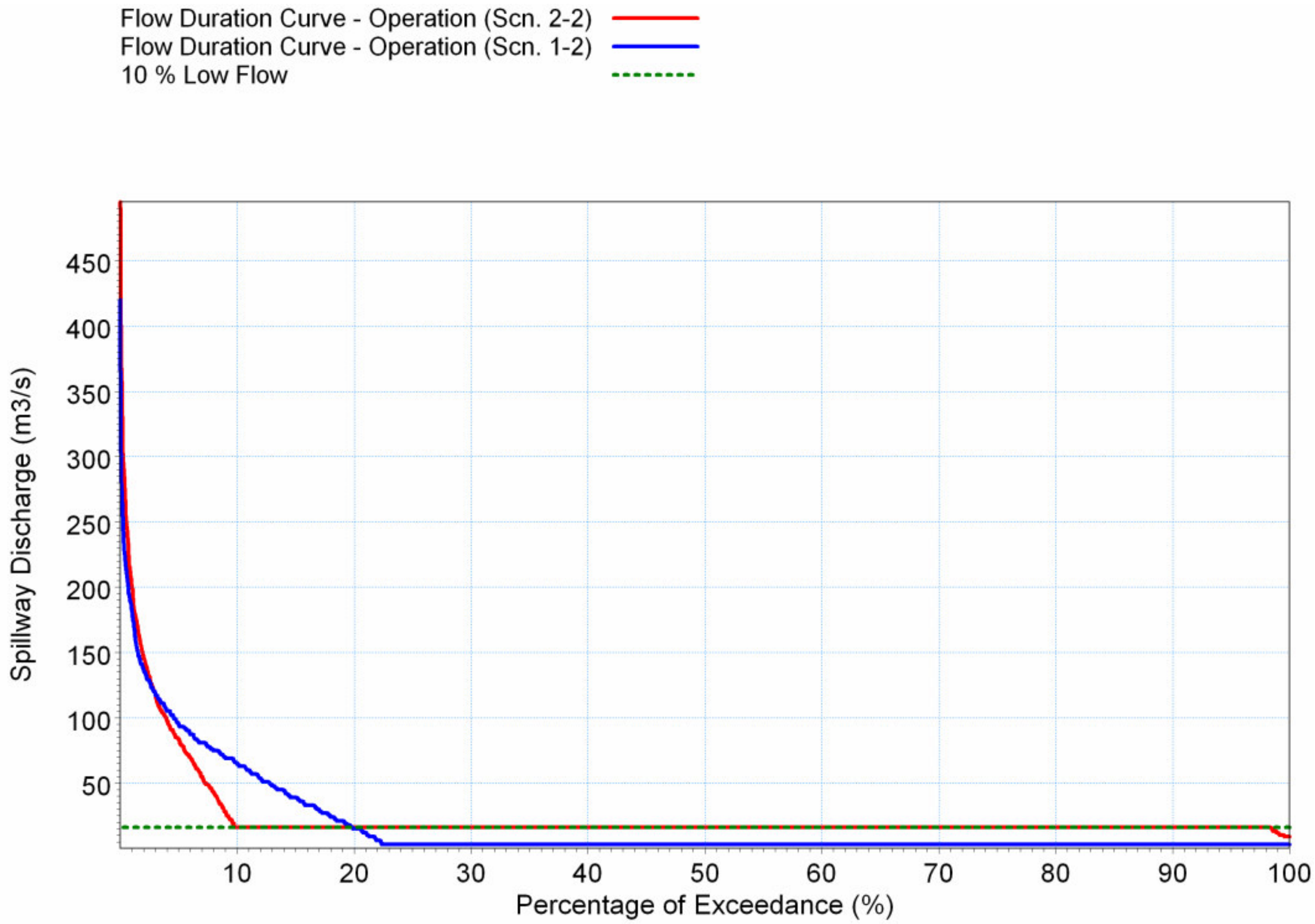


Figure 5.6.6 Spill Duration Curves for Mod 2-2 (red)



Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

5.6.4.4 Downstream of Reservoir

During the operation stage, a significant reduction of the "low to average" flow conditions between the dam site and the powerhouse is anticipated. During approximately 60 to 70 % of the time, the discharges will be equal to the environmental releases. It is noted that even during the three driest months – March to May – the monthly average flows are significantly higher than the minimum releases (refer **Table 5.6-6**).

The maximum discharge reduces from the baseline of 620 to 524 m^3/s (e.g. slightly more than the discharge going through the turbines) while the 95 and the 99 percentile are reduced by approximately 40 and 26 %, respectively.

The "Mod 2-1" reservoir operations rules set out in **Table 5.6-3** will give the highest flows between the reservoir and the powerhouse, while the "Mod 1-2" will give the lowest (**Figure 5.6.7**).

Figure 5.6.7 Monthly Average Releases from Reservoir

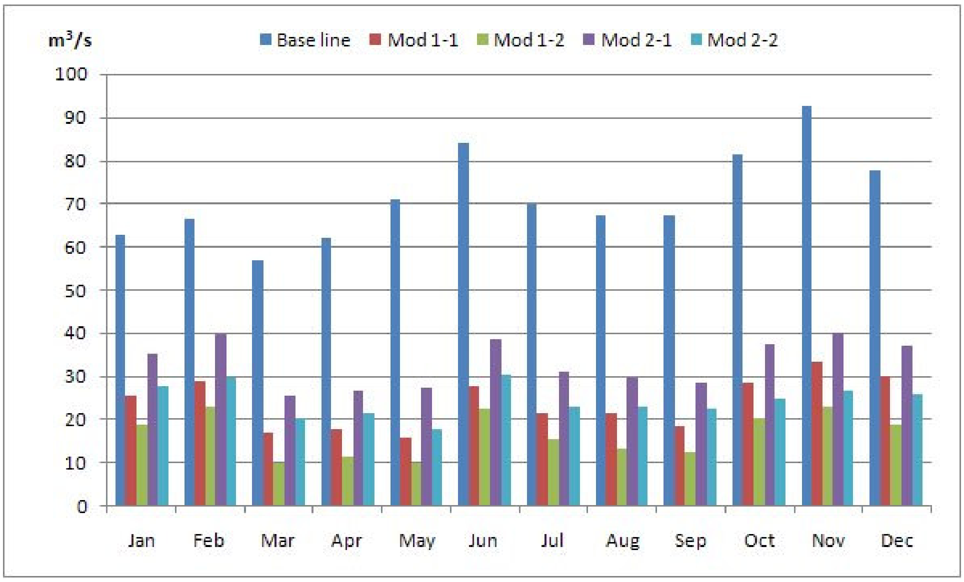


Table 5.6-6 Flow Frequency Table of Reservoir Releases (m^3/s)

Flow Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
1 percentile flow	11.9	3.0	3.0	14.1	11.6
10 percentile flow	15.5	3.0	3.0	16.0	16.0
20 percentile flow	20.8	3.0	3.0	16.0	16.0
30 percentile flow	29.5	3.0	3.0	16.0	16.0
40 percentile flow	39.6	3.0	3.0	16.0	16.0
50 percentile flow	52.4	3.0	3.0	16.0	16.0
60 percentile flow	67.4	3.0	3.0	16.0	16.0
70 percentile flow	87.3	18.0	3.1	16.1	16.0
80 percentile flow	115.2	42.0	3.1	34.5	16.1
90 percentile flow	155.1	79.2	54.2	85.1	16.2
95 percentile flow	189.5	109.2	101.8	123.2	84.0
99 percentile flow	284.7	189.1	213.5	170.6	147.5
Average	71.6	23.9	16.6	33.1	24.5
Maximum	620.1	420.0	524.2	524.2	524.2
Minimum	10.9	3.0	3.0	8.9	9.0

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

5.6.4.5 KEMABONG

Kemabong is located approximately 46 km downstream of the reservoir and 22 km downstream of the power house.

The monthly average discharges shown in **Figure 5.6.8** exhibit a noticeable reduction of the average discharges during the wet period (e.g. June, October and November). In January and February the average discharges increase by approximately 10 %. During these months the reservoir level is still close to the maximum level allowing a relative high power production. During the dry months of March and April the effect of the reservoir is negligible. Also, little differences can be seen between the different reservoir operations scenarios investigated in terms of monthly average discharges.

The absolute minimum flow is hardly affected by the proposed reservoir. The 10% low flow increases by approximately 100% (i.e. from 26 m^3/s to about 60 m^3/s, refer **Table 5.6-7**). The 90 percentile flows are reduced by between 10 to 20 % depending on the scenarios.

Figure 5.6.8 Monthly Average Discharges at Kemabong

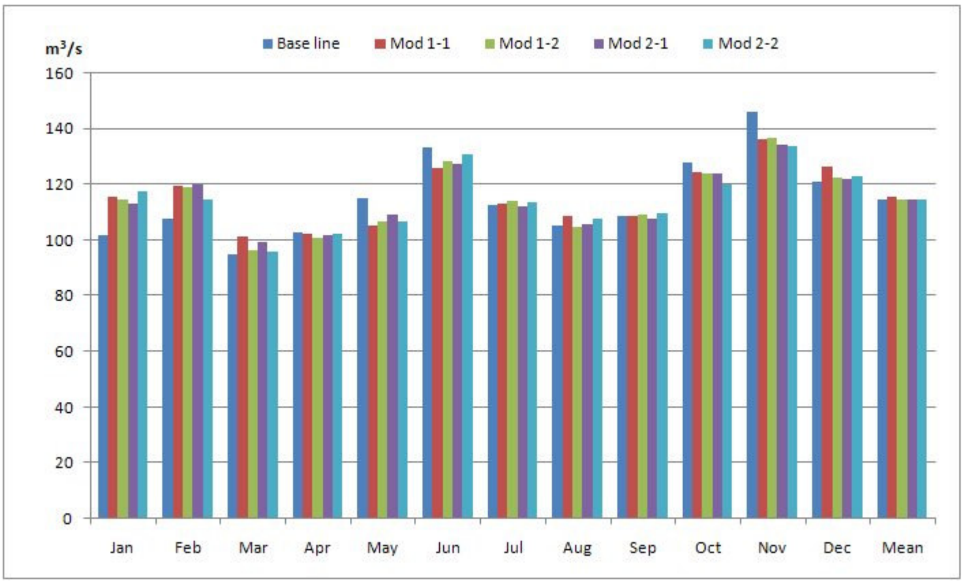


Table 5.6-7 Flow Frequency at Kemabong

Flow Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
1 percentile flow	19.4	30.0	34.7	25.6	20.8
10 percentile flow	26.0	63.9	59.4	60.2	59.3
20 percentile flow	35.4	68.2	65.0	63.5	72.2
30 percentile flow	49.6	72.7	72.9	68.8	79.1
40 percentile flow	65.1	78.0	80.6	75.6	86.9
50 percentile flow	84.8	86.5	89.2	83.6	95.8
60 percentile flow	108.2	99.9	100.6	95.9	107.5
70 percentile flow	139.1	121.2	116.9	115.5	121.8
80 percentile flow	181.7	154.3	143.0	147.0	141.3
90 percentile flow	243.6	214.9	203.4	217.4	183.1
95 percentile flow	296.3	260.0	268.6	280.6	244.3
99 percentile flow	447.3	380.7	434.6	359.6	338.9
Average	114.5	115.2	114.4	33.1	114.4
Maximum	1,097.7	860.4	1,070.7	524.2	1070.7
Minimum	17.5	11.9	21.1	8.9	17.4

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	3
Overall significance	Significant		

5.6.4.6 TENOM AND BEAUFORT

At Tenom and Beaufort further downstream, the influence from the proposed reservoir is reduced. In terms of changes in flow percentiles, the trends observed at Kemabong are similar but of lesser magnitude, with lower high flows and higher low flows (refer **Figure 5.6.9**, **Figure 5.6.10**, **Table 5.6-8** and **Table 5.6-9**).

Figure 5.6.9 Monthly Average Discharges at Tenom

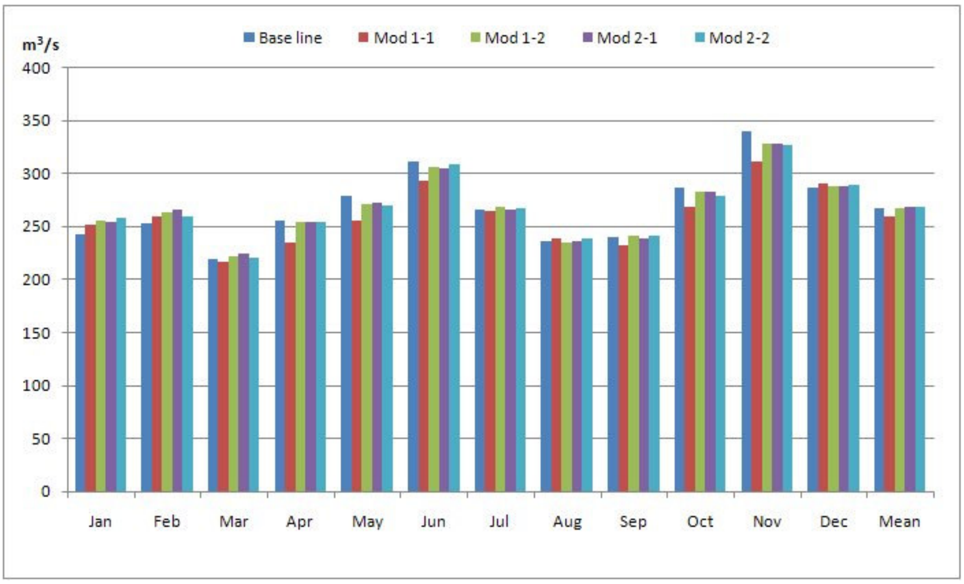


Figure 5.6.10 Monthly Average Discharges at Beaufort

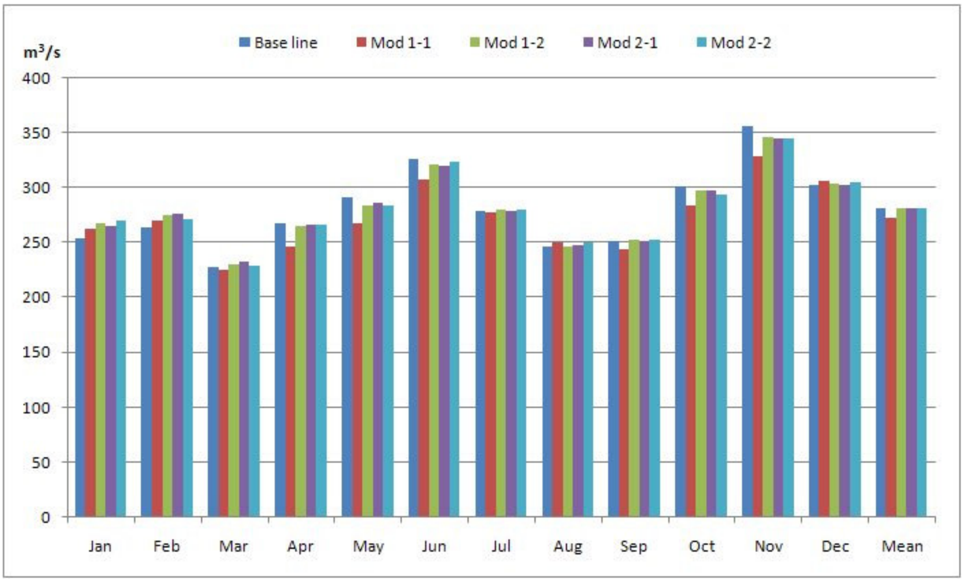


Table 5.6-8 Flow Frequency at Tenom

Flow Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
1 percentile flow	55.7	74.7	74.3	69.2	57.2
10 percentile flow	83.6	123.6	116.0	115.1	118.7
20 percentile flow	112.0	146.4	139.3	136.3	143.5
30 percentile flow	142.4	167.6	160.8	157.2	166.5
40 percentile flow	177.1	188.3	189.7	184.1	194.3
50 percentile flow	217.8	216.2	218.8	214.6	224.4
60 percentile flow	265.1	248.6	255.5	252.8	259.3
70 percentile flow	323.2	289.7	303.6	302.0	303.8
80 percentile flow	402.3	359.0	372.2	375.4	368.3
90 percentile flow	518.0	458.8	484.8	492.3	475.6
95 percentile flow	622.3	558.1	596.6	605.7	576.9
99 percentile flow	870.8	770.7	846.2	751.2	729.0
Average	267.2	259.2	267.2	267.2	267.3
Maximum	1,894.6	1537.4	1,862.7	1862.7	1862.7
Minimum	47.4	21.1	49.6	47.5	47.3

Table 5.6-9 Flow Frequency at Beaufort

Flow Frequency	Baseline	Mod 1-1	Mod 1-2	Mod 2-1	Mod 2-2
1 percentile flow	59.1	76.8	9.0	77.5	61.7
10 percentile flow	88.8	129.0	121.3	120.4	124.7
20 percentile flow	119.2	153.6	146.0	142.7	150.9
30 percentile flow	151.4	175.9	169.3	166.4	175.0
40 percentile flow	186.8	198.3	199.5	195.4	204.6
50 percentile flow	228.3	228.0	231.1	227.4	236.6
60 percentile flow	279.1	262.1	269.3	267.3	273.6
70 percentile flow	341.1	305.4	319.4	318.6	321.7
80 percentile flow	419.2	378.6	390.8	394.1	386.8
90 percentile flow	538.7	480.7	506.7	516.2	498.0
95 percentile flow	648.3	580.9	615.4	632.6	594.0
99 percentile flow	901.7	799.4	877.2	777.4	748.9
Average	280.1	271.9	280.2	280.2	280.3
Maximum	1,920.1	1553.5	1,885.1	1885.1	1885.0
Minimum	50.0	22.2	52.2	50.0	49.9

Arising from the reservoir operation modelling, the following conclusions with respect to the impact of the proposed reservoir on downstream water levels and flows can be drawn:

- Overall, because the reservoir live storage capacity is significant (i.e. 220 million m^3), the attenuation and storage effects will reduce the variations in downstream water levels discharges. In other words, during the operation stage, a lowering of flood levels and rising of drought levels are anticipated (i.e. higher low flows and lower high flows). The reduction in flow variability will result in a positive impact from a socio / human environment perspective; however, it may have consequences upon other environmental aspects such as aquatic organisms.
- The reservoir operation rules (in terms of environmental release and discharge at the turbines) will only have a significant impact in river flows and water levels in the dewatered reach (14.7 km) of Sg. Padas (i.e. between the reservoir and the powerhouse). Further downstream, (i.e. Kemabong, Tenom and Beaufort), the variability in the operation rules investigated have nominal impacts on downstream flows.
- The reservoir operation rules “Mod 2-2” set out in **Table 5.6-3** are recommended (i.e. environmental flow at 10th percentile and variable turbine discharge)[55]. These operational rules demonstrate a reasonable compromise between hydropower generation and maintenance of the baseline water quality in the dewatered reach of the river (refer to **Section 5.6.4.9: Downstream Riverine Water Quality**).
- Whereas the Project is primarily intended as a hydro generation facility, it has the potential to be operated in a manner which provides a level of flood control downstream. This is potentially important, given the serious flooding that occurs periodically in the towns of Tenom and Beaufort. The degree of flood attenuation achievable will depend on the mode of operation of the reservoir – for example, operating near the bottom of the live storage zone (i.e. 40 m below the normal top water level during the flood season, to provide flood storage) would be beneficial in terms of maximising the degree of flood control, but this would be at the expense of power generation output (i.e. due to the lower generating head). Input would be required from DID before this flood control potential could be more accurately quantified and decisions taken on the flood control imperatives to design into the Upper Padas Project.
- The modified flow regime in Sg. Padas will have effects on the Tenom Pangi hydroelectric power plant, 74 km downstream from the proposed Project, and further downstream, e.g.: The appreciable reservoir storage at Upper Padas will lead to changes in the ‘run-of-river’ mode of operation at Tenom Pangi, especially reduced spill.
- The trapping of sediment by the Upper Padas reservoir will reduce the sediment reaching Tenom Pangi, and potentially the amount passing through Tenom Pangi, and further downstream; i.e. there may be some effect on the river channel morphology downstream from Tenom Pangi and further downstream.

[55] *It is noted that the optimization of the reservoir operation rules with respect to hydropower production and/or flood control is beyond the scope of this study.*

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	1	1	3
Overall significance	Moderate		

5.6.4.7 WATER QUALITY IMPACT

5.6.4.8 RESERVOIR WATER QUALITY

Given that the Upper Padas live reservoir storage is equivalent to about 36 days at the mean flow rate, the average retention time is moderately long.

Temperature profiles for normal and low flow conditions have been extracted at the Dam Site, Point 4 and Point 3 (**Figure 5.6.11**). The temperature profiles, shown in **Figure 5.6.12**, indicate a steep thermocline with little spatial variation. The thermocline is situated approximately 10 m below the surface. Below the thermocline there is a thick layer of cooler, denser water with little differences between the normal and low-flow conditions. Temperature curves are virtually identical from one location to another within the reservoir. The model results indicate no sign of any vertical turn over in the water column i.e. flopping where cool deep water mixes with warmer shallow water, resulting in a removal of the thermocline during either normal or low flow conditions.

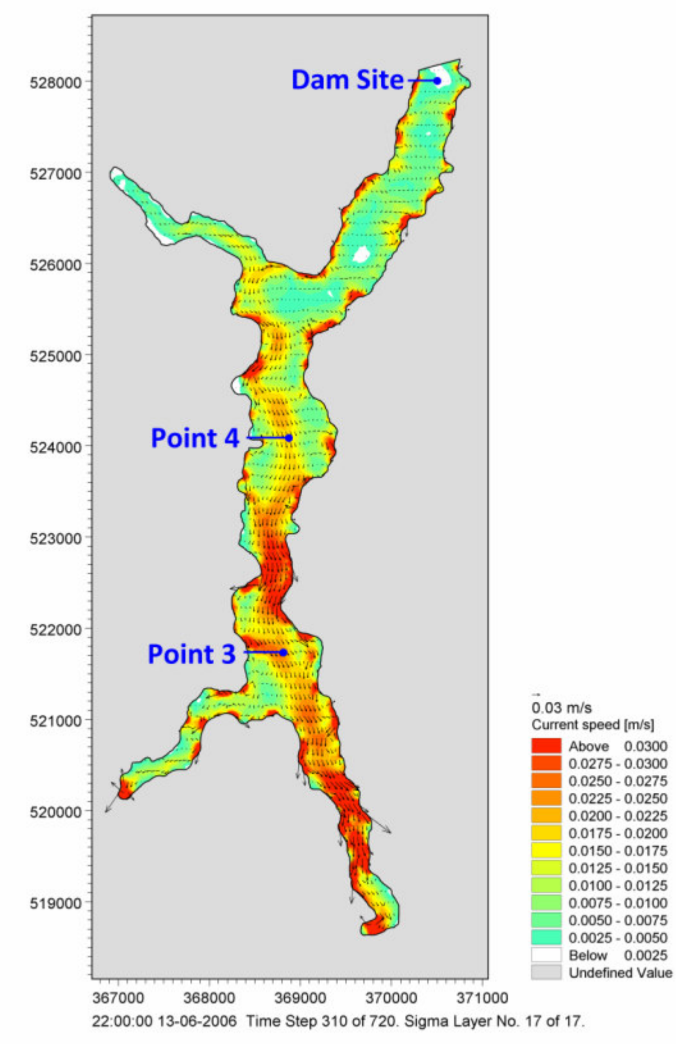


Figure 5.6.11 Location of Extraction Points for Assessment

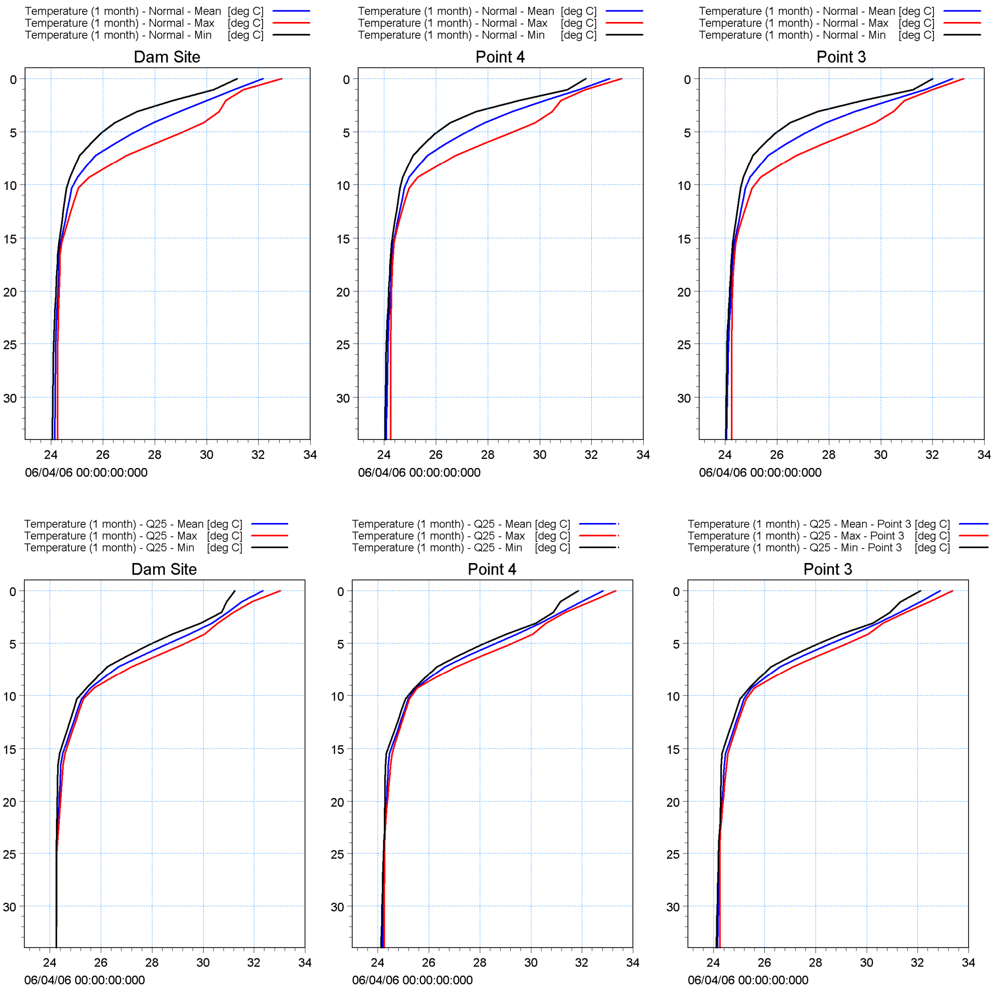


Figure 5.6.12 Temperature Variation Over Time with Water Depth at Dam Site, Point 4 and Point 3. TOP: Normal Flow; Bottom: Low Flow

Dissolved Oxygen. Vertical profiles of Dissolved Oxygen (DO) at the dam site, Point 4 and Point 3 are presented in **Figure 5.6.13**. DO concentrations are between 3-6.5 mg/l in the first 5 m depth of the water column at the dam site and position 4 and 3 for both the typical condition scenario and low flow scenario. Oxygen levels in the upper few meters of the reservoir are within the Malaysia Interim National Water Quality Standard for a healthy water body Class IIA (INWQSM).

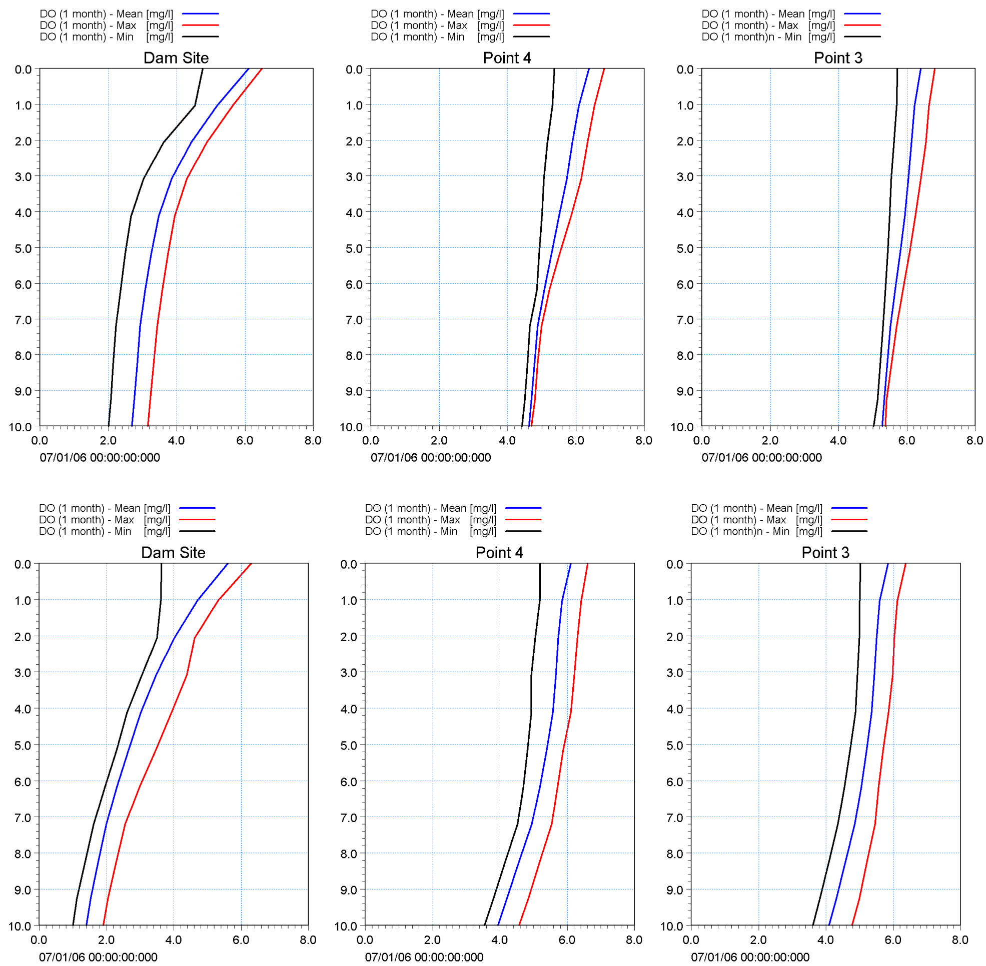


Figure 5.6.13 Simulated DO Vertical Profile Results and Basic Statistics from the Dam Site, Point 3 and Point 4. TOP: Normal Flow; Bottom: Low Flow

Chlorophyll-a. The model predicts Chlorophyll-a concentrations of 2-6 µg/L during both normal and low river flow periods in the upper 10 m of the water column in the reservoir. These relatively low predicted chlorophyll-a concentrations indicate that there will be no potential problem with surface algal blooms in the Upper Padas reservoir.

Summary

Table 5.6-10 is a summary of the main water quality results as simulated by the Ecolab/water quality model. Included in this table are predictions of Faecal Coliform and Total Coliform counts. All simulated results are below the acceptable levels of Class IIA water bodies in Malaysia, indicating that the reservoir water is expected to be of good quality and suitable for aquatic organisms to live and breed in. However, the TSS within the reservoir is expected to be high – simulated TSS indicates slight higher concentration than the acceptable levels of Class IIA water bodies in Malaysia.

Table 5.6-10 A Summary of the Main Water Quality Finding as Predicted by Simulations during Typical River Flow (73 m^3/sec), and Low River Flow (25 m^3/sec) Periods

Parameters	Unit	Classes		Normal flow		Low flow	
		IIA	IIB	2 m	8 m	2 m	8 m
BOD	mg/l	3	3	<1	<1	<1	<1
DO	mg/l	5 – 7	5 – 7	5.54	3.37	5.43	2.14
Total Suspended Solid	mg/l	50	50	53.81	54.27	-	-
Temperature (C)	^oC	Normal +2 ^0C		28.48	24.78	28.18	26.08
Faecal Coliform	counts/100 mL	100	400	<10	<10	<10	<10
Total Coliform	counts/100 mL	5000	5000	<500	<500	<500	<500
NO_2	mg/l	0.4	0.4	<0.1	<0.1	<0.1	<0.1
NO_3	mg/l	7	7	<0.1	<0.1	<0.1	<0.1

**Shaded boxes indicate level exceeded the stipulated limit.*

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	3	3	1
Overall significance	Moderate		

5.6.4.9 DOWNSTREAM RIVERINE WATER QUALITY

Downstream water quality will be influenced by the following factors:

- Changes in flow conditions due to storage and attenuation effects of the dam.
- Tail water discharge from the power station.

The reservoir will tend to entrap sediments and nutrients. In particular, a reduction in suspended sediment concentrations will improve water quality downstream. If dam discharges are taken from the upper portion of the reservoir, tail water flows are likely to be of good quality and will improve downstream water quality conditions, but this can be offset by poor quality tailwater discharges from deeper layers of the stratified reservoir.

It is noted that the modelling of the reservoir indicates no potentially excessive algal growth; however, this should be continually monitored and if excessive algal growth is detected, discharge from the surface zone should be avoided during algae blooms in order to minimise impacts to the downstream system.

A number of water quality simulations applying the reservoir operation rules as set out in **Table 5.6-3** have been executed. It is noted that the water quality simulations have been carried out applying average concentrations of the individual water quality parameters on the reservoir outflow.

Rather than presenting actual concentrations of each individual water quality parameters, the Water Quality Index (WQI, following the National Water Quality Standards for

Malaysia), was considered in this assessment. The WQIs for each scenario are presented as frequency curves extracted at the same locations used in the water quality impact assessment.

Arising from the riverine water quality modelling, the following conclusions can be drawn on impacts on downstream riverine water quality:

- At the power house, the modelling results show that applying the 10th percentile environmental baseflow will provide a slight improvement in the water quality index (i.e. slight positive impact). The maintenance of the 10th percentile low flow in the dewatered reach is therefore recommended in order to maintain the baseline water quality (refer to **Section 5.6.4.7**).

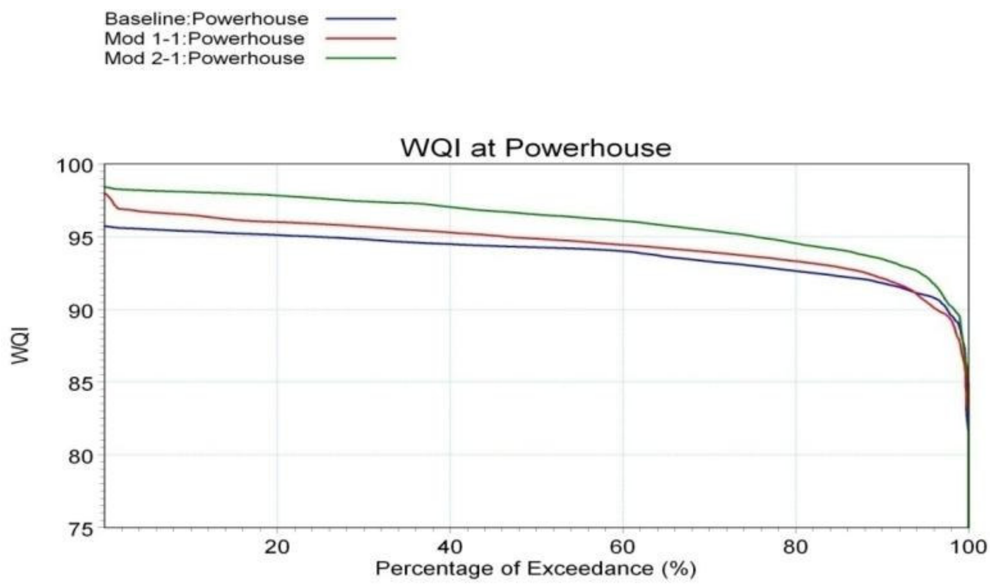


Figure 5.6.14 WQI Frequency Curve - Power House

- At Kemabong, Tenom and Beaufort the different reservoir operation strategies have little effects on the overall riverine water quality (**Figure 5.6.15** to **Figure 5.6.17**).

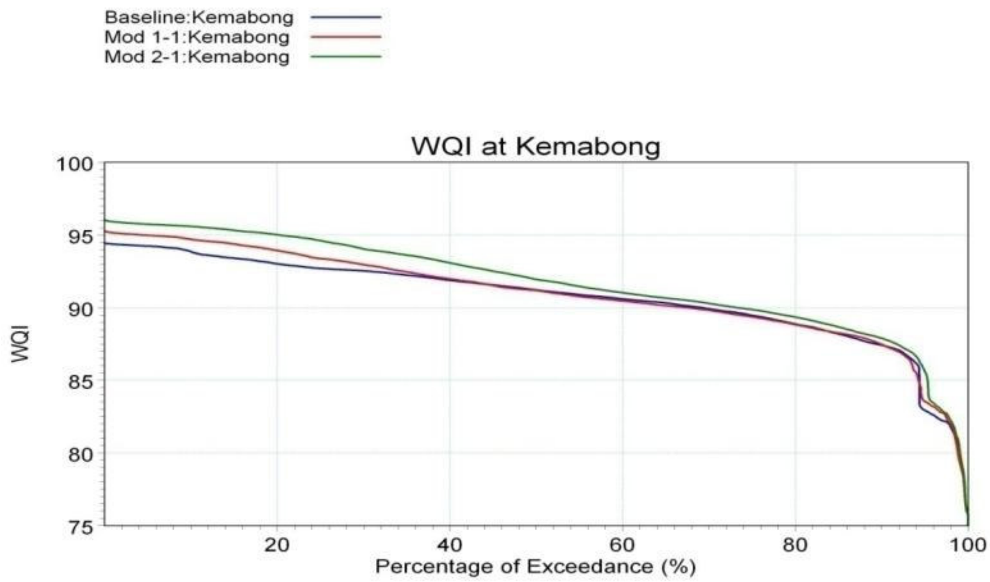


Figure 5.6.15 WQI Frequency Curve – Kemabong

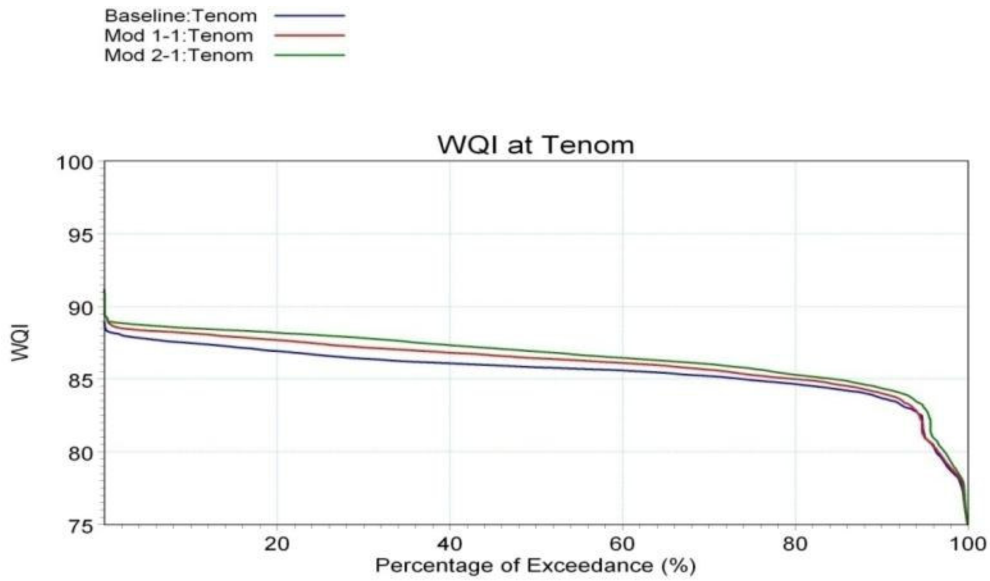


Figure 5.6.16 WQI Frequency Curve – Tenom

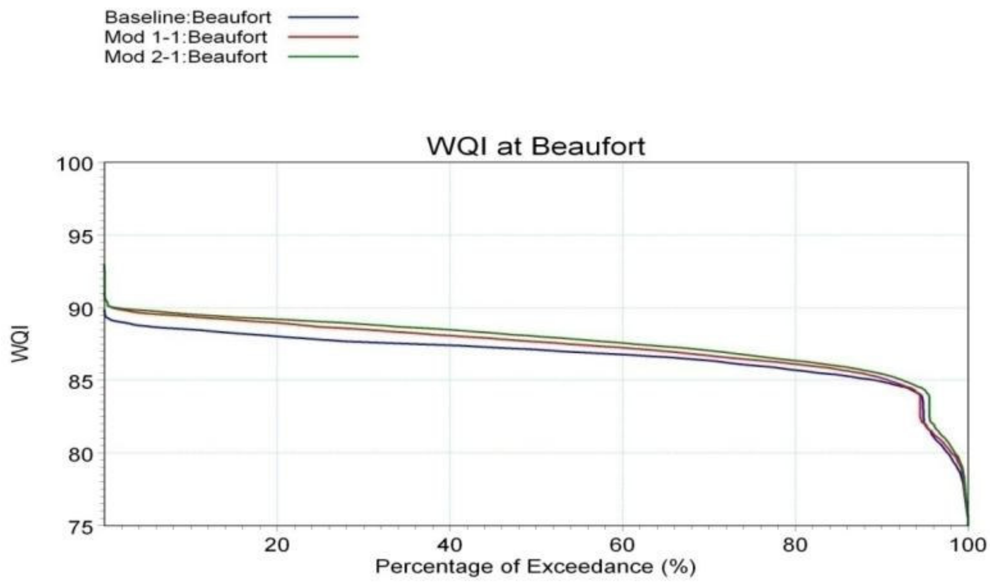


Figure 5.6.17 WQI Frequency Curve - Beaufort

- Overall, as stated in the water quality impact assessment, **Section 5.6.4.7**, the impact on water quality from the reservoir is small and decreases, with the distance from the dam (going downstream).

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.6.4.10 SALINE INTRUSION

Saline intrusion into the lower reaches of Padas River would reduce slightly with the Upper Padas dam operational, subject to there being no significant changes in the mode of operation of the Tenom Pangi hydro station. This is due to the more consistent flow regime in the Padas River achieved by the attenuation effect on flood flows and the boosting of low flows by the Upper Padas Project.

5.6.4.11 AQUATIC FLORA

With the creation of the reservoir, the phytoplankton and periphyton composition the part of the Padas River to be inundated by the reservoir is, as mentioned in **Section 5.5.1**, expected to change from lotic composition to lentic composition.

The low population in the surrounding settlement and minimal agricultures activities in the nearby catchment areas will not contribute significantly to the nutrient enrichment in the reservoir. Neither will the Sabah Forest Industries application of fertilizers as these are only used at the time of planting and in that activity, the fertilizers are applied into the planting hole before this is filled with soil. Lotic ecosystems such as lakes and ponds are often an ideal habitat for phytoplankton growth. Thus, a higher primary production is expected in the reservoir compared to the present primary production in the Padas River in this section. However, the increase of primary productivities will be within the acceptable level based on the model on chlorophyll a within the 10 m depth (Frachisse et al. 2009). No surface algal bloom is expected from Upper Padas reservoirs (Frachisse et al. 2009).

Decrease in river flow and velocity will enhance sedimentation in the reservoir. Substrates for periphyton such as boulders, rocks, and pebble will be smothered by siltation cover. Periphyton composition will not be affected upstream of the reservoir where the stream flow remains unchanged.

Impact:

- Oxygen depletion in the lower strata of the reservoir (Oxygen depletion has no significant impact, it is a natural phenomena in deeper lakes and reservoirs).
  - Mitigation: Removal of biomass prior to inundation. Maintenance of a compensation flow.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	3	3
Overall significance	Significant		

5.6.4.12 FISHERIES/AQUACULTURE

With the increased resident time of the water in the reservoir compared to the resident time in the previous river section will cause solids to sediment. The level of total suspended solids is thus expected to be reduced, i.e. the water will clear.

This will be a factor beneficial to aquaculture that may be introduced in the reservoir, not considering chemical water quality parameters.

Impact:

- Decrease of level of total suspended solids leading to improved conditions for fisheries, aquaculture, human use of water and for tourism and recreation.
  - Opportunity: The opportunity for further diversification of the use of the reservoir should be encouraged.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	2	3	3
Overall significance	Significant		

5.6.4.13 AIR QUALITY

While not directly associated with the operation of the Project, a substantial and significant amount of greenhouse gasses will still be released from the reservoir area during this period. The gasses originate from the continued decomposition of cleared or inundated vegetation and will mostly be in the form of carbon dioxide or methane. The amount of greenhouse gas emission is dealt with in **Table 5.5-1** for un-mitigated conditions and in **Section 8.1.2** as residual impact after implementation of the biomass disposal plan.

Impact:

- Dissolved greenhouse gasses in the lower strata of the reservoir water.
  - Mitigation: Removal of biomass prior to inundation. The biomass removal plan is included in **Section 7.4.4**.
  - Off-setting by establishing new growth of carbon sequestering plantations.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

5.6.4.14 MACRO-BENTHOS

At the time the Project enters into operation, a stretch of approximately 15 km of river, Sg. Padas and its tributaries, will be converted from a fast-flowing river to a reservoir with depths in excess of 100 m. As described earlier, the bottom of the reservoir will essentially be anaerobic wherefore no macro-benthos will be expected at the bottom of the reservoir.

However, there will be a new benthic environment created around the edges of the reservoir where conditions are more favourable for macro-benthos[56]. The shore area is suitable for macro-benthos because there is higher food diversity and in particular oxygen in the water column. There will be lower rates of organic matter in the sediment when compared to the anaerobic conditions of the middle of the reservoir[57]. Therefore species diversity is predicted to increase at the rim of the reservoir and decrease with depth where there will be less taxa but abundance in species such as oligochaetes that tolerate these harsh environmental conditions.

Water quality modelling shows DO concentrations to be around 5 mg/l at 6 m water depth in most areas. Hence benthic communities could establish in these areas from the edge of the reservoir to around 6 m or more water depth. Fluctuations of the reservoir water level may potentially increase the habitable area. No long term water quality issues in the reservoir are predicted which would prevent the establishment of such communities.

The macrobenthic community within the reservoir area ranges in abundance from less than 500 to more than 1,000 individuals per cubic metre. Ephemeroptera (mayfly) were the most dominant taxa of macro-invertebrates in the area, which is a typical insect found in the most rivers of Sabah. None of the organisms found during the survey were endemic to Padas River.

[56] *Pamplin, P.A.Z., Almeida, T.C.M., & Rocha, O. 2006. Composition and distribution of benthic macroinvertebrates in Americana Reservoir (SP, Brazil). Acta Limnol. Bras., 18(2):121-132.*

[57] *Prat, N., Real, M., Rieradevall, M. 1992. Benthos of Spanish lakes and reservoirs. Limnetica 8: 221-229.*

Impact:

- There will be a shift in habitat for macro-benthos from the original riverbed in the middle of the reservoir to the new reservoir shore-line where macro-benthos will have to (re-) establish itself.
  - Mitigation: No mitigation is required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Insignificant		

5.6.4.15 FISHES

The formation of a lacustrine habitat will undergo a period of stabilization after the reservoir is filled up. The primary productivity of the lake will increase. Certain species of fish that are well adapted to a lacustrine habitat will flourish while other species that have specialized adaptations for living in fast flowing waters - such as *Tor spp*. and those from the family Balitoridae and Sisoridae - will either move to other suitable areas upstream or perish. Therefore, species composition and relative abundance of fish species will change. The relatively deep nature of the reservoir would mean that benthic organisms important as one of the sources of food will only thrive in shallow areas of less than 10 m. Food resources for fish will be limited at the main reservoir area.

Impact:

- Initially some fish species will disappear due to the changed habitat.
  - Mitigation: Restocking with local species adapted to lacustrine environments should be considered. However, any introduction of new species must be subjected to assessment of environmental impact to avoid invasive species threatening local populations.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	3	3
Overall significance	Significant		

5.6.5 POWER HOUSES

The generation of power by letting water under pressure passing the turbines does not have any significant impact in itself. Fishes that go through the system will not survive but that is not considered a potential threat to the fish population.

The major impact is the release of water under high pressure.

This pressure release will impact at two fronts:

- Firstly, the head of the system creates a large pressure that results in an enormous splash, when released. This splash will create a constant mist over the area. The consequential impact will be a change of the vegetation habitat to a type thriving in the misty conditions. Mosses and lichens may be frequent and the entire epiphyte community will change with it. The potential for erosion at the release is great if the tailrace channel is not well dimensioned.

- Secondly, the water intake for the turbines is at 20-30 metres depth and the internal water pressure therefore 3-4 atmospheres. When this pressure is released, dissolved gasses such as carbon dioxide and methane will be released from the water. This is a benefit to the water but also a contribution to the greenhouse gas emission. The remaining dissolved greenhouse gasses will be released by the river and into the atmosphere over the next 20-40 km of river.
  - Mitigation: Mitigation is built into the tailrace channel system.
  - Mitigation for the release of greenhouse gasses is a proper biomass disposal already during construction. For releasing residual gasses, no mitigation is required as the overall effect is considered positive.
  - Mitigation of habitat change is built into standard designs of tailrace channels. No further mitigation is required.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	2	2	3
Overall significance	Significant		

5.6.6 TRANSMISSION- LINES

During the operational stage the high voltage current passing through the transmission-lines emit electric and magnetic fields but the impact of this on wildlife has not been well documented. Studies by WHO (WHO 2007) concluded that no substantive health issues could be associated with extremely low frequency (ELF) fields, so electric and magnetic fields originating from the overhead transmission- lines are unlikely to have any significant impact on wildlife. Thus the main impact on wildlife is the loss and degradation of their habitat that occurs during construction stage and thereafter to a lesser degree during the operational stage.

The transmission- lines are not expected to exercise any significant negative effect on aquatic life forms during the operation stage.

Impacts:

- Loss or fragmentation of habitat impeding migration routes or territorial affiliation.
  - Mitigation: The alignment corridor should preferably follow boundaries between natural habitats and the human landscape.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
1	2	2	1
Overall significance	Insignificant		

5.6.6.1 ENVIRONMENTAL HEALTH

The issue of environmental health and electromagnetic fields on human populations is dealt with in **Section 6.4**.

5.7 DAM BREAK

The proposed Upper Padas dam structure is provisionally a roller compact concrete dam (RCC). RCC dams have demonstrated a higher degree of reliability and a prolonged life-time compared to other types of dam structures. This includes increased structural stability and a reduction in seepage through or under the structure. The concrete used is not susceptible to internal erosion or failure due to overtopping.

A recent risk assessment of dams (Chauhan and Bowles, 2003[58]) provides an indicative risk of failure of a RCC dam to be $7x10^{-5}$ per year, or once in 10,000+ years. This estimate is site specific; factors such as higher risk of earthquake, poor construction techniques and terrorist / deliberate dam destruction are variable. Nevertheless, the likelihood of dam failure is expected to be very small. Furthermore, the likelihood of a sudden and rapid failure of a large portion of the dam is expected to be even less.

The most likely form of dam failure (although still unlikely) is one where a specific feature of the structure fails, while the overall integrity of the dam is maintained. The consequences upon downstream flooding in such instances are generally not severe and are considered to be an aspect of structural design. These include:

- Underestimation of PMP and PMF.
- Erosion and leakage through foundations.
- Capacity of spillways.
- Gated spillways, and their appropriate operation and sensitivity to debris blockage.
- Damage to spillway.

The timing of the flood wave from a catastrophic dam failure is initially dependent upon the nature and timing of the dam failure mechanism. The propagation speed would be relatively uniform in the upper and middle reaches of Padas River, but would diminish as it reaches the flatter, wider floodplain areas due to the change in gradient and the storage effects of floodplain inundation (refer **Figure 5.7.1**).

Inundation of the floodplains would continue for several days following the arrival of the flood wave front. Damage from a catastrophic dam failure could potentially be disastrous for riverside communities within the 70 km distance from the Upper Padas dam down to Tenom (Tenom will be reached by the wave front in approximately 6.7 hrs, refer **Table 5.7-1**). Further downstream, attenuation effects would progressively reduce the force and

[58] Proceedings of the Australian Committee on Large Dams Risk Workshop, Launceston, Tasmania, Australia. October 2003. Dam Safety Risk Assessment with Uncertainty Analysis. Sanjay S. Chauhan and David S. Bowles.

destructiveness of the flood wave. The wave front eventually reaches Beaufort in approximately 11 hrs with attenuated and delayed peak discharges.

Table 5.7-1 Timing of Dam Failure Flood Wave and Inundated Areas

Location	Inundated Area (km^2)	Timing of peak of flood wave (hours)[59]	Peak Discharge (m^3/s)
Tenom	42	6.7	2,850
Beaufort	84 (total)	11.3	1,440

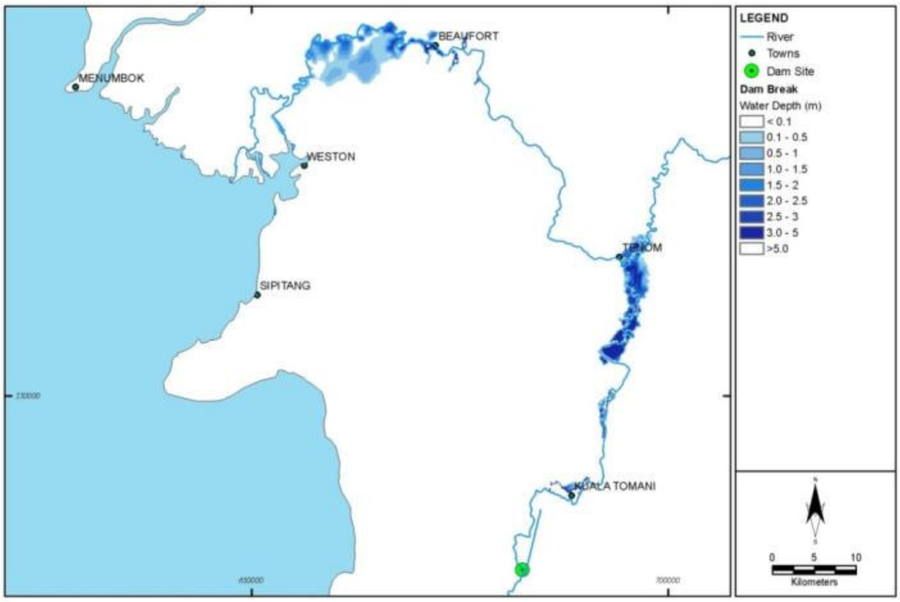


Figure 5.7.1 Overland Inundation As A Results of Dam Break

Mitigation: Refer to dam break/breach response plan in **Appendix 2.12** for further details.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
3	3	3	3
Overall significance	Significant		

5.8 ABANDONMENT AND DECOMMISSIONING

In the unlikely event of abandonmen/decommissioningt, mitigating steps are required to ensure residual impacts are insignificant. In the event of abandonment, decommissioning work would include permanent/temporary withdrawal of all personnel, equipment, halting of operations and dismantling all structures and facilities.

Abandonment/decommissioning during construction stage of the proposed Project will leave the site with bare slopes, exposed land surface and incomplete dam structures, site installations and ancillary facilities which can create visual repercussions and threat to

[59] *after initiation of the dam failure.*

safety, particularly the events of intensified soil erosion and slope associated with respect to the bare slopes and exposed ground. This shall incur great economic loss to the State and the Nation as a whole in terms of the initial investment which is not foreseen to generate any return, and the loss of a great potential for electric power supply. Besides, the natural conditions of the site, for instance, the hydrology and the ecology would have very much been altered.

Abandonment/decommissioning during operational stage of the dam will leave the dam, the reservoir and the ancillary facilities such as the powerhouse and power intake un-maintained, hazardous to the public and may harbour unwanted or illegal residents.

Proper abandonment/decommissioning will ensure the suitability of the Project site for other purposes in the future.

Impact:

- Risk of structural failures at the dam and ancillary structures.
    - Mitigation: The Project Proponent shall a minimum of 6 months before abandonment becomes a physical reality submit a Site Decommissioning Plan for securing and maintenance of the area and all facilities. The plan shall clearly identify responsible organisations and means of finance. On approval of the plan, contracts for continued maintenance shall be submitted for approval of the State Government.
    - Mitigation: The above mitigating measures for handover are also applicable for abandonment/decommissioning.
    - Mitigation: In establishing a Site Decommissioning Plan, a 3-phased plan is recommended:
        - ✓ Phase 1, decommissioning of process, operation and storage facilities;
        - ✓ Phase 2, dismantling of site facilities deemed necessary, decontamination, and transfer or sale of equipment; and
        - ✓ Phase 3, preparation of the site for redevelopment/ rehabilitation.
    - Mitigation: For abandonment/decommissioning during the operational stage, the decommissioning plan has to take into consideration the reservoir, particularly its large body of water.
    - Mitigation: Existing on-site treatment facilities and disposal areas should be utilised for decommissioning activities as much as possible, e.g. waste treatment plant to handle process effluent, wash-water and storm water.
    - Mitigation: The need for sediment, soil and hydro-geological investigations should be established at the outset of the decommissioning programme. This would be based on the review of past operating practices.

- Mitigation: Site visit to be carried out 3 months after the last work of abandonment activity to validate the progress of decommissioning plan. This is to ensure that the site is not hazardous (e.g. breeding ground for mosquitoes) after abandonment/decommissioning.

Magnitude of change / effect	Permanence of impact	Reversibility of condition	Cumulative impact
2	3	3	3
Overall significance	Significant		

5.9 OPPORTUNITIES

The Upper Padas Hydroelectric Project will offer a few opportunities in addition to those opportunities that follow the benefits of electricity.

During construction, there will be employment opportunities, opportunities for offering accommodation, and opportunities for offering other goods and services to the Project, staff or visitors.

The reservoir will offer new livelihoods opportunities in fisheries/aquaculture or in the recreational/tourism activities that now will be possible.

Improved access will further development of the area in general.

5.10 SUMMARY

The present Project will have a wide scope of unwanted impacts unless it is implemented in a responsible manner. Most of these concerns in one way or the other the flow of the water, which will be drastically changed several times during implementation.

Impacts on the Physical Environment

Air. The air will primarily be impacted through the decomposition of biomass that has to give way for the reservoir. Carbon dioxide and methane will be formed by aerobic and anaerobic processes and released either directly into the air or via first being dissolved in the water. This release will further contribute to the overall global climate change. Mitigation will be to optimise pre-inundation clearing and by off-set plantation.

Soil. Destruction of soil in itself is not really the issue. The issue is rather that through making the soil unstable, the waterways will be negatively impacted from suspended solids or sedimentation. The soils are made unstable whenever the Project needs to clear an area for construction of access roads, dams, camps, transmission- lines, power installations. Mitigation is mainly by means of minimising the gradient of cut slopes, ensuring proper drainage, installing silt traps and by establishing vegetation again on denuded places when the areas are no longer used. The consequence of the pollution of water by soil particles is a loss of aquatic environment and biodiversity.

Water. The waters of the Padas River will be affected on its flow and on its quality.

During the almost 1-year inundation period, flow through the construction site would be blocked if a compensation flow was not released at the dam site. The compensation flow or environmental flow will be at a minimum and much aquatic habitat will still be lost, particularly between the dam site and the confluence of the Tomani River. Later, during operation, flow will almost be natural as the total quantity of water that runs in the river will be the same as before but without the seasonal changes. This will to some degree mitigate the annual occurrence of floods in Tenom and Beaufort. The floods, however, do not only originate from the upper Padas but also from Tomani and Pegalan rivers.

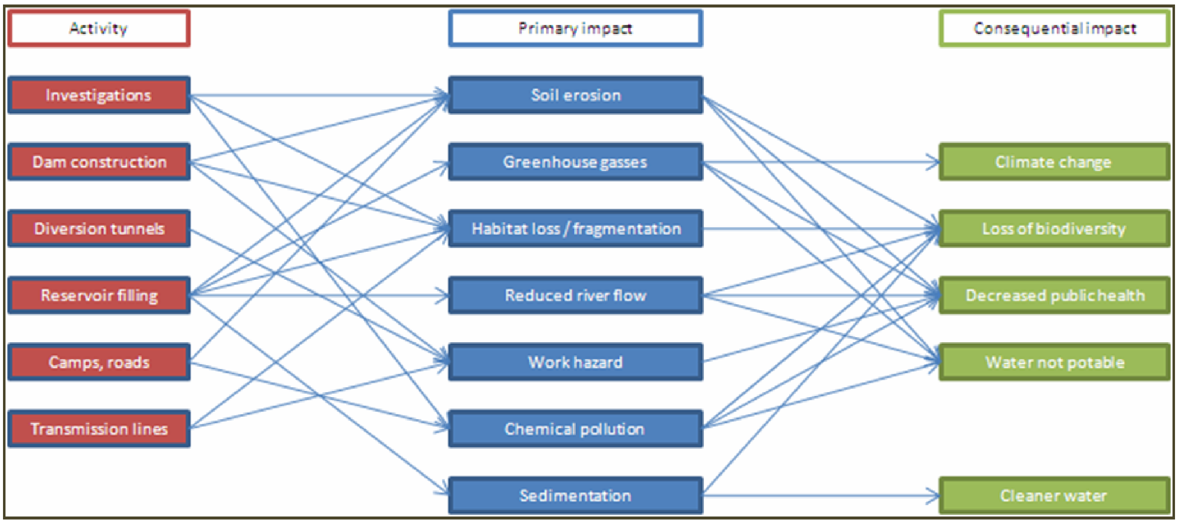


Figure 5.10.1 Schematic Presentation of Impacts

For water quality, again there are two issues: Suspended solids and chemical/biological pollution. The suspended solids issue is a chain of events and consequences: Soil instability - soil loss - suspended solids and sedimentation – loss of habitat – loss of biodiversity. It all originates from improper soil management and mitigation is therefore – as listed under the 'Soils' heading - directed towards maintaining the soil where the soil belongs: Out of the waterways. The reservoir will act as a huge silt trap, actually cleaning the Padas River for most of its suspended solids to the benefit of the downstream river communities.

The chemical and biological pollution of the water may originate from camps and workshops where waste and discarded oils and chemicals are discarded in improper manners. Mitigation for this is improved waste management, collection and treatment systems or removal and disposal.

A larger scale of water quality deterioration concerns dissolved oxygen, biological oxygen demand and dissolved greenhouse gasses such as methane. Oxygen is normally only present in the upper 5-10 metres of a lake. Since the water intake for the turbines will be lower than this, the water flowing through the turbines and released into downstream Padas will be poor in dissolved oxygen and this is not suitable for aquatic wildlife. Mitigation lies in technical solutions for aeration of the water after the turbines.

Decomposition of inundated vegetation, particularly forest trees, will use all available oxygen in the water and produce methane, which will be dissolved in the water till it is released after the turbines. Mitigation of the greenhouse gasses and depletion of oxygen is to optimise biomass disposal and offset-planting as mentioned under the heading ‘Air’.

Impacts on the Biological Environment

Impacts on the biological environment consists mainly of consequences of impacts on the physical environment in addition to issues such as removal of vegetation / habitat and fragmentation of habitat.

Terrestrial Flora. About 600 – 700 ha of terrestrial vegetation/habitat will be lost to the reservoir, roads and construction sites. While most of this is undisturbed dipterocarp forest, it does not represent any significant loss to the State but should still be mitigated by a similar area being established or protected elsewhere.

Terrestrial Fauna. The loss of vegetation will cause a loss of habitat for wildlife. There is, however, not much wildlife in the area as hunting and land conversion has taken its toll. Fragmentation of habitat is minimal, the reservoir being the largest obstacle to wildlife movement. Mitigation is therefore mostly concerned with control of further hunting pressure from the influx of many labourers during construction and easy access to established infrastructures.

Aquatic Flora. The aquatic flora will be drastically altered by the is Project as a large part of a hitherto fast flowing river with rapids and boulders will be converted into a deep slow-moving lake and as a river stretch will be with only minimal flow for a year. Mitigation is not possible in the reservoir as the plankton composition must change for the new conditions. Mitigation downstream is to make sure an optimised environmental flow of minimum 16 m^3/sec is maintained at all times.

Aquatic fauna. The aquatic fauna, particularly the fishes, will undergo dramatic changes where the river is transformed into a lake. The species composition and balance will change but not necessarily to anything less valuable. Mitigation is therefore concentrating on maintaining a living aquatic environment through maintaining the flow of the river and by controlling water quality as mentioned above.

CHAPTER 6 SOCIAL BASELINE AND IMPACT ASSESSMENT

6.1 GENERAL

The social baseline and impact assessment describes the impact of the proposed Upper Padas Hydroelectric Project on the socio-economic parameters of the people living within and in the surrounding areas of the Project.

The assessment provides a description of the demographic characteristics, socio-economic activities and perceptions of the people living within the study area to assess the situation, possible impact, including their acceptance and rejection on the Project. The findings have led to recommendations to minimize the adverse socio-economic effects of the Project as well as to maximize the positive contributions of the Project to the people in affected areas. These recommendations are included in the social management plan. A map of sampled villages is included as **Map 6.1- 1 Location of Surveyed Villages**.

Plate 6.1-1 Conducting socio-economic survey in Kg. Marais

Scope of study. The scope of this social impact study covers both the tasks of describing the existing socio-economic conditions and assessing the probable impacts. Description of the socio-economic aspects therefore includes:

- General demographic characteristics of the population and the sample studied for the districts and areas concern;
- Main economic activities and income level;
- Education level and other skills;
- Land ownership and utilization;

- Utilization of forest and river resources;
- Places of cultural significance and sensitivity;
- Tourism and recreational opportunities; and
- Public infrastructure and other social services.

Plate 6.1-2 Health Clinic in Kemabong

The data provided in this component is based on two sources: Primary survey data and secondary data obtained from literature, statistics and similar sources. The major source of data for the assessment is the primary data collected from the household surveys as well as by formal and informal interviews and focus group discussions with the people from villages within the area of study. The secondary sources include the Population Census, Reports from District. The data analysis is mainly presented in form of descriptive percentage analysis for the major part of variables studied as well as in the form of qualitative analysis.

6.2 INTRODUCTION TO TENOM AND SIPITANG DISTRICTS

Tenom District (see map in **Figure 4.3.5**) covers an area of about 2,238 square kilometre or 930 square miles, consisting of sub-district of Kemabong. It is bordered by Keningau, Nabawan, Beaufort, Papar districts and Indonesia. Sipitang District covers an area of about 2,732 square kilometres and is bordered by Beaufort, Tenom, Sarawak State and Kalimantan (Indonesia). The sub-district Kemabong in Tenom covers an area of about 1812 square kilometres. The Padas River where the construction of the dam and power station is proposed mainly runs through this sub-district which where the existing Pangi Hydroelectric Power is situated as well. **Table 6.2-1** and **Table 6.2-2** show total and rural-urban population distribution and some important socio-economic information of these two districts as presented in the general census statistic of Malaysia.

Plate 6.2-1 Conducting socio-economic survey in Kg. Katambalang

Table 6.2-1 Total, Urban & Rural Population in Tenom and Sipitang District (1980-1991)

District	Total population			Urban population		Rural population		
	1980	1991	2000	1980	1991	2000	1980	1991	2000
Sipitang	12,076	24,349	29,256	-	-	9,362	12,076	24,349	19,894
Tenom	26,353	37,954	46,106	-	-	7,377	26,353	37,954	38,729

Source: 1980, 1991 and 2000 Census from Statistics Department, Sabah

Table 6.2-2 Demographic Features Sipitang and Tenom

Year	Populations	Average Growth %	No. of living quarters	No. of householder
1980	26,353	-	5,727	4,727
1991	37,954	+3.32%	8,304	7,285
2000	46,202	+2.18%	10,158	8,871
2007	56,000			

Source: 1980, 1991 and 2000 Census from Statistics Department, Sabah

6.3 CHARACTERISTICS OF LOCAL COMMUNITIES

6.3.1 DEMOGRAPHY

Respondents from 300 households have been involved in the community survey with 200 individuals from Kemabong sub district and 100 respondents from Sipitang district (see **Table 6.3-1**). The 300 respondents represent households of 1542 people. The 300 respondents were randomly selected from 24 villages along the 3 originally proposed transmission-line alignments which basically run along the Tomani-Tenom and the Tenom-Sipitang roads. No settlements are found in the immediate vicinity of other Project components such as the Project reservoir and power house.

Table 6.3-1 Villages Involved in the Survey and Number of Respondents

District	Name of village	Number of respondents	Name of village	Number of respondents
Kemabong	Amboi 1	6	Ladang Sapong	30
	Baab	1	Mamaitom	10
	Baru Jumpa	2	Marais Baru	11
	Chinta Mata	22	Marais Lama	9
	Kalamatoi	3	Melalap	1
	Kalibatang	2	Pantungan	18
	Kalibatang Baru	29	Skim LIGS	15
	Kapulu	1	Sugiang baru	1
	Katambalang Baru	16	Sugiang Lama	1
	Kemabong Lama	1	Sugiang Tengah	13
			Tenom Lama	8
Tenom				
Sipitang	Bamban	5	Mendulong	14
	Bangsal	26	Pakiak	1
	Kaban	19	Solob	9
	Lubang Buaya	2	Tanah Merah	5
	Malamam	2	Tanjung Nipis	7
	Marau	5	Tunas Baru	5
Total	**300**			

Table 6.3-2 Surveyed Population, by Ethnic and Districts

Ethnic Group		Districts		Total
		Sipitang	Kemabong	
Murut	Count	21	99	120
	%	21.0%	49.5%	40.0%
Lundayeh	Count	38	34	72
	%	38.0%	17.0%	24.0%
Kedayan	Count	32	8	40
	%	32.0%	4.0%	13.3%
Dusun/Kadazan	Count	1	14	15
	%	1.0%	7.0%	5.0%
Malay	Count	1	20	21
	%	1.0%	10.0%	7.0%
Chinese	Count	0	2	2
	%	.0%	1.0%	0.7%
Brunei	Count	2	8	10
	%	2.0%	4.0%	3.3%
Others	Count	5	15	20
	%	5.0%	7.5%	6.7%
Total	**Count**	**100**	**200**	**300**
	%	**100.0%**	**100.0%**	**100.0%**

The ethnic distribution of the samples collected for the study reflect the general distribution of population by ethnic groups in the two districts as indicated in the census (2000). Out of the 300 respondents interviewed, the majority of them are Murut (40%), Lundayeh (24%) and followed by Kedayan (13.3%). There are other ethnic groups populate these areas such as Kadazandusun, Malay, Chinese and Brunei (22.7%).See **Table 6.3-2**.

Table 6.3-3 Religious Affiliation

Religion		District		Total
		Sipitang	Kemabong	
Islam	Count	37	62	99
	%	37.0%	31.0%	33.0%
Christianity	Count	63	138	201
	%	63.0%	69.0%	67.0%
Total	**Count**	**100**	**200**	**300**
	%	**100.0%**	**100.0%**	**100.0%**

There were only two religious affiliations identified among the samples studied. Majority of the respondents are Christians (67%) and the rest are Muslims (33%). See **Table 6.3-3**.

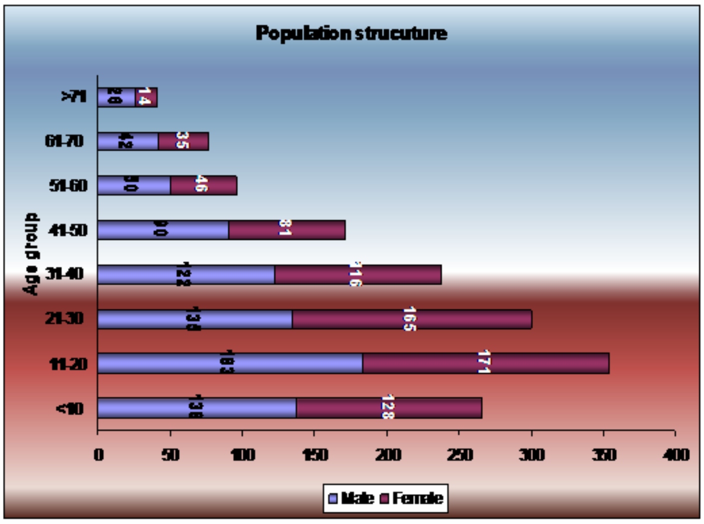


Figure 6.3.1 **Age and Gender Structure**

Figure 6.3.1 shows a population dominated by the young and with a balanced gender ratio. While being dominated by young, there is still a fair ratio of senior citizens above 60 years of age and even above 70.

6.3.2 LEVEL OF EDUCATION

The level of education among the household individuals shows that 77% have obtained formal education with 49% attaining secondary school. See **Figure 6.3.2**.

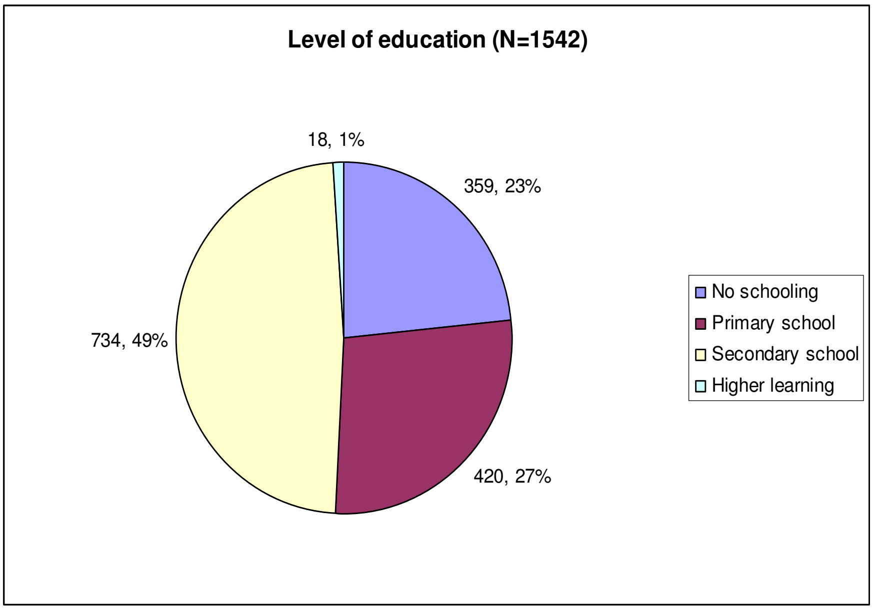


Figure 6.3.2 **Respondents' Level of Education (Respondent, ratio)**

Most of the rural community's skills are based on their daily economic activities, where 41.7% of the respondents are skilled in agricultural activities, followed by fishing activities (21%), carpentry (20.3%) and livestock breeding (19.3%).

Table 6.3-4 Respondent's Skills

Expertise	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Agriculture	32	46.50	41.70
Livestock breeding	12	23	19.3
Fishing	15	24	21
Carpentry	30	15.5	20.3
Cement work	11	10	10.3
Entrepreneurship	3	13	9.7
Hunting	1	3	2.3
Other	10	8.5	9
No skill	68	53.5	58.3

6.3.3 ECONOMIC CHARACTERISTICS

A majority of the respondents are in the agricultural sector with 32.3% farmers and 23.3% rubber tappers and 14.7% doing odd jobs. Occupational groups included workers in private sectors, government civil servants and people doing business. Remaining 'Others' consist mainly of students and housewives. See **Table 6.3-5**.

Table 6.3-5 Main Occupation Groups

Main Occupation	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Rubber tappers	33.0	18.5	23.3
Sabah Forest Industry	1.0	2.0	1.7
Retailer	2.0	4.5	3.7
Retiree (Government)	3.0	3.0	3.0
Governmental sector	6.0	7.5	7.0
Private sectors	6.0	15.0	12.0
Odd jobs	13.0	15.5	14.7
Farmer	36.0	30.5	32.3
Students		3.0	2.0
Housewives		.5	.3
Total	**100.0**	**100.0**	**100.0%**

More than 50% of the respondents are in the low income group. Almost 90% of the respondents earned income below MYR 1,500 monthly and the majority of them also live below the poverty line. Those who earn MYR 500 per month are mainly farmers, rubber tappers and those who do odd jobs. It should be noted that the survey did not assess the monetary value for agricultural products produced for self sustenance. See **Table 6.3-6**.

Plate 6.3-1 Rubber plantation in LIGS area, adjacent to proposed road to project site

Table 6.3-6 Monthly Income

Monthly Income	District		Total (%)
	Sipitang (%)	Kemabong (%)	
MYR 500 and below	59.0	47.5	51.3
MYR 501- MYR 1000	29.0	26.0	27.0
MYR 1001 - MYR 1500	8.0	11.0	10.0
MYR 1501 - MYR 2000	2.0	4.0	3.3
MYR 2001 - MYR 2500		4.0	2.7
MYR 2501 - MYR 3000	1.0	3.0	2.3
MYR 3001 - MYR 3500	1.0		.3
MYR 5001 and above		1.0	.7
No income		3.5	2.3
Total	**100.0**	**100.0**	**100.0**

The survey shows that 79.7% of the respondents possess land in their respective villages whereas 20.3% do not. A major part of the respondents from the Sipitang district (92%) and 73.5% from Kemabong district own their land. However, among those only 44.7% possess a complete land title (52% in Sipitang and 41% in Kemabong). See **Table 6.3-7**, **Table 6.3-8** and **Table 6.3-9**.

Table 6.3-7 Land Possession

Possession of land	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Yes	92.0	73.5	79.7
No	8.0	26.5	20.3
Total	**100.0**	**100.0**	**100.0**

Table 6.3-8 Plots of Land Owned

Number of plots	Districts		Total
	Sipitang	Kemabong	
1	30.0%	40.0%	36.7%
2	27.0%	23.5%	24.7%
3	19.0%	8.0%	11.7%
4	11.0%	.5%	4.0%
5	5.0%	1.5%	2.7%
Landless	8.0%	26.5%	20.3%
Total	**100.0%**	**100.0%**	**100.0%**

Table 6.3-9 Types of Land Titles Possessed

Possession of Land Title	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Full title	52.0	41.0	44.7
Various stages of ownership application	32.0	31.5	31.7
Without land title / without land	1.6	27.5	23.6
Total	**100.0**	**100.0**	**100.0**

61.6% of the respondents have less than 15 acres of land, planting mainly rubber (63.7%), fruit trees (53.7%) besides cultivating wet rice (26%). See **Table 6.3-10**.

Table 6.3-10 Size of Land Owned (acres)

Size of Land Owned	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Without land	8.0	26.5	20.3
00.1 - 5 acres	25.0	25.0	25.0
5.1 - 10 acres	23.0	16.0	18.3
10.1 - 15 acres	23.0	16.0	18.3
15.1 - 20 acres	5.0	6.5	6.0
20.1 - 25 acres	5.0	3.0	3.7
25.1 - 30 acres	3.0	4.0	3.7
30.1 - 35 acres	-	2.0	1.3
35.1 - 40 acres	2.0	-	0.7
40.1 acres and above	6.0	1.0	2.7
Total	**100.0**	**100.0**	**100.0**

Note: 1 acre = 4047 m^2

Table 6.3-11 Land Use Pattern

Land Use	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Rubber	71	60	63.7
Oil Palm	0	4.0	2.7
Fruits	79	41.0	53.7
Hill rice	3	5	4.3
Wet rice	40	19	26
Cocoa	2	4	3.3
Coffee	4	4	4
Livestock Breeding	1	1.5	1.3
Rented out	3	1	1.
Not cultivated	3	2.5	2.7

Beside cultivating their respective lands, the respondents also collects forest and river products in their daily life, either for personal consumption or extra income. About 76% still utilize the forest at least once a week to collect various resources with majority of them (61.6%) go into the forest one to three times a week. The respondents mainly collect wild vegetables (82.3%), fruits (67.7%) and fire wood (51.7%). See **Table 6.3-11** and **Table 6.3-12**.

Table 6.3-12 Types of Non-Timber Forest Products Collected

Forest Resources	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Wild vegetables	88	79.5	82.3
Fruits	88	57.5	67.7
Medicinal plants	17	23.5	21.3
Fire wood	62	46.5	51.7
Rattan	34	24.5	27.7
Bush meat	5	13.5	10.7
No utilization	4	13	10

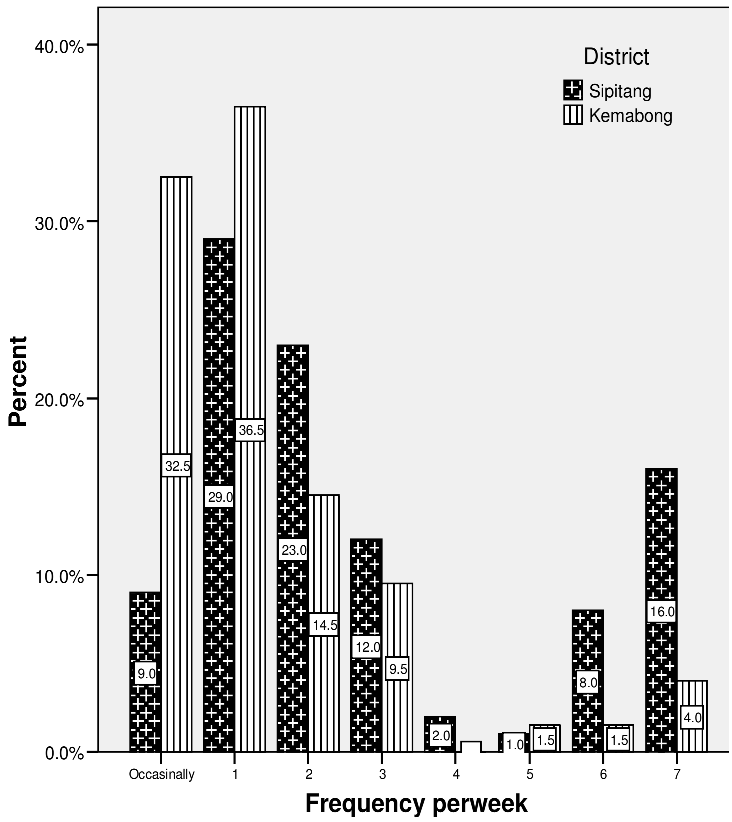


Figure 6.3.3 Frequency of Collecting Forest Resources per week

Almost all (90%) of the respondents indicated resourceful rivers in their respective villages are used for domestic purposes and a source of extra income. While 78.5% of the community in Kemabong identifies Padas River as the most resourceful river, 53% of the community in Sipitang utilizes the Mengalong River, as the main source, primarily for fishing. See **Table 6.3-13** and **Figure 6.3.4**.

Table 6.3-13 Most Resourceful Rivers

River	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Not sure	10.0	10.0	10.0
Mengalong River	53.0		17.7
Muaya River	11.0		3.7
Solob River	10.0		3.3
Marau River	2.0		0.7
Sugiang River		1.5	1.0
Padas River	2.0	78.5	53.0
Marais River		5.0	3.3
Kuala Tomani River		.5	0.3
Kalibatang River		1.0	0.7
Masilau River		0.5	0.3
Kemabong River		0.5	0.3
Luagan River		1.0	0.7
Mendulong River	8.0		2.7
Teluk Kusun River		0.5	0.3
Kaban River	3.0		1.0
Sulum River	1.0		0.3
Pagalan River		1.0	0.7
Total	**100.0**	**100.0**	**100.0**

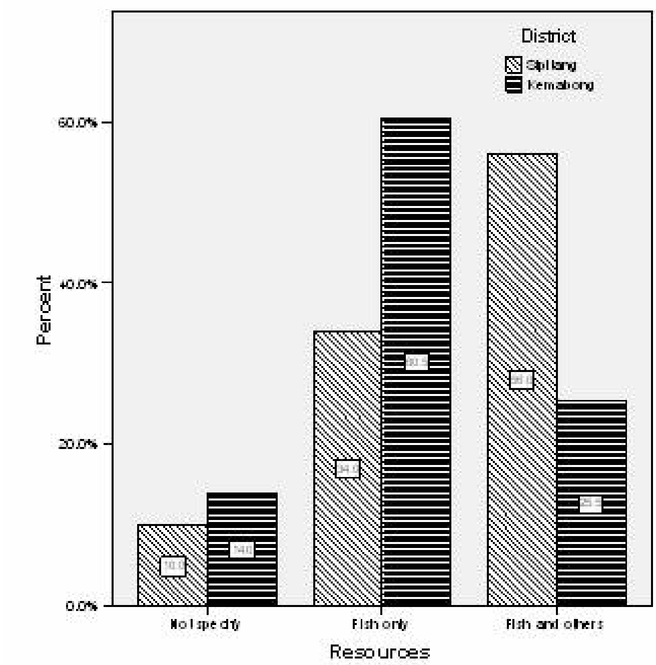


Figure 6.3.4 River Resources Collected

The local community is very much dependent on the river for their daily activities. About 62% of them utilize the river once to three times a week, whereas 9.7% utilize the river four to seven times weekly. Others utilize the river occasionally. See **Figure 6.3.5**.

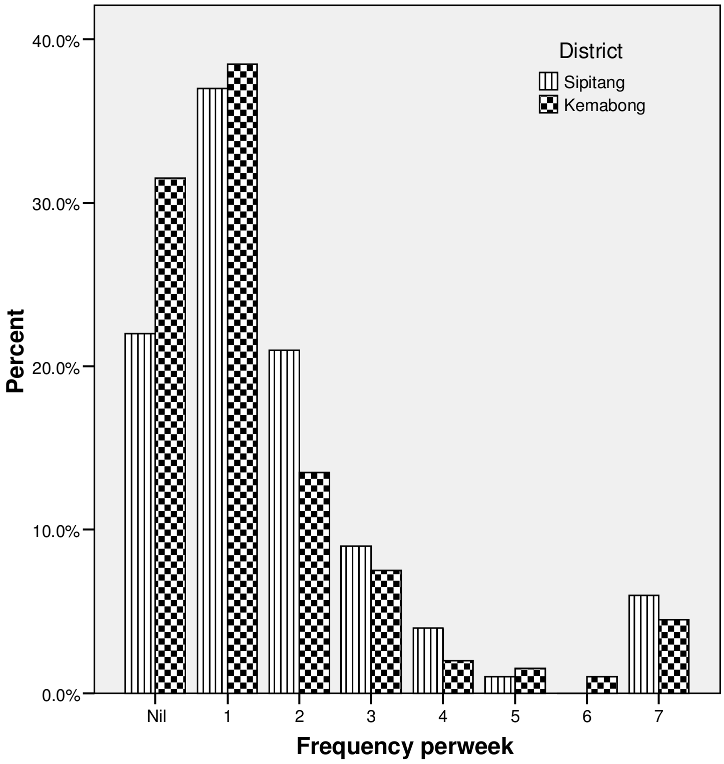


Figure 6.3.5 Frequency of Collecting River Resources per week

Table 6.3-14 Average Catch of River Resources by Weight (kg)

Weight of Catch (Kg)	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Not sure	21.0	30.5	27.3
Less than 2 kg	70.0	54.0	59.3
2.1 - 4 kg	5.0	8.0	7.0
4.1 – 6 kg	2.0	4.0	3.3
6.1 – 8 kg	1.0	1.0	1.0
8.1 - 10 kg		.5	.3
10.1 - 12 kg		1.5	1.0
Above 12 kg	1.0	.5	.7
Total	**100.0**	**100.0**	**100.0**

About 60% of the respondents' single catch is up to 2 kg of fish or other river products. 61.7% indicated that the value of their catch is less than MYR 10 (at MYR 5/kg). However, most of their catch is for household or own consumption. See **Table 6.3-14** and **Table 6.3-15**.

Table 6.3-15 Value of Average Catch (MYR) by District

Money Catchments Value (MYR /kg)	District		Total (%)
	Sipitang (%)	Kemabong (%)	
MYR 1–5	49.0	43.0	45.0
MYR 6–10	22.0	14.0	16.7
MYR 11–15	4.0	4.5	4.3
MYR 16–20	2.0	3.5	3.0
MYR 21–25	1.0	1.0	1.0
MYR 26 and above	1.0	4.0	3.0
Not sure	21.0	30.0	27.0
Total	**100.0**	**100.0**	**100.0**

Presently, the local community also shows various concerns towards river disturbances in their respective rivers. Most of them (24.7%) are concerned about the usage of tuba in the river as it will reduce the volume of the fish population. Other concerns are poisoning (16%), pollution (10.7%), usage of electrical current (8.7%), logging (5.3%) and others (3.3%). See **Table 6.3-16**.

Table 6.3-16 Concerns Towards River Disturbance

River Disturbance	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Tuba	30.0	22.0	24.7
Poisoning	16.0	16.0	16.0
Electric usage	17.0	4.5	8.7
Pollution	8.0	12.0	10.7
Logging		8.0	5.3
Others	1.0	4.5	3.3
Not sure	28.0	33.0	31.3
Total	**100.0**	**100.0**	**100.0**

6.3.4 POTENTIAL FOR TOURISM

About 1/3 of the respondents value their villages as potential tourism attractions especially in the Kemabong sub-district. The respondents feel that the natural environment (forest and river) is the main potential to attract tourists besides their unique cultural lifestyle. See **Table 6.3-17**.

Table 6.3-17 Villages' Potential as Tourist Attractions

Attractions in their Village	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Nature	2.0	29.1	20.1
Recreational activities		7.5	5.0
Historical site		.5	.3
Cultural	14.0	6.0	8.7
Not sure	84.0	56.8	65.9
Total	**100.0**	**100.0**	**100.0**

The tourism products and archaeological sites identified in both the Sipitang and Kemabong district include:

- Tenom Township;
- Murut Cultural Centre;
- Lagud Seberang /Tenom Agricultural Park;
- Kallang Waterfall;
- White water rafting in Padas Pangi River;
- Murut Cultural Village Mamaitom;
- Ulu Tomani Rock Carving;
- Antanom Fort, Rundum;
- Tenom Pangi Hydroelectric Station; and
- Crocker Range Sub-station, Melalap.

See locations in **Figure 6.3.6**.

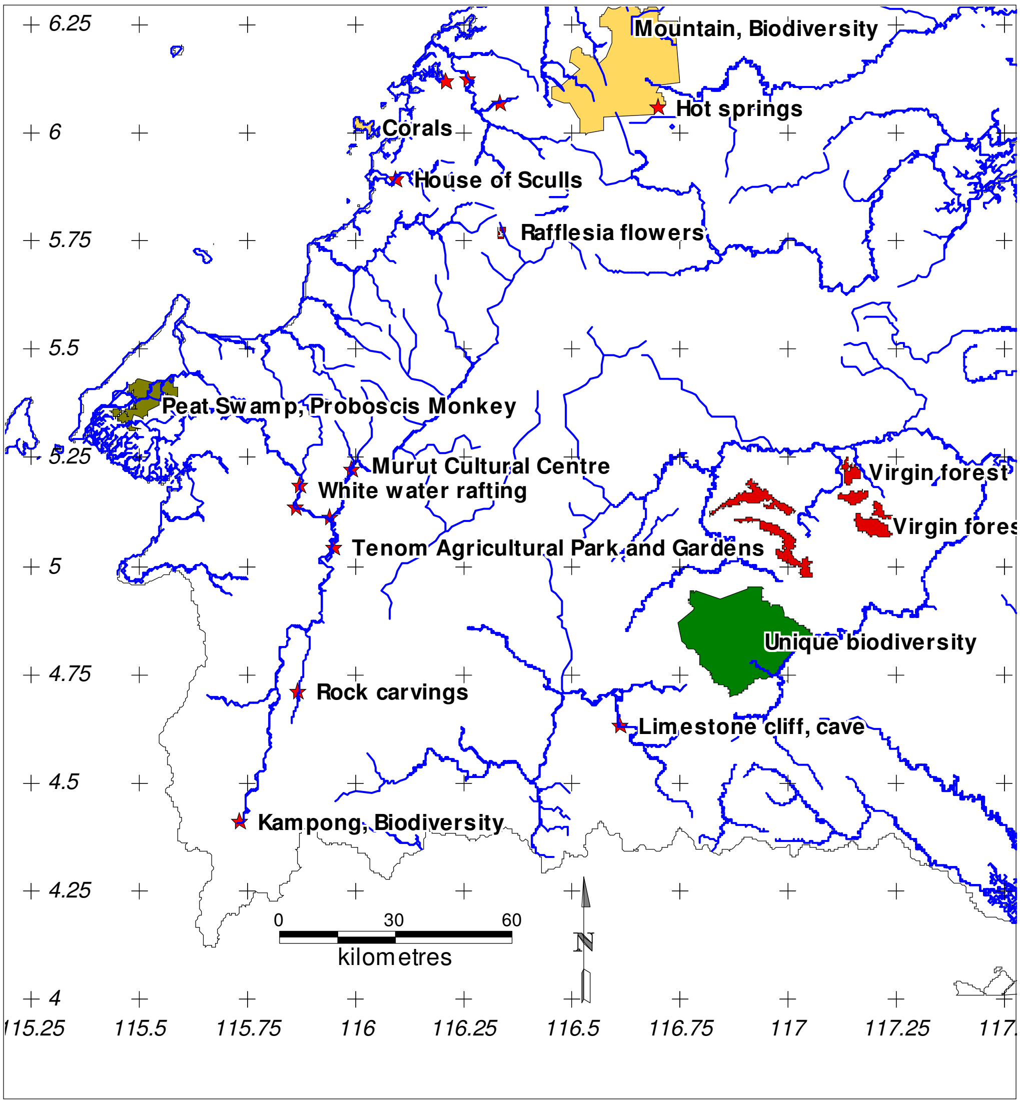


Figure 6.3.6 Places of Tourism Interest

6.3.5 LIVING STANDARD INDICATORS

The local communities have a relatively high access to public infrastructure in their respective villages and districts, compared to other rural communities in Sabah. Most of the villages are easily accessible by the main road. The majority of the community has access to electricity and clean piped water supply for their daily usage. The communities have good access to religious facilities such as church and surau. Other facilities accessible by the local people are multipurpose halls, balai raya, telephone signal, schools, health clinic and police station. See **Table 6.3-18**. Nevertheless, one should bear in mind that the facilities in the villages are very basic, consistent with the rural standard in Sabah.

Table 6.3-18 Accessibility of Public Infrastructure

Public infrastructure	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Roads	89.0	96.0	93.7
Schools	65.0	65.5	65.3
Clinics	44.0	44.0	44.0
Places of worship	97.0	88.5	91.3
Piped water supply	71.0	93.0	85.7
Electricity	83.0	96.0	91.7
Public Telephone (Land telephone line)	56.0	75.5	69.0
Police Station	22.0	36.0	31.3
Multipurpose hall	70.0	82.0	78.0

6.4 PUBLIC HEALTH IN THE LOCAL AREA

6.4.1 LOCAL HEALTH SERVICES

Various public health facilities are provided in the region surrounding the proposed Project. Such facilities are summarized in **Table 6.4-1** below.

Table 6.4-1 Public Health Facilities in Region Surrounding Proposed Project Site

Public Health Facility	Proximity to Project Site	Services Provided
Hospital Tenom (92 beds)	Tenom Town (Approximately 40 km from the proposed Project site)	*District Hospital Status* Outpatient services Inpatient services Emergency services General Practice Pathology Radiology Maternity Minor surgery Pharmacy Dialysis
Hospital Sipitang (93 beds)	Sipitang Town (Approximately 45 km from the proposed Project site)	*District Hospital Status* Outpatient services Inpatient services Emergency services General Practice Pathology Radiology Maternity Minor surgery
Various public and private clinics	Townships surrounding the proposed Project site including Tomani, Kemabong, Sapong, Tenom, and Sipitang. (At least 10 km from the proposed Project site)	General Practice First Aid services Distribution of general medication

Public Health Facility	Proximity to Project Site	Services Provided
Hospital Beaufort (275 beds)	Beaufort (Approximately 60 km from the proposed Project site)	*District Hospital Status* Outpatient services Inpatient services General Practice Pathology Radiology Physiotherapy Occupational therapy Patient Education Pharmacy and supply Blood Bank Emergency Services
Queen Elizabeth Hospital (589 beds)	Kota Kinabalu (Approximately 130 km from the proposed Project site)	*Main Hospital Status* Outpatient services Inpatient services General Practice Emergency Services Pathology Radiology Physiotherapy Occupational therapy Patient Education Pharmacy and supply Blood Bank Paediatrics General Surgery Obstetrics and Gynaecology Orthopaedics Ophthalmology Oral Surgery Anaesthesiology Dermatology Cardiology Nephrology Paediatric Surgery Urology Vascular surgery Neurosurgery Neurology Haematology

Sources – Individual health facilities

6.4.2 HEALTH STATUS

Information on the status of public health in the area of the Project area has been compiled from various local hospitals and the State Ministry of Health (Kota Kinabalu). Information from the following major, lethal illnesses registered locally at Hospital Tenom and Hospital Sipitang, noted as being the two main health facilities in the area surrounding the proposed site, are:

- Arboviral diseases;
- Leukemia;
- Cancer;

- Neurodegenerative diseases, and
- Developmental disorders.

The main non-lethal causes for emergency hospital visits are respiratory diseases. For details, see **Table 6.4-2** and **Table 6.4-3**.

Table 6.4-2 Status of Public Health, Sabah

Reasons for Emergency Department Visits		2006	2007	Percentage of Total Visits - 2006	Percentage of Total Visits - 2007
Respiratory Diseases		211,324	236,268	37.4%	38.9%
Unclassified		123,013	115,318	21.8%	19.0%
Injury, Poisoning, and Other Outcomes from External Causes		49,465	58,392	8.8%	9.6%
Diseases of the Digestive System		43,855	49,618	7.8%	8.2%
Infectious and Parasitic Diseases		28,729	34,740	5.1%	5.7%
Diseases of the Circulatory System (Heart Disease)		19,832	21,293	3.5%	3.5%
Skin Diseases		18,590	16,624	3.3%	2.7%
Total Emergency Department Visits – 2006		614,233		-	
Total Emergency Department Visits - 2007		680,743		-	
Arbovirus					
		2006		**2007**	
Malaria	Cases	3029		3191	
	Deaths	9		9	
Dengue	Cases	911		2222	
	Deaths	4		6	
Japanese Encephalitis	Cases	-		-	
	Deaths	-		-	
Fialriasis	Cases	11		35	
	Deaths	-		-	
Yellow Fever	Cases	-		-	
	Deaths	-		-	
Leukemia					
		2006		**2007**	
Childhood Leukemia	Cases	27		32	
	Deaths	0		0	
Cancer					
		2006		**2007**	
	Cases	1413		1303	
	Deaths	105		86	
Neurodegenerative Diseases					
		2006		**2007**	
	Cases	1871		2041	
	Deaths	115		124	
Developmental Disorders					
		2006		**2007**	
	Cases	49		33	
	Deaths	0		0	

Source: Department of Health – Sabah

Table 6.4-3 Status of Public Health, Region Surrounding Proposed Project Site

Reasons for Emergency Department Visits – Hospital Tenom	2006	2007	Percentage of Total Visits - 2006	Percentage of Total Visits - 2007
Respiratory Diseases	9,242	11,747	41.0%	47.9%
Infectious and Parasitic Diseases	2,299	2,826	10.2%	11.5%
Diseases of the Digestive System	2,100	1,889	9.3%	7.7%
Unclassified	2,508	1,506	11.1%	6.1%
Injury, Poisoning, and Other Outcomes from External Causes	1,092	1,476	4.8%	6.0%
Diseases of the Circulatory System (Heart Disease)	1,155	1,322	5.1%	5.4%
Skin Diseases	1,129	925	5.0%	3.8%

Arbovirus – Hospital Sipitang		**2006**	**2007**
Malaria	Cases	39	85
	Deaths	0	0
Dengue Japanese Encephalitis Fialriasis Yellow Fever	Cases	0	0
	Deaths	0	0

Leukemia – Hospital Sipitang		**2006**	**2007**
Childhood Leukemia	Cases	0	4
	Deaths	0	0

Cancer – Hospital Sipitang		**2006**	**2007**
	Total Number	7 (1 Death)	15 (4 Deaths)
	Main Types of Cancer	Ovary and Lung	Lung, Colon, and Nasopharyngeal

Neurodegenerative Diseases		**2006**		**2007**	
		Hosp. Sipitang	Hosp. Tenom	Hosp. Sipitang	Hosp. Tenom
	Cases	0	30	0	17
	Deaths	0	1	0	2

Developmental Disorders		**2006**		**2007**	
		Hosp. Sipitang	Hosp. Tenom	Hosp. Sipitang	Hosp. Tenom
	Cases	4	2	2	0
	Deaths	-	0	-	0

Emergency Department Visits – Hospital Sipitang			
	Total Number of Visits	26,909	22,122
	Main Presenting Illness	Diseases of the respiratory system	Diseases of the respiratory system
	Main Presenting Ethnic Group	Peribumi Sabah	Peribumi Sabah

Sources: Department of Health – Sabah, Hospital Tenom, Hospital Sipitang.

6.4.3 HEALTH SURVEY

Health survey questions were posed to members of the public regarding key areas of environmental health, In conjunction with the socioeconomic survey conducted as part of this

EIA. Original survey responses forms can be found in **Appendix 1-10: Demography: Social Survey Forms**.

298 respondents representing a cross section of society were involved in the survey. Respondents originated from various villages surrounding the proposed Project areas in both the Kemabong and Sipitang areas. Approximately 33 villages were sampled during the survey process, between July and August 2008. (See **Table 6.4-4**).

Table 6.4-4 Villages Surveyed

Area of Survey	Village		
Kemabong	Kg. Amboi 1	Kg. Baab	Kg. Baru Jumpa
	Kg. Chinta Mata	Kg. Kalamatoi	Kg. Kalibatang
	Kg. Kalibatang Baru	Kg. Kapulu	Kg. Katambalang Baru
	Kg. Kemabong Lama	Kg. Ladang Sapong	Kg. Mamaitom
	Kg. Marais Baru	Kg. Marais Lama	Kg. Melalap
	Kg. Pantungan	Kg. Skim LIGS	Kg. Sugiang baru
	Kg. Sugiang Lama	Kg. Sugiang Tengah	Kg. Tenom Lama
Sipitang	Kg. Bamban	Kg. Bangsal	Kg. Kaban
	Kg. Lubang Buaya	Kg. Malamam	Kg. Marau
	Kg. Mendulong	Kg. Pakiak	Kg. Solob
	Kg. Tanamh Merah	Kg. Tanjung Nipis	Kg. Tunas Baru

Table 6.4-5 contains a summary of the responses received from the health survey conducted.

Table 6.4-5 Summary of Responses to Environmental Health Survey

Question Summary	Responses	Potential Environmental Health Impact from Proposed Project
Q1 – Numbers of times per day bitten by mosquitoes	55.0% - 10 - 50 times / day 24.2% - 1 - 10 times / day	Impact on mosquito populations from possible expansion of breeding areas with the hydroelectric reservoir
Q2 – When mosquitoes seem to be worse than normal	53.0% - After heavy rain 29.8% - Other (including during night time)	Impact on mosquito populations from possible expansion of breeding areas with the hydroelectric reservoir
Q3 – Efforts to control mosquitoes	43.7% - Spraying 37.4% - Fogging	Impact on mosquito populations from possible expansion of breeding areas with the hydroelectric reservoir
Q4 – Sickness relating to mosquito bites	57.3% - Have been sick 41.1% - Have not been sick	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q5 – Type of sickness related to mosquito bite	87.3% - Malaria 6.1% - Dengue	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q6 – Occurrence of death in the region from a mosquito related illness	51.4% - Know someone who has died 46.6% - Does not know someone who has died	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir

Question Summary	Responses	Potential Environmental Health Impact from Proposed Project
Q7 – Main origin of mosquitoes in the area	58.7% - River 20.2% - Other (including stagnant water in the community, and from nearby plantation areas).	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q8 – Prevention strategies against mosquito bites	47.6% - Repellent 30.2% - Mosquito net	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q9 – Concern if there was an increase in mosquito activity in the area	96.9% - Yes 2.0% - No	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q10 – Reasons why there would be a concern if there was an increase in mosquito activity in the area	90.8% - Health reasons 6.8% - Nuisance	Impacts on mosquito borne illness from an increase in mosquito populations as a result of the hydroelectric reservoir
Q11 – Concern if there was a electrical transmission line passing the village	26.1% - Yes 72.9% - No	Impacts to human health and amenity from the proposed construction of electrical transmission lines in the area
Q12 – Reasons why there would be concern if there was a electrical transmission line passing the village	75.3% - Not practical 12.3% - Health hazard 4.3% - Amenity	Impacts to human health and amenity from the proposed construction of electrical transmission lines in the area
Q13 – Perceived overall health impacts from the proposed hydroelectric Project	22.3% - Yes 50.7% - No	Potential impacts to the environment and health of areas surrounding the proposed Project area
Q14 – Origin of drinking water	39.7% - Town supply 23.0% - River or stream	Impacts on the quality of drinking water from the proposed Project
Q15 – Origin of water used for agriculture	39.7% - River or stream 27.4% - Rainwater / tank	Impacts on the quality of irrigation water from the proposed Project
Q16 – Origin of main food eaten	99.0% - Local 0.3% - Imported	Impacts on food safety from the proposed Project
Q17 – Main disposal means for wastewater (toilet and kitchen)	50.6% - Septic tank 16.9% - Other (including into self made sewer system / dug outs).	Trends of disposal
Q18 – Main disposal means for household solid waste	60.4% - Buried 22.2% - Dumped	Trends of disposal

The information contained in **Table 6.4-5** indicates the following:

- Mosquitoes Vectors – The majority of respondents suggested a minimal to moderate bite rate from mosquitoes in the area, however with a greater than half sickness rate and knowledge of death from mosquito born diseases in the area. Malaria was noted as being the main mosquito borne disease in the area, in line with health statistics contained in **Table 6.4-3**. Mosquito populations were suggested as being the greatest after heavy rain, and anecdotally originating from breeding areas related to rivers in the area. Current prevention and management methods against mosquitoes mainly include personal use of repellents and mosquito nets, as well as boarder interventions such as fogging and spraying activities. The majority of respondents would harbour concern if mosquito populations increased, mainly due to a perceived possible increase in health risk from mosquito borne diseases.

- Electromagnetic Fields – The survey indicated that the majority of respondents would not be concerned of an electrical transmission line was located in close proximity to residential areas to which they were living. Concerns that were recorded related to the practicality of the transmission line being located close to residential areas, and also the health hazards and amenity issues presented by the transmission lines.
- Water – The majority of respondents suggested drinking water was mainly sourced from treated town water supplies provided to the majority of communities surveyed. However, a comparable percentage of respondents suggested that drinking water was sourced from rivers and streams in the area, one of which is Sg. Padas, presenting a potential health risk to users. Agriculturally, the majority of food crops in the area are irrigated by water extracted from rivers and streams in the area, followed closely by the use of rain / tank water.
- Other – Survey results indicate that the vast majority of the food consumed in communities surveyed was sourced locally, suggesting home grown or local garden/field grown produce for consumption. Additionally, disposal via septic tank is recorded as being the most common way of managing grey and black wastewater from domestic sources in communities surveyed. Furthermore, solid waste is commonly buried and burned usually close to the point of generation.

6.4.4 FIELD OBSERVATIONS

A field visit as made to the proposed Project site and surrounding areas on the 4th and 5th September 2008, the following observations with regards to environmental health were noted:

- Various residential areas, inclusive of support facilities such as shops, clinics, and schools, are located along the alignments (main road) proposed for the electrical transmission lines, the Tomani – Sipitang Transmission Line Options 2 and 3, and Tomani – Tenom Transmission Line (See **Table 6.4-6**).
- The closest settlement to the proposed Powerhouse and Substation located on Sg. Padas is approximately 1 km away.
- Extensive water extraction infrastructure is located on the northern side of Sg. Padas, downstream of the proposed Powerhouse, which is operated and maintained by Department of Irrigation and Drainage (DID) for irrigation purposes in the area. This observation is also confirmed by the response to Question 15 in the health survey (See **Table 6.4-5**), suggesting that the largest proportion of water for irrigation purposes originated from nearby rivers and streams, including Sg. Padas.
- The majority of villages on the northern side of Sg. Padas, directly downstream of the proposed Powerhouse are supplied potable drinking water from the town supply system, with rainwater as a supplemental source. This was substantiated by the presence of drinking water supply infrastructure in the area, such as rising mains, water meters, and nearby treatment facilities. This observation is confirmed by the response to Question 14 in the health survey (See **Table 6.4-5**), which suggest the largest proportion water used for drinking water is sourced from the town water supplies.

- Various pebble and sand beach locations were noted along the banks of Sg. Padas, downstream of Tomani, indicating probable recreational water areas.
- Sg. Padas was highly turbid, and fast flowing, presenting possible issues for recreational and potable water uses.
- The proposed reservoir is isolated from existing population centres, with the closest settlements (consisting mainly of isolated long houses) being Kg. Ketanun (approx 3 km west), Kg. Titiku (approx 4.5 km northeast), Kg. Kungkular (5.4 km east), Ulu Tomani (approx 5.1 km east), and Melutut (approx 4.2 km east), with the closest major centre Tomani located approx 10 km northeast.

Table 6.4-6 Existing Sensitive Receptors along the Proposed Transmission Line Alignments

Alignment Option	Location	Existing Receptors	Distance from Road / Proposed Transmission Line Alignment
Tomani – Sipitang Transmission Line Options 2 and 3	Marintaman	Residential areas	150 m
		School	50 m
		Teachers quarters	100 m
		Church	50 m
		Proposed receiving substation (<100 m from church)	50 m
	Padang Barampah	Residential areas	50 m
		Shop	50 m
		School	250 m
	Pantai	Residential areas	50 m
		Café	50 m
		Mosque	100 m
	Ranau	Residential areas	50 m
	Kg. Aru Bharu	Residential areas	50 m
	Kg. Bungsal Sipitang	Residential areas	50 m
		Shop	50 m
	Kg. Lubang Buaya	Residential areas	50 m
		School	50 m
	Kg. Kaban	Residential areas	50 m
		School	300 m
		Shop	50 m
		Police station	50 m
		Clinic	50 m
	Kg. Melaman	Residential areas	150 m
	Kg. Muaya	Residential areas	100 m
Tomani – Sipitang Transmission Line Option 3 Tomani – Tenom Transmission Line	Lembaga Industri Getah Sabah Quarters	Residential areas	100 m
		Random long houses	50 – 100 m
		Church	100 m
	Kg. Paal	Residential areas	50 m

Alignment Option	Location	Existing Receptors	Distance from Road / Proposed Transmission Line Alignment
	Kg. Kemabong	Residential areas	50 m
		School	150 m
		Shops	100 m
		Clinic	50 m
	Kg. Kalamatoi	Residential areas	300 m
	Kemabong	Residential areas	100-200 m
		School	200 m
		Clinic	200 m
		Shops and cafe	100 m
		Mosque / temple	200 m
	Jabatan Air Kemabong Quarters	Residential area	100 m
	Mamaitom	Residential areas	50 m
		Church	50 m
	Kalibatang	Residential areas	50 m
		Shop	50 m
		Church	50 m
	Tomani	Residential area	50 m
		School	100 m
Tomani – Tenom Transmission Line	Sapong	Plantation quarters	200 m
		Residential areas	50 m
		School (Pre and Primary)	50 m
		Police Station	50 m
		Clinic	50 m
		Church	50 m
	Chinta Mata	Residential areas	50 m
		School	100 m

Source – Field Observations, Sept 2008.

While **Table 6.4-6** is comprehensive, it is not exhaustive, and is designed to indicate the various existing sensitive receptors, and their proximity to the proposed transmission alignments, for alignment along main roads throughout the area.

It should be noted that the majority of the sensitive receptors, consisting of residential areas, schools and clinics located in the area are in close proximity to the existing road system for convenience, in some cases approximately 50 m from the road alignment.

6.4.5 MOSQUITO VECTORS

Mosquitoes are an important factor in considering the transmission of mosquito borne disease in the country, and more specifically in the region surrounding the proposed Project.

Voluminous species of mosquito exist, however with some species more indigenous to specific regions than others. **Appendix 1-12: Public Health** contains a list and pictures of known medically significant mosquitoes, which are or can be disease carrying vectors, to Sabah. Although the mosquitoes identified in the appendix have not been identified specific to the proposed Project area, assumption can be made that most if not all can be expected to be resident at the proposed Project site.

As noted the mosquitoes contained in **Appendix 1-12: Public Health** are all mosquito borne disease vectors, meaning they have the ability to transmit diseases to human and animals through bites. **Table 6.4-7** contains details of the diseases many of the above mosquitoes can carry, based on genus, together with health outcomes from these diseases.

Table 6.4-7 Common Mosquito Borne Diseases in Malaysia with Vectors

Disease	Health Outcome	Vector (Mosquito Genus)
Chikungunya	Sudden onset of fever, severe headache, chills, nausea and vomiting, fatigue and severe, sometimes persistent joint pain. The disease is generally not fatal. Some patients have reported temporary disabling joint pain or arthritis, which may last for weeks or months. The areas around the joints become swollen and painful to the touch. A rash may sometimes occur, but haemorrhaging is rare, (WHO-SEARO, 2008).	Aedes
Dengue / Dengue Hamemorrhagic Fever	Dengue Fever usually affects older children and adults with fever, violent headache, and severe pains in the muscles and joints following an incubation period of 5-8 days, and lasts about 4-7 days. Dengue Haemorrhagic Fever involves internal bleeding and is sometimes associated with severe shock and occurs most frequently in infants and young children, (University of Sydney, 2008a).	Aedes
Japanese Encephalitis	Sudden onset of fever, anorexia and headache, vomiting, nausea, diarrhoea and dizziness. Brain dysfunction may be experienced after a few days with lethargy, irritability, drowsiness, confusion, convulsions and fits. Neck stiffness can be expected, and both coma and death may ensue. It is rare for recovery from the encephalitic syndrome to occur without some residual mental or functional disability, (University of Sydney, 2008b).	Culex
Malaria	Fever (usually periodic), anaemia and splenic enlargement, and a range of syndromes resulting from the physiological and pathological involvement of certain organs, including the brain, liver and the kidneys, (University of Sydney, 2008c).	Anopheles

Disease	Health Outcome	Vector (Mosquito Genus)
Yellow Fever	Patients with yellow fever may be viremic (have virus in their blood) for 3 to 6 days before demonstrating symptoms. Initial symptoms include fever and chills, severe headache, back pain, general muscle aches, nausea, fatigue, and weakness. This phase may be followed by a short period of symptom remission. The toxic phase develops as the fever returns, with clinical symptoms including high fever, headache, back pain, nausea, vomiting, abdominal pain, and fatigue. Hepatic coagulopathy produces hemorrhagic symptoms, including hematemesis (black vomit), epistaxis (nose bleed), gum bleeding, and petechial and purpuric hemorrhages (bruising). Deepening jaundice and proteinuria frequently occur in severe cases. In the late stages of disease, patients can develop hypotension, shock, metabolic acidosis, acute tubular necrosis, myocardial dysfunction, and cardiac arrhythmia. Confusion, seizures, and coma can also occur. When epidemics occur in unvaccinated populations, case-fatality rates range from 15% to more than 50%. Secondary bacterial infections and kidney failure are complications. Symptoms of weakness and fatigue may last several months in people who recover, (CDC, 2008b).	Aedes

Source – See references in text, and MOH, 2008.

While as noted in **Appendix 1-12: Public Health** and **Table 6.4-7**, various vectors for mosquito borne disease exist within Sabah, high risk areas for the contraction of mosquito born diseases relate to more rural and remote areas of the state. Specific conditions which contribute to heightened breeding activity and subsequent risk of illness include (adapted from CDC, 2008a):

- Areas with high vegetation (forests, etc);
- Stagnant or slow moving water bodies (swamps, ponds, pools, etc);
- Areas of high rainfall (tropical regions);
- Rural and remote areas with low population, and
- Underdeveloped areas, with poor overall maintenance.

There is considerably lower risk of illness from arboviral diseases in urban and coastal areas, (CDC, 2008a).

Negative health outcome from mosquito borne diseases in Malaysia as a whole is moderate. In 2006, as reported by World Health Organization (WHO) Regional Office for the Western Pacific (2008), dengue fever and malaria were ranked both 3rd and 5th respectively in the top main notifiable diseases for Malaysia. Dengue Fever specifically recorded 24.6 cases per 100,000 persons, translating to 7008 total number of cases, with 23 deaths, during 2006. However, Malaria recorded 12.0 cases per 100,000, translating to 3189 total number of cases, with 5 deaths during the same year, (WHO-WPRO, 2008).

6.5 PERCEPTION OF THE PROJECT

6.5.1.1 PROJECT ACCEPTANCE

In general, more than 65% of the local community studied showed their acceptance towards the Project. However, the level of acceptance (ranging 67.5% to 95%) and rejection (ranging 5% to 32.5%) is varied according to their types of properties owned. See **Table 6.5-1**.

Table 6.5-1 Responses on the Construction of Power Line across Individual Housing, Land and Crops Area

Types of Property	Agree		Disagree		Total (%)
	Sipitang (%)	Kemabong (%)	Sipitang (%)	Kemabong (%)	
House site	80	69	20	31	100
Land	95	72.5	5	27.5	100
Crop land	78	67.5	22	32.5	100

Reasons for acceptance also varied according to their types of land owned. Overall, the respondents' reasons to accept are due to benefits gained. These include compensation, better electricity supply, better infrastructure and communal acceptance. The other reasons are being non-hazardous to health and the land being vacant. See **Table 6.5-2**.

Table 6.5-2 Intensity of Response on Various Reasons for Acceptance of the Project, by Types of Property

Reasons for acceptance	House site		Land		Crop Land		General	
	Sipitang	Kemabong	Sipitang	Kemabong	Sipitang	Kemabong	Sipitang	Kemabong
Provided Compensation	★★	★★★	★★★★★	★★★★★	★★★	★★★★★	-	-
Better Electricity Supply	★★★★★	★★★★★	★★★	★	★★★★★	★★★★	★★★★★	★★★★★
No Effect on Health and Safety	★	★	-	-	-	-	-	-
General Communal Acceptance	★	★	-	-	-	-	-	-
Government Development Project	★	★	★★	★★	★	★	-	-
Non Occupied Property/Area	-	-	-	-	-	-	★★★★★	★★★★★
Better Infrastructure/Roads	-	-	-	-	-	-	★★★★★	★★★★★

Indicator (%):
★ = less than 10
★★ = 11-20,
★★★ = 21-30
★★★★ = 31-40
★★★★★ = more than 41
- =Not applicable.

A small number of respondents also had rejections for the Project for various reasons. The local community showed concern that the proposed Project may have disadvantages. Most of those who owned houses felt that the power line transmission is hazardous and they have no other alternative place to move to, whereas those who owned land feared that they may lose their land. The fear of disturbance to cultivated or crop land, soil erosion along the river banks, effects on the river flow, on safety and pollution were among other reasons cited by the respondents for their rejection. See **Table 6.5-3**.

Table 6.5-3 Intensity of Responses on Various for Rejection by Types of Property

Perceived Disadvantages	House site		Land		Crop Land		General	
	Sipitang	Kemabong	Sipitang	Kemabong	Sipitang	Kemabong	Sipitang	Kemabong
No Other Alternative Place to Stay	★★★	★★★	-	-	-	-	-	-
Hazardous	★★★★★	★★★★★	-	★★	-	-	-	-
Deplorable Compensation	-	★	-	-	-	★	-	-
Nuisance	★	★★★	★	★★	-	-	★★	★★★★
Already Obtained Electricity	-	★	-	-	-	-	-	-
Loss of Land	-	-	★★★★★	★★★★★	-	-	-	-
Disturbance of Land	-	-	-	★	★★★★★	★★★	-	-
Noise Pollution	-	-	-	★	-	-	-	-
May Cause Rival Among the People	-	-	-	★	★★★★	★	-	-
Crop Damages	-	-	-	-	-	★	-	-
Health and Safety	-	-	-	-	-	★	-	-
Soil Erosion	-	-	-	-	-	-	★★	★★★★★
Effect on the Flow of the River	-	-	-	-	-	-	★★★	★★★★★
Bad for the Natural Environment	-	-	-	-	-	-	★★	★★★★
Water Pollution	-	-	-	-	-	-	★★★★	★★★★★
Safety	-	-	-	-	-	-	★★★★	★★★★★
Bad for the Agriculture	-	-	-	-	-	-	★★	★★★
Increase of Flood Cases	-	-	-	-	-	-	★	★★★★
Not Sure	-	★	-	-	-	★★★★	-	-

Indicator (%):
★ = less than 10
★★ = 11-20,
★★★ = 21-30
★★★★ = 31-40
★★★★★ = more than 41
- =Not applicable.

On the specific question on their willingness to relocate the site of their house site, a majority (47.7%) refuses to relocate and about 35.7% were willing to do so. See **Table 6.5-4**.

Table 6.5-4 Respondents' Willingness to Relocate Their House

Willingness to move	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Yes	28.0	39.5	35.7
No	62.0	40.5	47.7
Not sure	10.0	20.0	16.7
Total	**100.0**	**100.0**	**100.0**

6.5.1.2 OPINION ON THE POSSIBLE IMPACT OF THE PROJECT TO AGRICULTURAL AND FISHING ACTIVITIES

Generally the respondents from both districts did not perceive the construction of the dam over Padas River to cause any significant negative impact on their agricultural and fishing activities especially from the respondents in Sipitang. This may be due to the fact that the Padas River does not flow in the Sipitang district. However the community in Kemabong where the Padas River flows expressed some concern on the possible negative impact i.e. reduction in the volume of fish, crop damages (3.5%) and as well as a very small concern of the impact on river pollution and unpredictable water level. See **Table 6.5-5** and **Table 6.5-6**.

Table 6.5-5 Possible Impacts on Agricultural Activities

Impacts on Agricultural Activities	District		Total (%)
	Sipitang (%)	Kemabong (%)	
No impact	98.0	60.5	73
River pollution		3.5	2.3
Crops damages	2.0	36.0	24.7
Total	**100.0**	**100.0**	**100.0**

Table 6.5-6 Possible Impacts on Fishing Activities

Impacts on Fishing Activities	District		Total (%)
	Sipitang (%)	Kemabong (%)	
No Impact	99.0	51.0	67.0
Fish reduction		29.0	19.3
Fish increase		4.0	2.7
River pollution		2.5	1.7
Unpredictable water level		1.5	1.0
Not sure	1.0	12.0	8.3
Total	**100.0**	**100.0**	**100.0**

6.5.1.3 PERCEPTION OF AREAS OF SENSITIVITY

As per **Table 6.5-7**, about 65% of the respondents did not see any areas in their villages as a sensitive place that cannot be disturbed for the purpose of Project development. However, a very small proportion of the respondents did indicate certain sensitive areas that may create concern i.e. the grave site, settlement and farming area.

Table 6.5-7 Perception of Areas of Sensitivity

Sensitive Areas	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Grave site	17.0	8.5	11.3
Private land	2.0	.5	1.0
Water catchments	2.0	.5	1.0
Farm / garden	5.0	6.5	6.0
Riparian (river)	1.0	6.0	4.3
Waterfall		.5	.3
Settlement	5.0	7.0	6.3
Forest	1.0	1.5	1.3
School		2.0	1.3
Wet rice field	1.0	2.5	2.0
Not sure	66.0	64.5	65.0
Total	**100.0**	**100.0**	**100.0**

6.5.1.4 JOB OPPORTUNITIES

The respondents expect that the Project can generate various job opportunities such as manual labourers (86%), truck drivers (59.7%), heavy machinery handlers (47.3%), supervisors (35.3%), carpenters (32.7%), clerks (30.7%) and officers (25.3%) for people in nearby villages. The distance factor may have some bearing on the positive response on the job opportunities among the respondents in the Sipitang and Kemabong districts. Although the dam is in Sipitang district, considering accessibility it is nearer from Kemabong district wherefore the people from this district have higher expectations to these job opportunities than the respondents from Sipitang. See **Table 6.5-8**.

Table 6.5-8 Opinion on the Job Opportunities That Would Be Available to the Local

Types of Job opportunities	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Manual labours	89	84.5	86
Carpenters	16	41	32.7
Officers	8	34	25.3
Supervisors	15	45.5	35.3
Clerks	12	40	30.7
Truck/Lorry Drivers	52	63.5	59.7
Heavy machinery handlers	39	51.5	47.3

Some job opportunities are also expected to be generated for women i.e. as cooks (57.3%), clerks (32.3%), manual labourers (13%) and officers and supervisors (18.4%). See **Table 6.5-9**.

Table 6.5-9 Job Opportunities for Women

Types of Job Opportunities	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Cooks	38	67	57.3
Manual labours		19.5	13
Carpenters		1.5	1
Officers		16	10.7
Supervisors		11.5	7.7
Clerks	6	45.5	32.3

6.5.1.5 OPINION ON THE OUTSIDE/FOREIGN WORKERS

The respondents strongly feel that the local people from these two districts should be fully utilized as the labour force in the Project. The assessment however also showed that the respondents were in favour of using Sabahan workers from outside the district rather than the hiring of foreign workers.

Foreign labour is seen as skilled workers and as an additional work force for the Project. But foreign labour is still seen culturally as a nuisance why the priority should be given to the locals or at least Sabahans. See **Table 6.5-10** to **Table 6.5-13**.

Table 6.5-10 Reasons for Accepting Foreign Workers

Reasons for Acceptance	District	
	Sipitang (%)	Kemabong (%)
Not a problem	28.4	39.2
Skilled labourer	36.2	39.2
Need for Additional Work Force	35.4	21.6
Total	**100.0**	**100.0**

Table 6.5-11 Reasons for the Rejection of Foreign Workers

Reasons for Rejection	District	
	Sipitang (%)	Kemabong (%)
Priority to local	50.7	32.9
A nuisance	46.2	59.7
Not sure	3.1	7.4
Total	**100.0**	**100.0**

Table 6.5-12 Reasons for Acceptance of Non-Village Local Workers

Reasons for Acceptance	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Not a problem	21.5	27.5	25.7
Skilled Labourers	21.5	20.0	20.4
Local people	57.0	47.5	50.3
Not sure		5.0	3.6
Total	**100.0**	**100.0**	**100.0**

Table 6.5-13 Reasons for Rejection of Non-Village Local Workers

Reasons for Rejection	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Not agree		2.5	1.2
Work Competition towards the local people	25.7	42.5	34.8
Nuisance (peace and order)	28.6	32.5	30.8
No comment was given	45.7	22.5	33.2
Total	**100.0**	**100.0**	**100.0**

6.5.1.6 IMPACT OF ROAD DEVELOPMENT

The Project will inevitably generate construction of new roads as well as upgrading the existing roads in Sipitang and Kemabong districts. This road development will most likely cut across rivers, forest, settlements, plantations and farms in these two districts. Only a small proportion of respondents in Sipitang (12%) and about almost half of the respondents in Kemabong (41.5%) raised issues such as on safety, noise pollution and air pollution that may arise from road constructions. Similar views were expressed on the impact due to the upgrading of current roads in estates and villages. See **Table 6.5-14**.

Table 6.5-14 Response the Road Development along the Hydroelectric Project Area

Impacts of Road Development	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Not a disturbance	88.0	58.5	68.3
Safety concern	4.0	11.5	9.0
Air pollution	1.0	10.0	7.0
Road congestion		3.0	2.0
River pollution		4.0	2.7
Land slide		2.5	1.7
Noise pollution	7.0	9.0	8.3
Road damages		1.5	1.0
Total	**100.0**	**100.0**	**100.0**

Though more transportation may be available for the local due to the Project development (46.7%), the respondents in both districts also showed concern on the problems that may arise from the increasing number of vehicles following the implementation of the Project. They believed that the increasing number of vehicles may cause more road accidents and pollute the area with dust. See **Table 6.5-15**.

Table 6.5-15 Respondents' Response towards the Increasing Number of Vehicles

Responses	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Prefer (more transportation)	71.0	34.5	46.7
Don't prefer (too dusty)	16.0	40.0	32.0
Don't prefer (increasing road accidents)	13.0	25.5	21.3
Total	**100.0**	**100.0**	**100.0**

6.5.1.7 HEALTH CONCERNS RELATED TO POWERLINE TRANSMISSION

A majority of the respondents did not see the power line transmission as a risk to their health (77.7%). Only 22.3% saw a possible risk and these respondents strongly felt the need for health compensation (76.7%) with a higher percentage among the Sipitang respondents. See also **Table 6.5-16** and **Table 6.5-17**.

Table 6.5-16 Concerns on the Effect of the Power Line Transmission on Health

Health Risk	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Yes, health risk may occur	21.0	23.0	22.3
No health risk	60.0	46.0	50.7
Not sure	19.0	31.0	27.0
Total	**100.0**	**100.0**	**100.0**

Table 6.5-17 Response on the Need for Health Compensation

The Need for Health Compensation	District		Total (%)
	Sipitang (%)	Kemabong (%)	
Yes	92.0	69.0	76.7
No	2.0	11.0	8.0
Not sure	6.0	20.0	15.3
Total	**100.0**	**100.0**	**100.0**

6.6 ECONOMIC ACTIVITIES IN THE RESERVOIR AND WATER CATCHMENT AREA

6.6.1.1 SABAH FOREST INDUSTRIES

The proposed dam and reservoir is sited within the Sipitang and Ulu Sg. Padas Class II Forest Reserves (Forest Management Unit (FMU) 07) which is licensed to the Sabah Forest Industries (SFI).

The catchment area covers about 188,500 ha, which includes or cuts into three forest reserves and two areas of state land (**Table 6.6-1**).

Table 6.6-1 Land Classification

Forest Reserve/Classification	Total area	Area within the catchment area	Percent (%) of catchment area
Sipitang Forest Reserve (Class II).	246,664 ha	121,852 ha	64.6 %
Upper Padas Forest Reserve (Class II	60,529 ha	31,297 ha	16.6 %
Maligan Virgin Jungle Forest Reserve (Class VI)	9,240 ha	9,240 ha	4.9 %
Basio Virgin Jungle Forest Reserve (Class VI)	213 ha	213 ha	0.1 %
State land (Long Pa Sia and Long Maligan)	25,898.4 ha	25,898 ha	13.7 %
Total catchment area		**188,500 ha**	**100 %**

Of the 121,852 Ha of the Sipitang Forest reserve and the 31,297 ha of Upper Padas Forest Reserve, which cover the catchment area, 94,578 Ha are set aside for natural forest management with the remainder, 58,571 ha planned for conversion (**Table 6.6-2**). However, the areas set aside for conversion contain large areas of steep slopes and riparian reserves (**Map 6.6- 2 Existing Protection Area and Slope > 25^{o}** and **Map 6.6- 1 Existing Riparian Reserves**), which eventually will be excluded from the actual conversion and planting process.

A new strategic forest function plan (land use plan) is being negotiated between the Sabah Forest Industries and the Forest department.

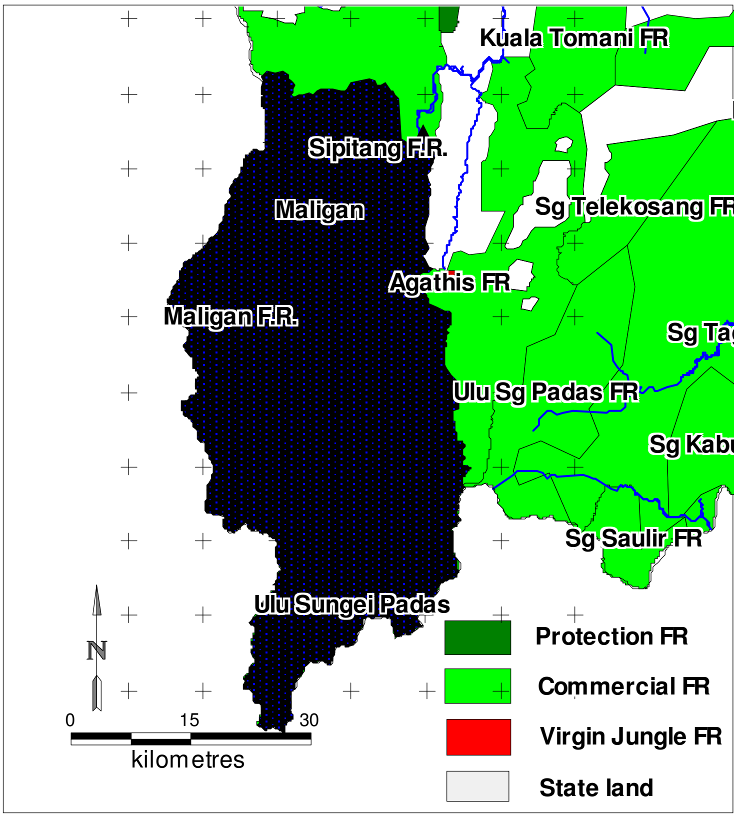


Figure 6.6.1 Forest Reserves and the Catchment

The new plan include the same overall areas for natural forest management and for industrial tree plantation areas but equal areas have been swapped between the two. The result is a larger proportion of natural forest management in the Project's catchment area. See **Map 6.6- 3 SFI Proposed Strategic Management Plan.** This map shows that compartments P36, P41 and P47 are now planned for natural forest management while the parts of P02 and P13 that used to be for natural forest management are now proposed for industrial tree plantation areas. The map also shows several areas set aside as High Conservation Value Forest or Protection Area. Of particular interest are the slopes of P14 and P19 on the Western side of the proposed reservoir and the slopes in P04.

The Sabah Forest Industries is currently establishing a new workplan including a plan for rotation of specific compartments and sub divisions of compartments. There is therefore at the moment no plan or map showing when different compartments will be harvested or planted.

Table 6.6-2 Strategic Land Use (area) of the Catchment Area

Forest land use	Area	Pct of catchment area
Natural Forest Management	94,578 ha	50 %
Industrial Tree Plantation	58,571 ha	31 %
State Land	25,898 ha	14 %
Virgin Forest Reserve	9,453 ha	5 %
Catchment area	**188,500 ha**	**100 %**

Sabah Forest Industries' (SFI) commercial operations began in January 1983 as the first integrated pulp and paper mill in Malaysia with a paper capacity of 144,000 t/year and pulp capacity of 106,000 t/year. Currently, SFI is in the process of expanding its annual pulp production to 210,000 t/year. The 98% increase in pulp production will i.a. yield additional pulp sheet of 63,500 t/year solely for shipping to external paper making facilities. The total saleable paper and pulp after the expansion will be 354,000 t/year. The pulp and paper produced is expected to cater for the international as well as the domestic markets.

The overall objective of the Sabah Forest Industries (SFI) 285,000 ha concession is to provide a reliable source of raw material for the SFI pulp and paper mill in Sipitang. Large areas are therefore set aside for conversion to industrial tree plantations (ITP), mainly with *Eucalyptus grandis* below 800 meter above sea level and *Acacia mangium* above. Remaining production areas are maintained as mixed natural forests under sustainable forest management (NFM).

Three nurseries supply seedlings for Sabah Forest Industries' plantation and enrichment programmes. The nurseries are listed in **Table 6.6-3** and depicted on a map in **Map 6.6- 4 Nursery Locations**. At the moment all planting stock is from seed. Acacia is a combination of seed Sabah Forest Industries' our own seed stands and seed orchard seed from CSIRO Australia. Eucalyptus is again seed from own collections and seed orchard seed from SAPI in South Africa.

Table 6.6-3 SFI Nurseries

Nursery location	Area	Species
Ganui	2.363 ha	*Acacia mangium* *Eucalyptus grandis*
Mendulong	12.819 ha	*Acacia mangium* *Eucalyptus grandis*
P28	2.939 ha	*Eucalyptus grandis* *Indigenous species*
Total	**18.121 ha**	

SFI has introduced natural boundaries for their administrative units (zones, regions and compartments). This greatly supports sound environmental management, which ultimately also will promote better production in the forest. It also means that riparian reserves and other exclusion zones rarely fragment administrative units as these zones tend to be boundaries of the units. **Table 6.6-4** lists all compartments within the catchment area and the approximate areas planned for ITP and NFM.

Table 6.6-4 Compartments within the Catchment Area (Hectares)

Compartment	Land Use (Ha)						
	Forest Function	Production	Wildlife Buffer	Recreation	Conservation	Community Forestry	Total
MENDOLONG	ITP	0	0	0	356	0	356
P01	ITP	2,333	233	0	215	0	2,780
P02	ITP	2,284	0	0	0	0	2,284
P03	ITP	2,261	44	0	159	0	2,464

Compartment	Land Use (Ha)						
	Forest Function	Production	Wildlife Buffer	Recreation	Conservation	Community Forestry	Total
P04	ITP	2,320	39	0	313	0	2,672
P07	ITP	2,872	132	0	0	0	3,004
P08	NFM	1,062	134	0	1,023	0	2,219
P12	ITP	2,379	84	0	0	0	2,463
P13	ITP	2,774	116	0	0	0	2,890
P14	ITP	3,995	29	0	0	0	4,024
P17	ITP	2,094	66	0	0	0	2,160
P18	NFM	1,825	187	0	451	0	2,464
P19	ITP	3,170	54	0	0	0	3,224
P20	ITP	3,834	104	0	350	0	4,288
P24	ITP	2,863	169	0	0	0	3,032
P25	NFM	2,059	80	0	581	0	2,720
P26	ITP	1,849	0	0	551	0	2,400
P27	ITP	2,420	0	0	0	0	2,420
P28	ITP	3,508	172	0	0	0	3,680
P29	ITP	3,064	232	0	0	0	3,296
P30	ITP	2,574	506	0	0	0	3,080
P31	ITP	3,177	83	0	0	0	3,260
P36	ITP	425	0	0	0	0	425
P36	NFM	2,951	0	0	0	0	2,951
P37	ITP	3,278	142	0	0	0	3,420
P38	NFM	3,795	169	0	0	0	3,964
P39	NFM	4,086	406	0	0	0	4,492
P41	ITP	541	42	0	0	0	583
P41	NFM	3,057	236	0	0	0	3,293
P42	ITP	3,436	200	0	0	0	3,636
P43	NFM	2,680	110	526	0	0	3,316
P44	NFM	3,507	97	0	0	0	3,604
P45	NFM	2,788	320	0	0	0	3,108
P46	NFM	2,320	34	0	386	0	2,740
P47	NFM	2,782	34	0	0	0	2,816
P48	NFM	1,760	160	0	665	0	2,584
P49	NFM	2,910	83	0	749	0	3,742
P50	NFM	2,235	64	0	0	1	2,300
P51	NFM	514	35	0	2,543	0	3,093
P52	NFM	3,962	117	0	0	281	4,360
P53	NFM	3,622	0	0	0	0	3,622
P54	NFM	4,220	0	0	680	0	4,900

Compartment	Land Use (Ha)						
	Forest Function	Production	Wildlife Buffer	Recreation	Conservation	Community Forestry	Total
P55	NFM	3,304	0	0	0	0	3,304
P56	NFM	2,514	60	0	0	182	2,756
P57	NFM	2,182	66	0	0	0	2,248
P58	NFM	2,115	157	0	289	0	2,561
P59	NFM	2,327	52	0	426	0	2,804
P60	NFM	3,324	0	0	0	0	3,324
P61	NFM	3,776	0	0	0	0	3,776
P62	NFM	3,301	0	0	0	0	3,301
P63	NFM	2,761	41	0	12	0	2,814
P64	NFM	3,141	143	0	0	0	3,284
P65	NFM	2,689	55	0	0	0	2,744
Total	NFM	83,570	2,840	526	7,805	463	95,205
Total	ITP	57,449	2,449	-	1,944	-	61,841
Grand Total		141,019	5,289	526	9,748	463	157,046

Source: Sabah Forest Industries (Some differences with other tables due to different map sources).

It should be noted that the areas listed in **Table 6.6-4** are approximate and that a compartment set aside for ITP may not be fully utilised for this purpose. Slopes and riparian reserves are but a few of the reasons for keeping some areas of natural forest within ITP compartments. **Table 6.6-4** depicts a new land use plan by the Sabah Forest Industries, which has been approved in principle but not yet contractually signed with the government.

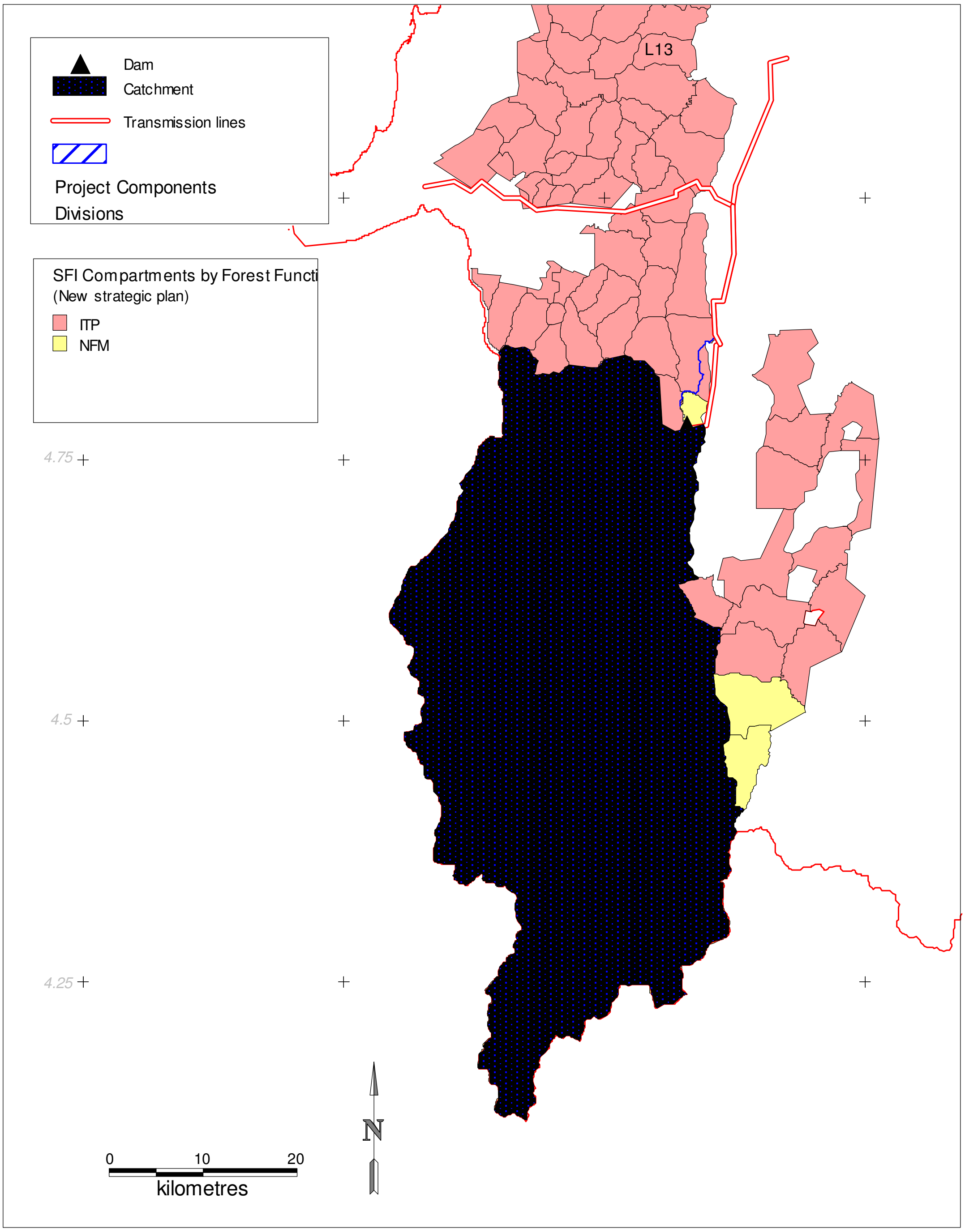


Figure 6.6.2 SFI Compartments and New Land Use in the Catchment Area

The Sabah Forest Industries concession is a license to convert suitable parts of the forest area into industrial tree plantation areas. A strategic plan for this conversion is depicted in **Figure 6.6.2**.

A preliminary environmental impact assessment was undertaken in 1981 by AF-Industtrins Processkonsult AB, Stockholm, Sweden when the SFI's Pulp and Paper Mill was first proposed by the Government. The environmental impact assessment was done in collaboration and contribution of the Department of Environment, Kuala Lumpur; the Department of Environment, Sabah; the Ministry of Manpower and Environmental Development, Sabah; the Ministry of Agriculture and Fisheries Development, Sabah; and Universiti Kebangsaan Malaysia, Kota Kinabalu, Sabah.

A final EIA was submitted in 1986 incorporating the results on a study on the impact of forest operations on soil and water. The final environmental impact assessment included 12 different studies of which four dealt directly with forest management namely:

1. Environmental conditions in forest areas
2. Social profile, economic activities
3. Raw material supply
4. (a) Environmental impact of forestry operations

   (b) Impact of forestry operations on soil and water - Monitoring report.

The concession's industrial tree plantation (ITP) areas have been subjected to Environmental Impact Assessment studies in 2001 and 2002. The Environment Protection Department subsequently imposed environmental conditions upon the Sabah Forest Industries. Among its conditions are; maintenance of riparian reserves (50 m and 20 m width) on both sides of all water courses having a water surface of 3 metres or more, prohibition of open burning, use of reduced impact logging techniques, definition of wildlife corridors and protected areas (which may act as additional soil protection zones), limitation of operations to slopes less than 25°, drainage requirements for all roads and tracks and a monitoring and reporting schedule once in every four months to the Environment Protection Department. The riparian reserves and excluded slopes are shown in **Map 6.6- 1 Existing Riparian Reserves** and **Map 6.6- 2 Existing Protection Area and Slope > 25°.**

In developing the Industrial Tree Plantations following measures were be adopted:

- *Mostly areas with slopes of less than 15°. will be converted into forest plantations. No plantations will be developed on slopes greater than 25°.*
- *The plantations will be subdivided into planting blocks of about 100 ha each and will be separated by buffers of natural forests. The buffers act as firebreaks and wildlife corridors.*
- *A system of linked riparian reserves and buffers throughout the forest plantations will be established and maintained for conservation.*
- *Uncontrolled open burning will be strictly prohibited.*
- *Blading of topsoil will be prohibited except for the road construction.*
- *Terracing will be prohibited.*
- *Riparian reserves of 20 m wide on each side of the river or permanent water courses will be fully protected.*
- *Clearing will progress towards wildlife protection areas and natural forests areas to protect wildlife.*

SFI is also increasing its supervisory and monitoring presence in the field by planning to have a forest area manager stationed in camps for each 10,000 ha. At the same time, the company is planning to venture into cable yarding to increase efficiency and decrease environmental impact.

The production in the mixed natural forest is planned to be high quality saw and veneer logs, not logs for pulp and paper production. The floral description of plantation area and mixed natural forest is presented in **Section 3.4**.

The company's medium term strategy includes efforts to qualify for MTCC (Malaysian Timber Certification Council) certification for sustainable forest management. Due to market considerations, Forest Stewardship Council (FSC) certification would be better. However, FSC does not accept conversion from natural forest to plantation forestry.

This assessment is primarily concerned with the effect of the catchment area management on soil stability and its consequential impacts on the water. In this context, the requirements to soil and water protection are almost similar in the two certification systems.

6.6.1.2 NATURAL FOREST MANAGEMENT (NFM)

As **Figure 6.6.2** shows, most of the southern part of the catchment area is dedicated as forest under natural forest management, mainly due to slope limitations for plantation development. The total area of the natural forest management will be around 95,000 ha or about half of the catchment.

In the areas under natural forest management, selective logging is carried out under the Forestry Department regulations for reduced impact logging or RIL.

Reduced impact logging, (RIL) is a harvesting system designed to minimize damage to potential future crop trees and the area's general production capacity. It will simultaneously minimise damage to soil and water resources. RIL requires detailed mapping and planning of the harvesting operation: Single trees are mapped and the extraction of each tree is planned in order to minimize general disturbance of the area. During the harvesting operation, directional felling is implemented, debris is maintained on skid tracks and various limitations are imposed on other infrastructure developments. Post harvest activities includes rehabilitation of landings, prevention of run-off erosion on abandoned roads and tracks through water bumps and other diversion measures.

For the purpose of this assessment it is important to note that the Sabah RIL regulations require riparian reserves to be established also in areas under natural forest management.

A site visit in 2010 into the NFM areas (P43, P44, P53, P57, P62, P61) verified adherence to the reduced impact logging requirements in the logged areas. It was particularly noticed how tracks were minimized, how they were protected by debris and that drainage in various forms were installed even on old tracks. Crossings of water courses were minimal and where they had been necessary, they were removed and the original flow of the rivers re-established. Damage to residual stand was within acceptable limits.

The Sabah Forest Industries has currently not done much in form of enrichment planting but is considering doing so using the local species Agathis and Kayu Cina (*Antocephalus chinensis*).

The Forest Department has made small patches of enrichment plantings using a variety of species.

With the current condition of the primary and remnant natural forest it is highly doubtful if enrichment planting has any practical or conservation purpose.

The roads are in general in good conditions and there are effective restrictions on driving on wet roads.

Various new methods of bringing the logs out without having large ground based tractors moving from tree stump to tree stump are being considered. These methods include improved winching (log fishers) and high-lead cable systems.

Figure 6.6.3 Log Fisher

It should be noticed that there officially are no protected riparian reserves in the natural forest areas. The RIL regulations, however, serve to protect rivers and streams.

As in most if not all large forestry operations in Sabah, the Sabah Forest Industries does not carry out all field operations with own staff and machinery. A large fleet of contractors and sub contractors are in the field.

Most of the contractors have been with the Sabah Forest Industries for many years. The company have in recent years advertised for contractors and selected them on the basis of their relevant experience and on the content and substance of their written proposals. Contracts are only awarded if the Sabah Forest Industries are satisfied that the applicant has the technical and financial resources to do the work. The contracts explicitly refer to the EIA and require the contractor to be familiar with it and to adhere to its provisions. The contract also details Sabah Forest Industries' intention to obtain forest certification and the requirement that the Contractor comply with any certification requirements.

There has previous been only little incentive for the contractors to follow e.g. RIL guidelines as field supervision of the contractors has been minimal. With the new management in Sabah Forest Industries, field supervision has been intensified and as mentioned, the plan is to have an SFI field supervisor for each 10,000 hectares.

6.6.1.3 CONVERSION TO INDUSTRIAL TREE PLANTATION

Areas intended for conversion to plantation are mainly located in the northern part of the concession. Exclusion zones such as riparian reserves (**Map 6.6- 1 Existing Riparian Reserves**) and slopes exceeding 25° (**Map 6.6- 2 Existing Protection Area and Slope > 25°**) are demarcated prior to conversion activities. **Map 6.6- 5 2008 Plantation Status** depicts the current plantation and replanting area as of 2008.

Commercial timbers are extracted by conventional methods, i.e. using large ground based tractors to create access to felled stems and to extract these before actual land preparation for plantation establishment. The principles of RIL are applied for this salvage operation to the degree that is compatible with the objective of land clearing. Riparian reserves are clearly demarcated and tractors are kept out of these zones and are not allowed to cross streams and rivers. This is where Sabah Forest Industries' compartment alignment comes to its true value: The compartments follow ridges and rivers, thus eliminating the need for crossing natural boundaries during work.

Remaining biomass is toppled and crushed *in situ* by driving over it with an excavator. The environmental conditions strictly prohibit open burning; thus, new plantation is established in between debris. There is no soil preparation and no digging of open planting holes in advance of the actual planting.

Planting of Acacia and Eucalyptus was earlier done at 4x2 m spacing (1250 trees per ha) but the new management of Sabah Forest Industries has increased planting density to 2.5x2.5 m (1600 trees per ha). Weed control has been intensified and canopy closure is generally expected within a year. Fertilizers are applied as 30 grams of slow release NPK (10:26:10) applied in the planting hole. No other silvicultural activities such as thinning, singling or pruning is envisaged.

A site visit in 2010 to working ITP areas and to areas cleared and planted 1-3 years earlier confirmed that field operators were following instructions, that field supervision was in place and that the field organisations had authority to exclude areas that for some reason should be excluded from clearance. This could be dense high quality natural forest, steep slope, rocky terrain, water courses.

Weed control is manual and the fertiliser application is done by applying slow release fertilizers directly into the planting hole together with the seedling before covering with soil. This prevents loss to surface run-off and ensures a slow but constant access to nutrients in the important period where the seedling must establish a root system. Later applications, if they become necessary, can be applied on the soil surface as the trees by this time have developed superficial roots that can absorb the released fertilisers. However, as mentioned, there is currently only one application applied.

Forestry applications of fertilizers is considered minimal and since the major part is dug into the ground in the planting hole, pollution of water courses is also considered minimal to a level where there has not been any identified need for particular monitoring programmes.

With proper planting material (seed sources, provenances, root-top ratio etc) proper planting technique (respect for root position, temporary storage facilities, planting time, fertilizer application etc) canopy closure can be achieved within 1-2 years. With Sabah Forest Industries' intention not to carry out any silvicultural treatment in the form of thinning, canopy closure should not come too soon as this may impede growth. Canopy closure is, however an important tool for weed control and self pruning. In an open forest, the soils may be protected by the weeds whereas in the closed stand, the canopy will protect the soil surface from direct impact of the rain plus there will be a better layer of litter covering the soil.

Harvesting is expected after about 8 years; however SFI expectations for shorter rotation age may be achieved. Nevertheless, this may lead to increased surface erosion and may even lead to decrease of the areas' production capacity, *i.e.* less forest cover.

However, at the present operation levels, all efforts are taken to reduce negative environmental impacts by adhering to the environmental conditions as stipulated by the Environment Protection Department.

Map 6.6- 6 Plantation Species (2008 Status)) shows the species used on different plantation sites. Acacia species are mainly planted in the north of the concession, outside the catchment area for this Hydroelectric Power Project. On the higher ground within the catchment area, the preferred species are *Eucalyptus grandis, E. Urophylla, E. Camaldulensis* and a small part of *Gmeline arborea.* Mixed stands do also occur both with Acacias and Eucalyptus.

The Acacias used are *Acacia Mangium, A. Aulacocarpa* and *A. Crassicarpa*. Some areas are also planted with *Albizia falcartaria*. Of particular interest is that the *Acacia auriculiformis* is not among the common species and that the hybrid *mangium x auriculiformis* is not in use at all.

Nurseries. Three nurseries (**Map 6.6- 4 Nursery Locations**) are currently in operation: P28, Mandulong and Ganui.

Land slips and slope failures. Land slips and slope failures are a natural and common phenomena even under primary forest conditions. When a tree gets too large to be supported by the skeleton soils, the slope fails, the tree falls and brings sometimes a rather large portion of the slope down. The only thing that can be done to prevent this is to log areas with large trees in time before they fall naturally. Such slope failures can be seen in many places but are not seen to be due to logging activities except for road building.

Roads. Roads must at times pass very steep areas and it is necessary to cut slopes. The cut face or the bank of the roadside below, where the soil is deposited will for some time be exposed. This is a costly affair for the company, who therefore will do its best to avoid further failures which will interrupt use of the road and cause a need for repairs. Road maintenance crews are therefore constantly roaming the road network in order to foresee any problems and do the necessary repairs before anything goes wrong.

The road gradient is limited in the environmental conditions issued by the Environment Protection Department. Sabah Forest Industries is seen as complying with the requirements not only because it is a requirement but also because it is common sense to ensure safe and year round transportation and to minimise the need for costly repairs of roads or vehicles.

Implications of industry expansion

With 58,000 hectares ITP area in the catchment area 7,250 hectares will be ready for harvest and re-planting every year if the area is fully developed according to plans. Assuming a yield of about 120 m^3 per hectare, the area will provide 870,000 m^3 of raw material to the mill in Sipitang.

Impact of forestry activities on the Project

The Project will need a flow of water, a buffer (the live storage) to compensate for peaks and dry spells and a height difference to provide the pressure for the turbines.

The turbines are not particularly sensitive to suspended solids or to the chemical composition of the water.

The intake points for the turbines are at about 35 metres depth or about 85 metres from the bottom. The water below the intake points is in reality dead storage and without any use for the Project except for one thing: It provides for storage space for sedimentation as the reservoir will act as a large silt trap. If sedimentation exceeds this storage, the intakes will get blocked and the Project will fail.

Some dams are equipped with flushing outlets at the bottom of the structure but this is not considered a feasible option in the current case. It should not be necessary.

The risk and the fear is therefore that the management regime of the large land conversion programme and the annual re-planting programme will suddenly cause an unexpected inflow of soil, which too quickly will fill the dead storage and render the Project a failure.

This may happen for other reasons than forestry. If the improved access or the general development in the area attracts squatters or even tourism activities close to the reservoir, an unexpected amount of soil may end up in the reservoir and threaten the water intake. It will take many years but it will still shorten the life of the Project.

The Project therefore has one single interest in the catchment area management: To control the annual erosion rates, to ensure it does not escalate beyond the present level. How it is done is of less importance for the Project. As a corporate citizen, the Project Proponent must be working for maintenance of biodiversity and healthy habitats but based on the technical and economic viability of the Upper Padas Hydro Electric Power project, his concern is not to have his dead storage filled before time.

Under the present conditions, this is an unlikely but not unimaginable event. Management regimes can be changed, development policies and strategies can be changed.

6.6.1.4 LOCAL USE OF NATURAL RESOURCES

6.6.1.5 RIVERINE FISHERIES

Fishing activities are mainly carried out at Padas River and its major tributary, Maligan River. The pools found along the two rivers are important fishing sites for the local people. The popular fishing sites in Padas River are located mainly above the proposed power house area up to the tributary of Maligan River (**Map 6.6- 7 Location of Fishing Sites in Padas River**).

The fishing sites along the stretch of Padas River are allocated among the different villages. The stretches of Padas River from Lubok Laamukon up to Lubok Ansaiangkinam are fishing sites for the villagers from Kg Kemabong up to Kg Katambalang Baru. The stretches of Padas River from Lubok Pungiton up to Lubok Puta are fishing ground for villagers from Kg Kungkular. The stretches of the river from Lubok Maulor upstream are fishing ground for villagers from Kg Lelang, Kg Ulu Tomani and Kg Melutut (**Table 6.6-5**).

Table 6.6-5 Fishing Sites Along the Stretches of Padas River

No.	Fishing Sites	Villagers Allocated to Fishing Sites
1	Lubok Laamukon	Kg Kemabong, Kg Mamaitom, Kg Bangkulin, Kalibatang, Kg Tomani, Kg Kaliwata and Kg Katambalang Baru
2	Lubok Batu Paya	
3	Lubok Luhan	
4	Lubok Lingguangon	
5	Lubok Tingkaluron	
6	Lubok Pena'awan	
7	Lubok Ansaiangkinam	
8	Lubok Pungiton	Kg Kungkular
9	Lubok Tohokon Aningka	
10	Lubok Karaamoh	
11	Lubok Mansam	
12	Binaung	
13	Lubok Puta	
14	Lubok Maulor	Kg Lelang, Kg Ulu Tomani and Kg Melutut
15	Lubok Pomotoran	

Fisheries at the Stretches from Lubok Laamukon to Lubok Ansaiangkinam. There are seven popular fishing sites at the stretches of the Padas River from Lubok Laamukon to Lubok Ansaiangkinam. These sites are assigned to be the fishing ground for the villagers from Kg Kemabong up to Kg Katambalang Baru.

Fishing is normally carried out during the dry season when the water level is low. During normal fishing time, up to four groups would go to this area to fish (and hunt for wildlife) and normally stay for one to two nights. Each group would consist of 3 - 4 persons and the catch could be up to 20 kg of fish. However, during certain occasions e.g. for preparing for a marriage ceremony, up to 14 persons would come to this area to fish. They would stay here for up to 12 days and normally would catch up to 400 kg of fish. Fish caught are degutted, cut into smaller pieces and salted before they are placed in containers for transportation.

The commonly used fishing methods are gill net of mesh sizes 7.5 cm, 10.0 cm and 12.5 cm and each trip 10 - 20 gill nets were used. Other fishing methods used include cast net, hook and line and spear fishing. Catch per unit effort (CPUE) varies depending on the purpose of fishing. During normal fishing time, CPUE range from 5 to 7 kg per person per day. However, during certain occasion the intensity of fishing increases and CPUE increase to 8 to 11 kg per person per day.

The dominant species caught are *Tor* spp. and *Barbonymus* sp. The other species caught are *Mystus baramensis*, *Lobocheilus bo*, *Osteochilus chini* and *Kryptopterus* sp.

Fisheries at the Immediate Vicinity of the Proposed Dam Site. There are five popular fishing sites within the immediate vicinity of the proposed dam site from Lubok Pungiton up to Lubok Puta (**Table 6.6-5**). There are five groups from Kampung Kungkular who fish at this stretch of Padas River during dry season when the water level is low. Each group consists of 4 - 5 persons and they would spend 4 - 5 days per trip. Due to the distance of these fishing sites from the village (about 5 hours walk), most of the fishing trips are carried out in preparation for certain occasions such as marriage ceremony or memorial service for the death.

The commonly used fishing methods are gill net of mesh sizes 7.5 cm, 10.0 cm and 12.5 cm and each trip 10 - 15 gill nets were used. Other fishing methods used include cast net, hook and line and spear fishing.

The dominant species caught are *Tor* spp. and *Barbonymus* sp. The weight of most of the *Tor* spp. caught ranged from 0.8 – 1.0 kg. However, fish of up to 5 kg can be occasionally caught from the area. Other species caught are *Mystus baramensis*, *Lobocheilus bo*, *Osteochilus chini* and *Kryptopterus* sp. During each trip, approximately 150 kg of fish of different species was caught. The catch per unit effort at this site is approximated at 7.5 to 9.4 kg per person per day.

Fish caught are degutted, cut into smaller pieces and salted before they are placed in containers. They are sold at the village for MYR 150 – MYR 180 per container.

Fisheries from Lubok Maulor upstream. There are two popular fishing sites for the villages from Kg Lelang, Kg Ulu Tomani and Kg Melutut namely Lubok Maulor and Lubok Pomotoran. Fishing is also carried out during dry season when the water level is low. Due to the distance of these fishing sites from the village, most of the fishing trips are carried out in preparation for certain occasions such as marriage ceremony. The commonly used fishing methods are gill net of mesh sizes 7.5 cm, 10.0 cm and 12.5 cm and each trip 10 - 15 gill nets were used. Other fishing methods used include cast net, hook and line and spear fishing. The dominant species caught are *Tor* spp. and *Barbonymus* sp. The catch per unit effort at this site is approximated at 7 to 9 kg per person per day.

Fisheries at Kampung Pangi. Fishing activities are normally carried out during drier season when the water level is low. On average, there are only 4 – 5 fishing days monthly. However, once or twice a year when the power station ceased operation during drought season for about 6 - 7 hours, almost all families in Kg Pangi and other villages downstream would go to the river to fish.

Due to its close proximity to Tenom town, fish caught from Padas River are sold in the town normally about two days a week, on Wednesday and Sunday. There are five regular fishermen in Kg Pangi and three in Kg Rayu who fished and sold their catches regularly in Tenom town. Gill net of mesh sizes 4.2 cm, 5.0 cm, 7.5 cm and 10.0 cm is the most popular method of fishing used in this area. The other fishing methods include long lines fishing, hook and line, and cast net.

Each fishing trip would normally yield about 10 – 15 kg of fish. These will be sold in Tenom town for about MYR 15 per kg. The commonly caught species are *Lobocheilos bo*, *Barbonymus* sp., *Mystus baramensis*, *Hampala macrolepidota*, *Osteochilus chini*, and *Tor* spp. Other species that are occasionally caught are *Chela* sp., *Puntius binotatus*, *Kryptopterus macrocephalus* and *Monopterus albus*. Catch per unit effort at this site is about 5 to 7 kg per person per day.

However, when the power station ceased operation, water level at Padas River would be exceptionally low and deeper water would only be found at the pools. Fish would therefore congregate at these pools and during this time they could be easily caught. During this time almost all families from Kg Pangi, Kg Rayu as well as Kg Alau Gilat, Kg Saliwangon and Kg Batu 60 would go fishing at Padas River. Each family would normally use three gill nets, each net about 90 m long and 3.5 m deep with mesh size of 6.2 cm. Each family could catch about 60 – 120 kg of fish during this time. However, the dam has not ceased operation for the last two years, in 2007 and 2008. Catch per unit effort at this site when the dam cease operation is about 20 to 40 kg per person per fishing trip.

Estimated Fish Yield. Based on the information gathered from the local inhabitants, the estimated annual yield of riverine fisheries in the area to be inundated due to the Upper Padas Hydroelectric Project is 1,104 kg. The annual value of the riverine fisheries is estimated at MYR 15,180.00 (**Appendix 1-8: Aquatic Fauna (Fishes, Macro Invertebrates)**).

6.7 PUBLIC CONSULTATION AND COOPERATION

6.7.1 BENEFICIARIES, STAKEHOLDERS AND INTEREST GROUPS

Several groups are affected or activated one way or the other by the present Hydroelectric Power Project:

Beneficiaries. Beneficiaries are those who are the target group for implementing the Project, i.e. the electricity consumers.

Stakeholders. Stakeholders are individuals or organisations, who stand to lose or gain an investment, their land or livelihoods. This includes SESB, resident communities, Sabah Forest Industries, Tour Operators already operating in the area.

Interest Groups. Interest groups are those groups, who out of interest for the stakeholders or the environment seek to get involved in influencing the Project, its planning process or its implementation. NGOs are typical interest groups: Sabah Society, WWF Malaysia, Malaysia Nature Society, Sabah Consumer Association, Sabah Environment Protection Association.

Government authorities are in many ways similar to interest groups except that they are required by law to take an interest in the Project and to exercise authority in accordance with their mandates.

6.7.2 PUBLIC CONSULTATION PROCESS

The consultation process for this assessment has been conducted in four phases:

Phase 1 (Engagement with Related Government Offices and Private Enterprises). During this phase, the legal basis for control of this Project and the government organisations' mandate and capacity for such control is considered. The assessment is included in **Chapter 2**. The assessment results in some proposals for further strengthening of government capacity included in the Environmental Management Plan in **Chapter 7**.

Phase II (Public and Panel Review for TOR). This dialogue offered an opportunity for the public as well as concerned government agencies to voice their concern and to influence the entire scope and process of the assessment.

Phase III (Group and Communities Consultation Activities). Focuses primarily on consultation with the groups and communities, who stand to have their livelihoods affected by the Project. The assessment included two types of activities:

- Kemabong / Kuala Tomani Engagement Activities
- Focus Group Dialogue

The consultation program was designed to achieve the objectives outlined in the state guidelines besides conforming to the requirements of international guidelines i.e. The World Bank Group, the Asian Development Bank, and the Equator Principles Financial Institutions.

Phase IV (SEIA Public Review). The fourth phase will take place when the draft Social and Environmental Impact Assessment report is completed. This draft will be offered for comments to the public and interested organisations alike. The public will then be offered an opportunity and insight to understand the Project and to suggest final adjustments of findings and proposals.

The consultation process is to be a continuous process where the Project Proponent must keep the affected groups informed in a free, prior and informed manner, where transparency and trust must prevail in order to remove all fear of the Project and to avoid unnecessary social or political resistance to the Project.

The issue of compensation to affected villagers will require its own series of consultations guided by state legislation, guidelines and precedence.

A particular form of consultation is the reception of grievances. A grievance procedure and organisation will be set up as further defined in **Section 7.5.9**.

6.7.3 STUDY APPROACH

The consultation process was developed and implemented taking into account various areas of influence, i.e. the study zones mentioned in **Chapter 4**:

(i) The primary Project site (i.e. zones 2,3,4);

(ii) Associated facilities (i.e. access roads, transmission line, i.e. zone 5);

(iii) Cumulative effects (i.e. downstream / indirect users of the river, zone 6); and

(iv) Unplanned but predictable developments (i.e. potential development within the reservoir, see also **Section 8.1.5**).

Based on these recognised areas of influence, **Table 6.7-1** below outlines the stakeholder groups that were consulted with and a summary of how those consultations were undertaken.

Table 6.7-1 Consultation Activity Summary

Stakeholders	Consultation Activities
Government Agencies	Meetings were held with various government agencies as part of the Scoping Process. During the environmental impact assessment process, consultations were held with the Environment Protection Department, Sipitang Forestry Department, the Department of Irrigation and Drainage, Wildlife Department, Water Department, Department of Environment (Sabah), District Office of Tenom and Sipitang and Sub-District of Kemabong.
NGOs (WWF)	WWF is a member of the SEIA review panel. Given WWF's role as a reviewer their concerns and interests were noted and have been incorporated into the TOR. Additional consultations were held with the WWF during the environmental impact assessment process.
Other NGOs (SEPA)	SEPA is a member of the SEIA the review panel. SEPA's views were captured through discussion as well as later correspondence on findings SEPA and the consultants.
Local communities	Through the District Office contact was established to the local communities in order to inform them of the Project. Public briefings were held in the affected communities particularly in Kemabong area to advise people of the Project proposal and to receive their comments and concerns.
Project Affected Persons (PAPs)	PAPs representatives, directly affected groups, were consulted in Focus Group Discussions. Their interests were considered in meetings with the affected villages considering issues such as affected land, crops, fishing ground and transmission line.
Other affected Parties	The Sabah Forest Industries has been extensively consulted during the environmental impact assessment process and the company has provided a substantial amount of information useful for the assessment.

Stakeholders	Consultation Activities
Tourism Operators and Tourists	Tourism activities in the area are based primarily on white water rafting on the Sg Padas approximately 7 km downstream from the existing Tenom Pangi Dam. The Upper Padas Dam Project will not flood the rapids that are commercially rafted. There are at least four major rafting companies that operate on the affected section of the river but since the Project is not expected to have any significant effect upon the river section where they operate these operators have been excluded from the present profiling. If there are any impacts of the Project on the rapids, it will be positive as the Project may alleviate seasonal fluctuations that sometimes halt rafting activities.

6.7.4 PUBLIC AND PANEL REVIEW OF EIA TOR

6.7.5 GROUP AND COMMUNITY CONSULTATION

The following provides a summary description of the stakeholders involvement in the consultation activities. , i.e. local communities and other affected parties. The socio economic baseline information of these groups are included in the earlier sections of this chapter.

The stakeholders consulted include the four (4) villages located in close proximity of the planned main powerhouse or the transmission line:

- Kg Katambalang, Kg Marais and Lembaga Industri Getah Sabah (LIGS) smallholders (indirectly affected by the powerhouse construction and ancillary activities); and,
- Kg Kungkular (indirectly affected - frequent fishermen and hunters around dam site).
- Villages along the access roads (directly affected).

The locations of the communities that were consulted with are shown in **Figure 6.7.1.**

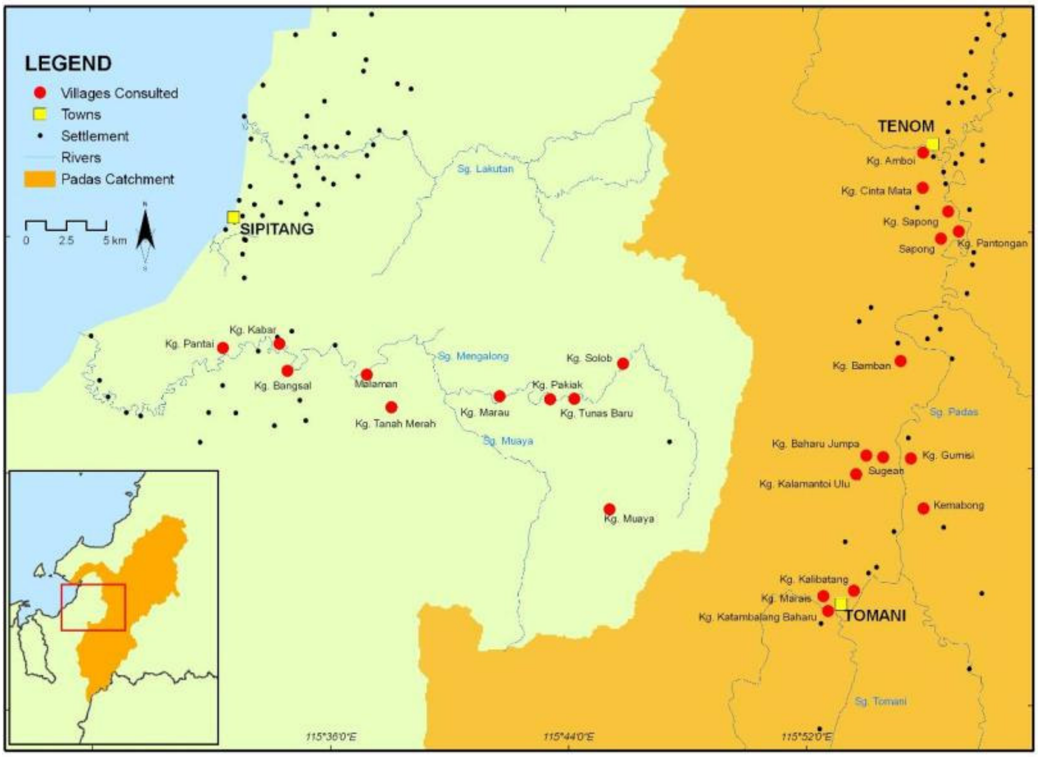


Figure 6.7.1 Location of the Villages Represented in the Consultation Exercises

6.7.6 FINDINGS

The consultation programme was designed and implemented to foster community awareness of the proposed Project and SEIA study and to provide opportunities for community input and involvement in the Project design. The consultation was guided by the various national and international principles/policies/guidelines on public awareness and involvement in EIA studies[60,61].

6.7.6.1 GOVERNMENT, RRIVATE ENTERPRISES AND COMMUNITIES CONSULTATION

Parties involved in the government and private enterprises consultation as part of scoping process were the District Office of Tenom and Sipitang, Pejabat Daerah Kecil Kemabong, Jabatan Pengairan dan Saliran (Tenom), Lembaga Industri Getah Sabah (Tenom) and SESB (Keningau and Tenom). Total number of representatives who attended the meeting was 11 participants as shown in **Table 6.7-2**.

The method utilised to derive issues were conducted through the use of questionnaire as well as general discussion. This exercise was performed in 12th June 2008.

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[60] Public Involvement in Environmental Assessment: Requirements, Opportunities and Issues. Environmental Assessment Sourcebook Update, Number 5, October 1993. Environment Department, The World Bank.

[61] Public Consultation in the EA Process: A Strategic Approach. Environmental Assessment Sourcebook Update, Number 26, May 1999. Environment Department, The World Bank.

Table 6.7-2 Representatives of the Stakeholders' Consultation According to District

District	Name	Designation / Office
Sipitang	Abdul Wahap B. Abd Hamid	District Officer
Sipitang	Ariffin Rukot	Assistant District Officer
Sipitang	Matlin B. Dullah	SESB, Sipitang
Tenom	Hj. Faimi Kamin	District Officer
Tenom	Ahmad Yunus	Jabatan Pengairan dan Saliran
Tenom	Rapin Sungkit	Lembaga Industri Getah Sabah
Tenom	Alexsius Modiun	Lembaga Industri Getah Sabah
Tenom	Roysius Kagi	SESB, Keningau
Tenom	Suffian Hassan	SESB, Tenom
Tenom	Chong Poh Ming	SESB, Keningau
Tenom	Sylvester Leisar Tuki	Pejabat Daerah Kecil Kemabong

Main Concerns

Based on the result of the questionnaire collected from the consultation, main concerns were mostly on the threat to daily activities of local communities, threat to natural resources and the possible relocation of households / villages. Minor concerns were also reported such as impact to water quality, threat to wildlife and impact to surrounding Project area from the development of the Project.

Perceived Benefits from the Project

The majority of the representatives agreed that the Project will bring benefits to the district as a whole as well as to the individual departments. Only the Department of Irrigation and Drainage stated otherwise as the Project was not seen to have neither benefit or institutional strain to the department.

Among the key perceived benefits are:

- New infrastructure and facilities to the district
- Power supply and access road will be maintained by SESB
- Sufficient power supply to the whole of Sabah
- Provides an alternative power supply
- To generate and sell power supply to the consumers

Affected Individuals / Groups

Most, including the Department of Irrigation and Drainage (Tenom) anticipated that local communities living or having interest around the Project especially those doing agriculture will be affected.

Lembaga Industri Getah Sabah (LIGS) voiced some concerns on the potential occurrence of landslides when water is released from the dam. This may affect land owners whose land may be affected by such landslide. Residual bank instability is included in **Section 8.1.2**.

There may also be orchards of affected land owners including the settlers of rubber schemes that will be within the proposed access road or transmission line paths. It was stressed that these affected land owners need to be compensated and / or relocated to new plots to plant rubber trees.

Main Economic Activity for communities in the Project Area

Two main economic activities for communities in the Project area are agriculture and fisheries. Other activities mentioned include tourism and hunting.

Development Potential for Tenom and Sipitang

Agriculture and tourism were rated as the highest potential for development for Tenom and Sipitang district. Others include fisheries and industry.

Constraint to Development in Tenom and Sipitang District

The most selected parameters for constraint of development in the districts were pollution, decrease of river water quality and flooding incidents. These were followed by lack of potable water supply and road network. Other parameters which contributed to the district development constraints but of lesser importance are no electricity, river sedimentation and decrease of fisheries catch. Some of these constraints are consequences of the others.

Other Issues brought up in the Discussion

There was a fear that the Project would cause a permanent decrease of water flow downstream of the powerhouse. Downstream Sg Padas is a main source of irrigation water for farmers / paddy land and the Water Department has an intake for potable water supply. This issue, as so many others, is based on a high degree of ignorance of the processes in a hydro electric power Project. The participants therefore also argued that there was a need for good dissemination of information especially to affected individual / groups to ensure this Project can be successfully implemented.

The Sipitang District representatives highlighted the potential impact on fish stock in Sg Padas downstream of the dam. Concerns on the impact of fisheries resources upstream of the dam, such as Sg Maligan, was also raised should the flow / water level in Sg Maligan be affected by the impoundment area. Sg Maligan is reported to have high fisheries resource.

The Tenom District representatives showed some concerns over local community resistance to the Project possibly due to traditional uses of the area such as tribal burial grounds or as hunting grounds. The district recommended that community consultations will be carried out at an early stage in order to avoid unnecessary panic to certain quarters of the local community. The representatives also stressed that sourcing of labour should prioritise the locals whenever possible.

6.7.6.2 ENVIRONMENT PROTECTION DEPARTMENT

Consultations with the Environment Protection Department has concerned institutional assessment and formalities concerning this environmental impact assessment.

6.7.6.3 DEPARTMENT OF ENVIRONMENT, SABAH

The Department of Environment was consulted during a meeting in March 2009. The Department of Environment did not expect to be deeply involved in this Project apart from its mandated roles such as management of scheduled wastes.

6.7.6.4 WATER DEPARTMENT

The Water Department has been consulted by mail. The Department operates water intakes along the Padas River and is naturally concerned with river flow and quality.

6.7.6.5 FOREST DEPARTMENT, SIPITANG

Meetings have been held with the Forest Department, Sipitang, mostly in connection with simultaneous discussions with the Sabah Forest Industries.

As the overseer of the Sipitang Forest Management Unit, the Department's primary objective is to ensure the integrity of the forest area and that the Government can live up to its commitments under the licence agreement with the Sabah Forest Industries. The proposed Project is not seen as a threat to the commercial forestry as the Project does not impose production restrictions but rather attempts to protect the resource and ensure environmental sustainability.

6.7.6.6 WILDLIFE DEPARTMENT

The Wildlife Department was extensively consulted for methodologies and secondary data during the field assessment. This was followed up by a formal consultation with the Department (March 2, 2010), where the Director agreed with the findings of this assessment that there is very little wildlife interest in the area. The issue of tembedau (*Bos javanicus*) and orchids was discussed but again, it was agreed that the Project-induced activities would have little, if any, impact on the overall situation. On the contrary, the Project is expected to support sustainability of the area – apart from the clearings – and this may be positive.

The Department must be notified by the developer before clearing in order for the Department to advice on wildlife rescue.

6.7.6.7 DEPARTMENT OF IRRIGATION AND DRAINAGE

A formal consultation was held with the Department of Irrigation and Drainage in March, 2010. This has been followed up by telephone conversations and e-mails on various issues.

The DID foresees minimal involvement in the Project as most issues are covered by legal agreements with the Forest department and the Environment Protection Department. The Department has been actively involved in determining the minimum level of compensation flow. The Department is adamant, the minimum flow shall be the 90% exceedance flow, based upon annual means and adjusted for actual rainfall in the catchment. The Department has thus approved 16 m^3 per second as compensation flow. This figure is a scaled back figure from monitoring at Kemabong and adjusted for rainfall differences in the catchment.

Information about the Sabah Water Resources Council has also been obtained from the Department of Irrigation and Drainage. The Department of Irrigation and Drainage was of the opinion that the Council would have no major stake in this Project.

6.7.6.8 SABAH FOREST INDUSTRIES

Visits to the Sabah Forest Industries have been made at different times for different purposes and there has been an exchange of information by telephone and e-mail. A site visit to Sabah Forest Industries concession area was carried out on 12 December 2008 to highlight the concerns of the Project on the land use activities in the reservoir and catchment area which are part of the Sabah Forest concession area. Meeting with the Chemsain team were the Sipitang Forestry Officer and Sabah Forest Industries representatives. However, the team was unable to visit the logging area on this occasion due to bad condition of the logging track. The concession area was later visited by several Chemsain consultants as part of field investigations.

On 2-3 April 2009, the consultant made another visit to Sabah Forest Industries to discuss on the issue of Sabah Forest Industries' operations' influence on water quantity and turbidity of water flowing into the planned reservoir. Other concerns that were raised by the Sabah Forest Industries during the meeting were:

- Rumours of plans to excise the entire catchment area as a total exclusion zone. Such intervention would jeopardize the entire feasibility of the SFI operation, in particular with the current plans of increasing production and efficiency.
- The experience of Sabah Forest Industries that sufficient attention should be paid to dialogue with the local communities at an early stage and in full openness and transparency.

The current assessment does not consider a complete halt to all activities in the catchment area neither justified nor feasible. The assessment recommends optimal ways to implement the Project within the scope of the coexistence of the Upper Padas Hydroelectric Power Project, the Sabah Forest Industries and the legal, existing settlements. The current assessment also promotes free, prior and informed consultations in line with the requirements of the Equator principles.

The Sabah Forest Industries has recently undergone a change of management and thus also organisation and policy framework. The Company is currently doing its best to comply with social, environmental and forestry requirements. The company is also being partly restructured at its field level operations with increased emphasis on field monitoring of contractors. There seems currently no reason to apply additional restrictions on the Sabah Forest Industries and its operations but if at the stage of dam operation it is proven that siltation is in excess of the expected, additional riparian reserves, siltation weirs or slope stabilisation measures may be considered.

During a meeting on July 8, 2010, Sabah Forest Industries expressed concern, whether sufficient attention is given to the local communities in the vicinity of the Project area as history has shown that local communities always blame the Sabah Forest Industries for whatever goes wrong, whether Sabah Forest Industries' fault or not. Sabah Forest Industries is therefore concerned whether the company in this case will have to deal with social issues created by the Upper Padas Hydroelectric Project.

Apart from this, the Sabah Forest Industries' attitude to the prospect of losing about 2000 ha to the reservoir and transmission lines is that this is a loss of production capacity, which can only be compensated by allocation of a similar production capacity. Compensation if the form of cash payment is not in the interest of the company. The Sabah Forest Industries points out that the Pangalubon state land is 1: embedded in the Sabah Forest Industries concession, 2: not allocated to anyone else; and 3: of a suitable size and quality to be a replacement area. Pangalubon is already logged by other parties and there are currently no legal claims to this area from any party.

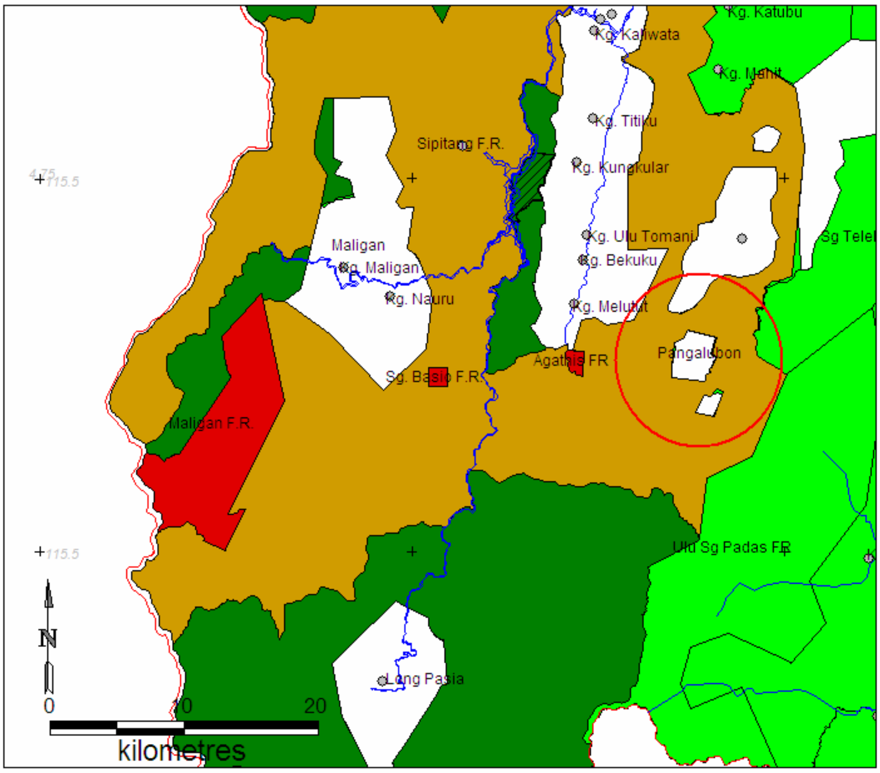

Figure 6.7.2 Pangalubon State Land

The Sabah Forest Industries also states that the company in the future will not be able to use mixed tropical hardwoods as a raw material for their pulp production. Biomass from land clearing will therefore be used for either timber processing (veneer/sawn products) or as fuel for the pulp production. The company does not have own capacity for clearing of the reservoir or the transmission lines but would, in case they were asked to manage this activity, require the assistance of one of their contractors.

6.7.6.9 KEMABONG / KUALA TOMANI ENGAGEMENT ACTIVITIES

A briefing and dialogue session for community leaders and residents of Kemabong and Kuala Tomani was held on 27 November 2008 at Dewan Ontoros, Kemabong with estimated attendance of 151 local residents.

SESB briefed on the Project concept, benefits as well as issues that may arise during the construction period of the dam. This was followed by question and answer session chaired by YB Datuk Radin Malleh a local politician from Tenom.

Among the concerns raised during the question and answer session were as follows:

- Effects on agricultural land.
- Dam break.
- Request for emergency response plan in the event a dam break occurs.
- Employment opportunities created by the Project.
- Health impact due to exposure of radiation from the transmission line.
- Flooding in the low lying areas.
- Impoundment causing insufficient flow of water to downstream users of the river. The communities downstream of the dam currently depend on the river for irrigation as well as household use.

Minutes of the dialogue session are attached in **Appendix 1-11**.

Overall the objective of the briefing was achieved which is to inform the local community of the Project and obtain direct input of their concerns.

Following the dialogue, a brief report on the activity was submitted to SESB and it was recommended that another consultation be carried out to further discuss some of the concerns of the participants. In particular, some participants requested more detailed information on the Project, such as the location of the power station and alignment of the access roads.

6.7.6.10 FOCUS GROUP DIALOGUE

The focus group dialogue was held on 20 May 2009 at Balai Raya Skim Tomani with attendance of 79 local residents from Skim Kuala Tomani, Kg Marais, Kg Kuala Tomani, Kg Katambalang Baru, Kg Tilis, Kg Kungkular, Kg Mamaitom, Kg Kalibatang, Kg Kalibatang Baru and Kg Kaliwata Baru. Among those present were the Ketua Anak Negeri and Wakil Ketua Anak Negeri of Kuala Tomani. Representatives of SESB were present and EIA Consultants from Chemsain and DHI Water & Environment.

The programme kicked off with an opening speech from Ampalang Payu, the Information Officer for N.28 Tenom followed by a presentation on the proposed Project and the EIA study by DHI Water & Environment. Content of the presentation outlined the Project background, objective, components (Project activities, layout) and purpose of the focus group discussion and preliminary result of the socio economic component of the EIA study.

The main purpose of the discussion was to create awareness of the Project among the local people, to record comments towards the Project as well as comments on the preliminary findings of the EIA study components presented.

Eighteen participants voiced their views towards the proposed Project of which some were issues already mentioned by other participants of this dialogue. The following summarises the comments/suggestions of the participants:

- Suggestion to relocate the power house site approximately 2 km upstream given that the present identified location of the power house is surrounded by land owned and cultivated (primarily fruit orchards) by them. This suggestion arose from the concern that the accessibility to property such as land or orchard will be limited due to level of security within the power house that may have restricted access.
- Proposed that the access road to dam site does not go across the Kungkular village water catchment area estimated at 120 hectares (300 acres) based on the ridges contour.
- Employment opportunities created by the Project to prioritise local intake.
- Smallholders in Scheme Kuala Tomani requested that compensation be given directly to the affected individuals instead of through the LIGS management. It was claimed that approximately 20 persons will be affected
- Access road to include proper drainage and to be sealed to avoid pollution
- Immediately downstream of the dam site is a location of a murder scene. Family requested compensation from SESB given that the site of the murder will be permanently inaccessible. Mr. Payu suggested that this is done in accordance to the native law.
- Dam site was reported to be an important fishing ground for Kg Kungkular as well as surrounding villages especially when there is festivity such as weddings.

Figure 6.7.3 Local Communities Turning Up for the Focus Group Discussion

Figure 6.7.4 One of the Participants Contributing His Comment/View towards the Project

6.7.6.11 DIALOGUE WITH KG KUNGKULAR RESIDENTS ON ACCESS ROAD

A dialogue session between Kg Kungkular residents and SESB team comprising the contractor and government representatives from Land & Survey Department, Forestry Department, Department of Drainage and Irrigation was carried out on 28 October 2009 to primarily discuss the road access to the dam site that encroaches into the water catchment area of Kg. Kungkular. This issue was raised in the earlier focus group dialogue.

The proposed access road to the dam site will traverse the catchment area of Kg Kungkular source of gravity water at two points affecting an area of approximately 0.6 ha and 4.7 ha, respectively. Due to the resource being the only source of clean water for the whole of Kg Kungkular, there is resistance to the proposed road alignment from the villagers in Kungkular unless it is proven that there are no other viable road alignment options.

During the dialogue it was resolved that a site visit will be conducted by SESB together with representatives from Kg Kungkular to try to come up with a viable alternative route. It aims to avoid crossing over the catchment area where possible. Refer **Appendix 1-11** for detailed minutes of the dialogue.

6.7.6.12 WORLD WIDE FUND FOR NATURE (WWF)

The Kota Kinabalu office of the WWF has been consulted concerning social and environmental issues. WWF has for some years been involved in a local tourism related Project in Long Pa Sia and has also been involved in various tourism and environmental master plans for Sabah. WWF has earlier raised concerns about the possible existence of a resident herd of Tembedau

(*Bos javanicus*) in the catchment area. WWF shares Chemsain's findings that there most likely is only a small group of roaming Tembedaus passing the area. However, the Project was not seen as a threat to these animals. Other than this, WWF did not see any major conservation values in the area.

Plate 6.1 Representatives from the related government offices and SESB team.

Plate 6.2 Attendance of more than 20 people from Kg Kungkular

The table below summarises in order of highest concern the issues / concerns / comments raised through the series of government institution, private enterprise and community consultations. Ranking of priorities was derived based on those issues raised by people throughout the consultation process, shown in **Table 6.7-3**.

Table 6.7-3 Ranking of Concerns Based on Ratings Received from Consultation

Priority	Issue / Concern	Stakeholder Group (Villagers/local authorities)
1	Handling of compensation	Villagers
2	Employment opportunities to prioritise local residents	All
3	Traditional uses of the affected area i.e. Burial ground at Sg. Maligan, Kuala Tomani	All
4	Dam Break	ALL
5	Encroachment on orchards or agricultural land	All
6	Prioritise supply of electricity to Tenom locals	Villagers
7	Access road to be built properly	Villager
8	Decrease in volume / flow of water downstream i.e. affect water supply and irrigation water	Local Authority
9	Landslide to land along the river due to release of water from dam	Local Authority
10	Impact to fisheries resources and fish stock	Local Authority
11	Health impact from exposure of transmission line radiation	Villager
12	Flooding in low lying area	Villager
13	Access road cutting across Kg Kungkular water catchment	Villager
14	Relocation of power house location to be relocated --> so as no restriction to access orchard	Villager
15	Request for compensation where body was dumped in a murder case	Villager
16	Dam site is a popular fishing site (Casual conversation)	Villager
17	Proper study of the Project	Villager
18	Grievances avenue	Villager

6.8 SOCIAL IMPACT

6.8.1 RESETTLEMENT

No resettlement of communities is planned for this Project. There may be a need for adjustment of individual houses along the transmission line even though this is not considered likely at the planning stage.

6.8.2 LAND TENURE

Some land will be required

- around the main power station,
- for substations on the transmission line,
- and for the patches of land, where the pylons for the transmission lines will be erected.

There will also be imposed land use restrictions under the transmission lines. In this area the height of crops will be restricted to 2 meters, i.e. oil palm, rubber trees, fruit trees and forest trees will not be permitted while agricultural crops, cocoa, pepper, etc. will be permissible.

There is a possibility that land use restrictions and riparian reserves may be imposed in the agricultural areas embedded in the Sabah Forest Industries concession in the catchment area. This may cause some hardship for the land owners compared to their present land use practices but will also be to their absolute benefit as it will ensure their own sustainability in the long run. The restrictions will only be imposed if their activities are such that regulations become necessary.

The implications for the Sabah Forest Industries are dealt with in **Chapter 5** and **Chapter 7**.

Real estate prices will in the vicinity of the transmission lines go down whereas some plot owners near the reservoir and the powerhouse may benefit from increased prices.

6.8.3 POWER PRODUCTION

The local communities have made it a very clear priority that they should be provided with access to stable electricity supply. Such delivery will to a far extent alleviate and mitigate the burden they carry for the rest of the society by having this Project in their backyard.

Stable power supply is one of the cornerstones of social and economic development. Together with improved access and communication, it will enable the communities to interact with the state economy without abandoning the village sites. Electricity is the basis for communication and flow of information (TV, radio, telephones), businesses, social interaction and common evening activities such as school home work and domestic chores.

6.8.4 FLOODING

Floods are not an issue near the Project site but unfortunately a recurrent problem downstream in Tenom and Beaufort. Regulation of the flow from the Upper Padas will not totally alleviate this problem but it may contribute positively to flood control.

Floods also occasionally destroy the railway line through the Padas Gorge. The regulated flow will contribute to controlling this problem.

However, flooding occurs at times when there has been excessive rainfall in the upper catchments of Padas, Pegalan and other tributaries. It is therefore likely that the reservoir will be full to its brim when a reserve capacity is needed for flood control.

The state and national authorities may consider raising the height of the dam for flood control purposes but this is seen as outside the scope of this assessment.

6.8.5 RIVER TRANSPORT

The current level of river transport is insignificant but the option of sailing along the river still exists. This option will be blocked at the power station and the dam. Below the power station, the river will be more or less as usual for transportation whereas the river above the dam will be a 300-500 m wide lake. There will be a positive effect during operation, as flash floods, causing a danger to crossing the river, will be avoided, if the dam is properly managed. Low flows will be avoided below the power house due to the regulating effect.

The lake naturally offers other kinds of transport options such as larger vessels or new types of recreational sailing.

6.8.6 TOURISM

White-water rafting on the Padas River is an important tourism product. Rafting normally takes place further downstream in the gorge, where the Padas flows through the Crocker range.

The rafting is dependent on just the right water level in the river. Changing water levels will either expose too much rock or flood the rapids so there is no white water. Currently, the tourism industry suffers from the uncertainty and frequent cancellations.

A regulated flow will help ensuring the river is always suitable for rafting, thus providing the tourism industry with a stable product.

The reservoir will offer entirely new opportunities for tourism as the reservoir will be suitable for all sorts of recreational use or just for its tranquillity.

6.8.7 ACCESS

The Project will create improved access to the area benefitting local transportation and transportation to town centres. The access may, however, also create access for negative development such as squatters from outside, poachers, illegal logging etc.

6.8.8 SOCIAL EXPOSURE

The sudden influx of 1,000-2,500 workers in the area contains a potential social problem with unwanted social relations, unwanted businesses, crime and spread of diseases.

On the other hand, the social exposure may also be a kick-start for parts of the local communities to enter a faster development track than at present.

6.8.9 PUBLIC SERVICES AND AMENITIES

The Project will provide improved medical facilities, transportation, electricity etc to be available together with an increased presence of government authorities such as police, the Environment Protection Department, Public Works Department.

6.8.10 NATURAL RESOURCES

There will be some loss of access to gathering of forest products in the area that will be converted to reservoir.

Fisheries in this section of the river system may decrease during construction. To be off-set by increased fisheries in the reservoir. No impact upstream reservoir and 5-10 km downstream powerhouse.

6.8.11 PUBLIC HEALTH

6.8.11.1 *HAZARD IDENTIFICATION*

Hazard Identification examines the capacity of an agent to cause adverse health effects in humans. It is a qualitative description based on primary environmental investigations and assessments, complementary information, and the weight of evidence from these sources in regards to potential health impacts.

Various hazards associated with the proposed Project have been identified as being potentially detrimental to the human health, and are listed and discussed in the following subsections.

6.8.11.2 *ELECTROMAGNETIC FIELDS*

Electricity has been used to great advantage for over 100 years. Associated with this generation, transmission, and use of electrical energy is the production of electric and magnetic fields, (NIEHS, 1999). Physically, electromagnetic fields radiate from the point or line of transmission and decrease in power exponentially when increasing distance from the source.

With the ever increasing need to supply more areas with electricity, comes the need to transport electricity often over large distances, from the point of generation, to the point of usage, which may be industrial, commercial, or residential. Transporting electricity often involves the increasing of power of the electricity to be transported, from the normal 240 V commonly used in household appliances to upwards of 110 kV, to ensure long distance transmissions, (SCENIHR, 2007). Together with an increase in power, comes an increase in electric and magnetic fields generated.

Transportation of electricity is commonly conducted via telegraph like power lines (shorter distance transmission) and high tension power lines (longer distance transmission), which are both located above ground. In recent years, transmission lines have been located underground to achieve better outcomes for aesthetic and health concerns. In addition to transmission lines, substations are a common part of electrical transmission and distribution infrastructure. Substations are, as the name suggests a subsidiary station of generation, and forms the interface between the transmission and distribution. Commonly, substations are located in or close to the area of electrical distribution, mainly commercial or residential areas, where the high power electricity from transmission is converted to low power electricity for short distance distribution and use. Depending on the demand for electricity, substations are commonly located on individual industrial sites to serve individual needs.

Due to the need to supply large amounts of electricity to various domestic, industrial and commercial users, power transmission lines and substations are often located in close proximity to high human population areas, inclusive of designated residential and commercial areas such as villages, residential estates, business districts, apartment complexes, and other sensitive facilities such as schools and hospitals. For many years, the only impact to these areas from the existence of transmission lines and substations was an aesthetic impact, however since the awakening to potential levels of health impact from electricity use in the 1970's, concern has been raised as to the influence of electromagnetic fields on health outcome.

As will be discussed later in this health risk assessment, electromagnetic fields from various sources may contribute to negative health outcomes, with epidemiological substantiation wavering as to whether electromagnetic fields contribute categorically to a negative health outcome. Nevertheless, risk presented from this hazard is determined in largely by the duration of exposure (how many hours per day) and the level of exposure (strength of field). These factors and many more underpin the determination of health risk to the identified hazard of electromagnetic fields, (IARC, 2002).

Included as part of the social survey were components which were designed to gauge the significance of this perceived health hazard to the surrounding community. While the majority of respondents were not overly concerned with a transmission line being in proximity to their place of residence, approximately 12.3% did indicate a level of concern as to the health effects of the transmission line in operation. Additionally, through field observations made) the proximity of some options of the proposed transmission line alignment to residential areas, and schools, and clinics is significant, in some cases 50 m from the proposed alignment, where it is likely a heightened level of electromagnetic field exposure will occur.

It is determined that electromagnetic fields generated by the proposed development of transmission lines (Max 275 kV lines) from the downstream powerhouse to Sipitang (Options 1 to 3), and Tenom respectively, do present a hazard to public health worthy of further investigation, and will be assessed as part of this Health Risk Assessment (HRA).

6.8.11.3 MOSQUITO VECTORS

Throughout the tropical regions of the world, mosquitoes are common insects from the family Culicidae. Mosquitoes are extremely diverse with over 300 different species, which are habitat specific, meaning only living in specific locations where certain conditions exist, (University of Sydney, 2008d).

Both male and female mosquitoes are nectar feeders, however only the females of some species of mosquito are capable of biting for hematophagy (drinking blood). This practice is necessary, not for survival, but rather for the extraction of protein and iron for the formation of eggs, (University of Sydney, 2008d).

As a result of this practice, mosquitoes can be disease vectors. Mosquitoes are a vector agent that carries disease causing viruses and parasites from person to person without the mosquito itself becoming infected. This process occurs through female mosquitoes feeding on blood from people and other animals as part of their eating and breeding habits. When a mosquito bites, it also injects saliva and anti-coagulants into the blood which can contain disease-causing viruses or other parasites, which can cause disease in the human receptor. These diseases are called mosquito borne disease, and commonly include Dengue, and Malaria, see **Section 6.4.5**).

Mosquito borne diseases are one of the biggest forms of disease across the world. Such diseases are more common in developing countries where large areas remain under developed or poorly maintained, with minimal awareness or preventative action against the proliferation of mosquitoes, presenting suitable areas for mosquito breeding. Mosquito borne disease can be serious, in the presentation of symptoms, and in some cases leading to death.

It should be noted that, specific species of mosquito are vectors for specific diseases. Additionally, specific species of mosquito breed and bite in certain ways, however it can be suggested that generally, mosquitoes enjoy hot humid climates, with stagnant water bodies, with protection (often in the form of vegetation) in which to breed and proliferate, (See **Section 6.4.5**).

The proposed Project proposes the development of a hydroelectric reservoir in which water is sourced for the running of the hydroelectric powerhouse downstream of the reservoir. This will involve the damming of the normally fast flowing Sg. Padas. As a result this will inevitably create significantly greater breeding areas for mosquitoes, chiefly along the shoreline of the largely stagnant reservoir. Even though the proposed reservoir is currently positioned in a remote location, the closest human settlement is located approximately 3 km from the shoreline of the reservoir, well within the flight range of various medically significant mosquitoes.

Part of the health survey explored various areas of relevance to the Project with residents of communities in proximity to the proposed Project area. While most of these findings can be found in **Section 6.4.3**, 96.9% of respondents noted that there would be concern should there be an increase in mosquito population from the proposed Project, and that the majority of this concern related to the potential health risk this increase in population presented.

It is determined that, mosquitoes and mosquito borne diseases, contributed by the proposed damming of Sg. Padas and the subsequent generation of breeding areas, does present a hazard to public health worthy of further investigation, and will be assessed as part of this health risk assessment (HRA).

6.8.11.4 DRINKING WATER

Drinking water is considered by the World Health Organization (WHO) as an essential service for the sustaining of life, and therefore safe drinking water supplies need to be protected for consumers globally, whether in a rural or urbanized setting.

Drinking water originates from a variety of sources. These sources include surface water (including reservoirs, rivers, streams, lakes, and lagoons), rainwater (from roof catchments via tanks), and ground water (including bores, springs, spear points, and wells). In areas of moderate to high rainfall, water supplies for large urbanized centres commonly originates from surface water sources, such as reservoirs, and rivers.

Due to the basic nature of water being a solvent, drinking water sources can become polluted easily, in some cases exceeding the upper pollutant capacities of existing treatment trains. It is commonly understood that a wide range of measurable compounds, characteristics, and constituents can be found in water as a result of influence from the surrounding environment. This influence can reduce the overall water quality of the source, potentially impacting the suitability of the source for drinking water. These measurable characteristics fall into the following categories:

- Physical;
- Microbial;
- Chemical, including inorganic, organic, and pesticides, and;
- Radiological, (NHMRC, 2004).

The safety of drinking water, in terms of public health is dependent on each of these categories, however of these, microbiological characteristics are most important, (NHMRC, 2004).

Unsafe drinking water from polluted source waters can cause considerable negative health outcome. Often these health outcomes are linked specially to the main pollutant, however can act to significantly reduce the quality of life of consumers through potentially severe symptoms, which can in extreme cases lead to death. Classic waterborne diseases, which can include diarrhoea, dysentery, hepatitis, cholera, and typhoid fever are commonly resultant of the ingestion of water contaminated with microbiological organisms originating from the gut of humans or other animals, (NHMRC, 2004).

The proposed Project involves the development of considerable infrastructure across and surrounding Sg. Padas, which has been indicated through responses to the health survey (See **Section 6.4.3**) to be the source of water for drinking and agricultural purposes for surrounding villages downstream of the proposed Project area. Indicated in responses to questions posed in the health survey conducted, approximately a quarter of all respondents sourced drinking water and agricultural water from river and surface water sources. The proposed Project, both during the construction and operation stages has the potential to impact on the water quality downstream of the proposed Project area.

It is determined that, drinking water quality, potentially impacted from the proposed construction works to be undertaken as part of the proposed Project, and hydroelectric operation, do present a hazard to public health worthy of further investigation, and will be assessed as part of this health risk assessment (HRA).

6.8.11.5 RECREATIONAL WATER

Contained in **Section 6.4.4**, as being identified during field observations of the downstream reaches of Sg. Padas, various possible recreational water areas were noted, consisting of small sandy and pebble beach areas along the shoreline of the river, commonly near riverside communities and villages, where bathing and swimming activities are likely to occur. Additional recreational water uses, in part coupled with livelihood may include boating and fishing on the river.

The recreational use of water bodies can present various public health hazards to users. These include:

- Physical danger and injury (strong currents, risk of drowning)
- Water quality and microorganisms;
- Algae;
- Aesthetics (turbidity), and;
- Dangerous aquatic organisms, (WHO, 2003).

It is projected that the areas which may be impacted as a result of the proposed Project will include water quality and aesthetics, including transparency and colour, and currents.

As shown in **Section 6.4.4**, presently the Padas River is a highly turbid and fast flowing river. The projected impacts on the river downstream of the proposed Project area are:

- Turbidity–Turbidity may marginally increase during the construction of the dam and during other earth works. However this will not pose any significant further deterioration in recreational water quality (aesthetics) compared to the present conditions; Upon completion of the filling of the reservoir, there will be a reduction in turbidity due to sedimentation in the reservoir, improving the water quality compared to the present situation.
- Currents – In natural water bodies where high velocity flows are present, currents can cause distress and drowning. During the construction stage, until filling of the reservoir, the present current conditions will remain. During filling of the reservoir the environmental flows will be maintained, reducing currents considerably downstream the dam. Upon completion of filling the reservoir and during subsequent operation, the currents will be somewhat controlled, especially avoiding flash floods reducing the risk of injuries and drowning

6.8.11.6 DOSE RESPONSE

The Dose Response assessment involves the consolidation of information on each hazard, as it poses a significant risk to public health. This can be in the quantitative form of reference doses and concentrations, or qualitatively in the form of research findings and indicated levels of effect from stimulation from key hazards. For the assessment health effects, the threshold dose concept has been applied.

This section will concentrate on both mosquito vectors and electromagnetic fields, in the context of the proposed Project. Analysis will be conducted in this section as to the carcinogenicity of hazards which may be presented by the proposed Project.

6.8.11.7 MOSQUITO VECTORS

Mosquitoes, in addition to presenting nuisance, can present credible health risk to the human and animal populations, from mosquito borne diseases. Such diseases, as indicated in **Table 6.4-7** can significantly impact human health and wellbeing, and in some cases cause death. It should be noted, that mosquito borne diseases are not carcinogenic, but however their severity should not be underestimated.

Mosquito born diseases are difficult to assess in the context of dose response, due to the highly variable biological nature of the exposure route and the variable rates of infection versus mosquito activity and biting. This differs, for example to exposures from industrial chemicals, where exposure routes are defined, and significant doses through these exposures almost guarantee a negative health outcome. Some key factors which conspire against the determination of quantitative dose response values and the ease in determining health risk from mosquitoes and mosquito borne diseases includes:

- Prominence of mosquito species and availability of disease highly localised geographically;

- Characteristics of mosquito species, with some preferring to bite animals rather than humans, and others biting indoors rather than outdoors (See **Table 6.4-7**);
- Variability of exposure potential from mosquitoes, being related to breeding areas, weather conditions, natural predators, etc;
- Ability for predominant mosquito species in geographical area to be medically significant i.e. being able to carry disease for transmission (not all mosquitoes are disease vectors);
- The variable nature of infection outcome in the human population, as a result of such factors as naturally acquired resistance, and immunity levels resultant from previous exposures;
- The potential severity of one encounter with a disease carrying mosquito on the human population, potentially resulting in significant negative health outcome and potential death.

As a result of these above variability's, which contribute to difficulty in determining specific dose response values, ultimate preventative stances has been adopted by public health professionals, governments, and the World Health Organisation.

To be bitten by a mosquito presents a significantly greater risk of negative health outcome, than if not bitten. In some cases a bite carries a 100% negative health outcome potential (seroconversion), meaning negative disease outcome potentially resulting in death can occur from the single bite. However, this scenario is not always the case with any extremely large range of variables such as mosquito viability, presence and viability of viral isolates, actual seroconversions, and the potential of asymptomatic infections contributing to the highly subjective nature of health risk assessment involving biological entities such as mosquitoes and mosquito born disease. Thus, the ultimate preventative management stance which has been adopted globally is to prevent the bites occurring, which in turn reduces the disease risk potential, and the occurrence of the potential one bite = sickness and death scenario.

From this dose response assessment, it is determined that a non-carcinogenic qualitative health risk assessment will be conducted on the potential negative health risks presented to the surrounding human populations from mosquitoes resultant from the proposed Project.

6.8.11.8 ELECTROMAGNETIC FIELDS

Electromagnetic fields generated by transmission lines comprise of two potential avenues of health impact, that of electric fields and magnetic fields. Various negative health outcomes have been associated with electric and magnetic fields since concern was first raised in literature in 1979, by Wertheimer and Leeper, most of which are contained below. The epidemiological strength of each of these suggested outcomes varies, which contributes to uncertainty as to the actual health risk presented as a result of exposure to electric and magnetic fields:

- Lymphomas;
- Brain and nervous system tumours;
- Leukaemia;

- Breast cancer;
- Neurodegenerative disease;
- Amyotrophic lateral sclerosis;
- Alzheimer's disease;
- Suicide and depression;
- Cardiovascular diseases, and;
- Reproductive effects.

The frequency to which power is transmitted in transmission lines is generally between 50 to 60 Hz, (WHO, 2001; IARC, 2002). **Table 6.8-1** contains reference levels for general public exposure from electric and magnetic fields generated by transmission lines. In this table, electric fields are indicated by E-Field Strength (Vm^{-1}), and magnetic fields indicated by B-Field (µT).

Table 6.8-1 Reference Levels for General Public Exposure To Time-Varying Electric and Magnetic Fields

Frequency range	E-field strength ($V\ m^{-1}$)	H-field strength ($A\ m^{-1}$)	B-field (μT)	Equivalent plane wave power density S_{eq} ($W\ m^{-2}$)
up to 1 Hz	—	3.2×10^4	4×10^4	—
1–8 Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8–25 Hz	10,000	$4{,}000/f$	$5{,}000/f$	—
0.025–0.8 kHz	$250/f$	$4/f$	$5/f$	—
0.8–3 kHz	$250/f$	5	6.25	—
3–150 kHz	87	5	6.25	—
0.15–1 MHz	87	$0.73/f$	$0.92/f$	—
1–10 MHz	$87/f^{1/2}$	$0.73/f$	$0.92/f$	—
10–400 MHz	28	0.073	0.092	2
400–2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	$f/200$
2–300 GHz	61	0.16	0.20	10

[a] Note:
1. f as indicated in the frequency range column.
2. Provided that basic restrictions are met and adverse indirect effects can be excluded, field strength values can be exceeded.
3. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, H^2, and B^2 are to averaged over any 6-min period.
4. For peak values at frequencies up to 100 kHz see Table 4, note 3.
5. For peak values at frequencies exceeding 100 kHz see Figs. 1 and 2. Between 100 kHz and 10 MHz, peak values for the field strengths are obtained by interpolation from the 1.5-fold peak at 100 kHz to the 32-fold peak at 10 MHz. For frequencies exceeding 10 MHz it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width does not exceed 1,000 times the S_{eq} restrictions, or that the field strength does not exceed 32 times the field strength exposure levels given in the table.
6. For frequencies exceeding 10 GHz, S_{eq}, E^2, H^2, and B^2 are to be averaged over any $68/f^{1.05}$-min period (f in GHz).
7. No E-field value is provided for frequencies <1 Hz, which are effectively static electric fields. perception of surface electric charges will not occur at field strengths less than 25 kVm^{-1}. Spark discharges causing stress or annoyance should be avoided.

Source – ICNIRP 1998

The reference values in **Table 6.8-1** represent the values to which the risk of negative health outcome is considered more likely should these exposure values be surpassed. Hence these values have been set to prevent exposure to contribute to either direct or indirect negative health outcome as a result of electrical and magnetic fields from transmission lines.

In consideration of carcinogenicity of EMF, an expert scientific working group, commissioned by the International Agency for Research on Cancer (IARC) reviewed numerous studies related to the carcinogenicity of static and extremely low frequency electric and magnetic fields, such as those emitted by transmission lines. Considering human, animal, and laboratory evidence, EMF has been classified using the standard IARC classification, as also adopted by the USEPA, as contained in **Table 6.8-2**, (WHO, 2001).

Table 6.8-2 Classification of Carcinogenicity

IARC Classification	USEPA Classification	Examples of Agents
Carcinogenic to Humans	Group A	Asbestos
		Mustard Gas
		Tobacco
		Gamma Radiation
Probably Carcinogenic to Humans	Group B	UV Radiation
		Formaldehyde
		Diesel Fumes
Possibly Carcinogenic to Humans	Group C	Welding Fumes
		Extremely Low Frequency Magnetic Fields

Source – WHO, 2001

As can be noted in **Table 6.8-2**, extremely low frequency magnetic fields have been classified as Possibly Carcinogenic to Humans, Group C, largely based on epidemiological studies of childhood leukaemia. Extremely low frequency electric fields were considered not classifiable either due to insufficient or inconsistent scientific information. The classification, Possibly Carcinogenic to Humans is a classification used for an agent to which there is limited evidence of carcinogenicity in humans and less than sufficient evidence for carcinogenicity in experimental animals, (WHO, 2001).

As a result of this classification, a non-carcinogenic based health risk assessment will be conducted on both electric and magnetic fields, as generated by transmission lines, proposed as part of this Project.

6.8.11.9 DRINKING WATER

The extent of environmental water quality impact from the proposed Project has been determined in **Chapter 5** of this report. Reduced environmental water qualities as a result of the proposed Project during either the Construction of Operation Stage are not expected to occur or have any compounding indirect impact on the suitability of downstream waters to be used for potable or non-potable uses and human health.

Water quality projection modelling for downstream areas of the proposed Project site, suggests water qualities are expected to improve as a result of the proposed Project. This suggested improvement acts to qualitatively reduce the level of health risk presented to downstream users of water from the river. As such, the further consideration of drinking water as part of this health risk assessment is not warranted, in the context of the proposed Project.

However, as indicated in responses to the health survey conducted, there exist many downstream users of water extracted from the river, which independent of this proposed Project, present credible levels health risk to users, either as non-potable or potable water. In appreciation of this resident risk to the overall health of the population surrounding Sg. Padas, this health risk assessment will recommend general mitigation measures and monitoring in an ethically justified effort to mitigate and monitor issues of significance to the public health of the communities surrounding the proposed Project site.

6.8.11.10 EXPOSURE ASSESSMENT

Exposure Assessment involves the determination of the magnitude, frequency, extent, character and duration of exposures. There is also the identification of exposed populations and potential exposure pathways, as part of the assessment. Environmental monitoring and predictive models can be used to determine the levels of exposure at particular points on the exposure pathways. The contaminant intakes from the various pathways under a range of scenarios, including worst case situations, can then be estimated.

Exposure assessments for the main hazards identified to present part of this proposed Project are mosquito vectors and electromagnetic fields. Detailed assessments are contained in subsequent subsections.

6.8.11.11 MOSQUITO VECTORS

Rudimentary modelling shown in **Map 6.8- 1 Modelled Mosquito Influence from the Proposed Reservoir** indicates varying zones of projected increases in mosquito activity as a result of the proposed Project which presenting a likely impact to health upon receiving populations. As indicated in the figure, the projected areas of greatest increase in mosquito population, are indicated in red occur directly surrounding the proposed reservoir, of which there are no reported inhabitants. However, in the orange and yellow zones, where moderate to minimal projected increases in mosquito activity are expected, various villages including Kg. Ketanun, Kg. Kungkular, Kg. Melutut, Kg. Titiku, Ulu Tomani as well as parts of Tomani township, are affected.

For the purposes of this exposure assessment, there will be a projected moderate increase in exposure to increased mosquito populations, and subsequent disease transmission potential, in the above mentioned residential village locations.

6.8.11.12 ELECTROMAGNETIC FIELDS

It is unclear at this stage the exact routing of the proposed transmission line corridor, from Tomani to Tenom, and Sipitang respectively, or the type of transmission line that will be constructed. However it has been anecdotally suggested that the transmission line routes will follow the road corridors in the area, with exception to the first half of the Tomani to Sipitang transmission line, which has been suggested will traverse jungle area.

Section 6.4 demonstrates clearly the proximity of sensitive receptors, inclusive of residential areas, shops, schools, and clinics, in reference to the main road corridors from Tomani to Sipitang and Tenom respectively. **Table 6.4-6** shows that various sensitive receptors are located directly on the road side, in some cases 50 m from the road.

Even though it cannot be confirmed at this stage the routing or the design of the transmission line, a worst case exposure assessment is made regarding the exposure to identified sensitive receptors to electromagnetic fields. For this, the assumption that the transmission line corridor will follow exactly the line of the road corridor will be made.

Table 6.8-3 proposes likely scenarios as to the type and operation of transmission line to be applied as part of this Project, and references against international magnetic and electric field reference values, at varying distances, to determine exposure to surrounding potential receptors. As has been discussed earlier, both magnetic and electric fields present the greatest health risk to humans, when in proximity to transmission lines.

Table 6.8-3 Transmission Line Exposure Assessment

Transmission Line Scenario	Magnetic Fields 50 m from centreline (μT)	Magnetic Fields 100 m from centreline (μT)	ICNIRP Reference Levels for Magnetic Fields (μT)	Electric Fields 50 m from centreline (Vm^{-1})	Electric Fields 100 m from centreline (Vm^{-1})	ICNIRP Reference Levels for Electric Fields (Vm^{-1})
275 kV Lines, with 7.6m clearance, U Phasing, 4.7 kA loading (maximum worst case scenario)	11.7	3.1	5	307	107	250
275 kV Lines, with 13 m clearance, T Phasing, 0.4 – 0.6 kA loading (typical design for larger lines)	0.6	0.1	5	73	22	250

Source - National Grid, 2008

Table 6.8-3 indicates that in the maximum worst case transmission line scenario, at 50 m from the centreline of the transmission line alignment, magnetic fields exceed the ICNIRP reference values for exposure to magnetic fields emitted from transmission lines. However, 100 m from the centre line of the transmission line alignment, magnetic fields are within the reference values. Electric fields emitted during worst case and typical case is within the reference values.

Sensitive receptors located at 50 m or less from the centre line of the transmission line alignment are exposed to levels of magnetic field which are higher than recommended international reference values, and have a greater likelihood of negative health outcome.

6.8.11.13 RISK CHARACTERIZATION

Risk Characterization estimates the health risk which may be presented to the residents who live in proximity to the proposed Project. In this assessment both acute (immediate) risks and chronic (long term) risks will be characterised.

The assessment of acute health risks involves the utilization of epidemiological information available in both local and international literature to assist in determining the acute health impacts / risks from exposures.

Chronic health risk assessment is the assessment of risk to human health over the lifetime of an individual in regular if not constant exposure to environmental stimulants. Commonly environmental stimulants can cause two types of health response, both non-carcinogenic and carcinogenic over a life time of chronic exposure.

Commonly, either quantitative or qualitative risk characterisations are made as part of health risk assessments. Quantitative risk characterisation involves the application of internationally recognised mathematical formulae for the numerical determination of levels of risk on target populations from key exposure sources. Qualitative risk characterisation involves the application of the internationally accepted qualitative risk assessment matrix, shown below and as **Table 8.1-1**, which uses key terms to determine levels of risk, similarly on target populations from key exposure sources. This matrix has been known to be applied in diverse settings globally. (The number of classes may differ in different reference texts but the principle remains the same).

Table 6.8-4 Qualitative Risk Assessment Matrix

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Severe 5
5 (almost certain)	Moderate	High Risk	High Risk	Extreme Risk	Extreme Risk
4 (likely)	Moderate	Moderate	High Risk	High Risk	Extreme Risk
3 (moderate)	Low Risk	Moderate	Moderate	High Risk	Extreme Risk
2 (unlikely)	Low Risk	Moderate	Moderate	Moderate	High Risk
1 (rare)	Low Risk	Low Risk	Moderate	Moderate	High Risk

Source: www.dpmc.gov.au

The application of either of these risk characterisation methods is largely determined by the type and the ability to quantify rates and levels of exposure to target groups. It should be noted, that not all environmental stimulants can be quantified, qualifying for risk characterisation quantitatively. In these cases the qualitative risk assessment matrix can be used to provide indicative outcome to the health risk assessment process.

The following subsections will characterise the health risk presented to sensitive receptors in the context of acute and chronic risk, for both non-carcinogenic and carcinogenic health outcomes, in both quantitative and qualitative manners.

6.8.11.14 MOSQUITO VECTORS

A projected increase in mosquito populations are expected to present an acute, long term, non-carcinogenic health impact, within the modelled impact zones depicted in **Map 6.8- 1 Modelled Mosquito Influence from the Proposed Reservoir**.

Due to the nature of mosquito activity and arboviral diseases, as described earlier, it is not possible to conduct a specific quantitative risk characterisation of the health risk presented to human populations falling within the demonstrated impact zones, from increased levels of mosquitoes resultant from the proposed Project. However, the qualitative risk assessment matrix will be applied to provide an indication of levels of risk expected by receiving human populations.

In applying the qualitative risk assessment matrix, the following key areas are considered in determining the qualitative risk assessment outcome:

- Projected increases in mosquito population with reference to surrounding sensitive receptor areas, as indicated in **Map 6.8- 1 Modelled Mosquito Influence from the Proposed Reservoir**;
- Potential ratio of mosquito bites to negative health outcome (worst case – 1:1), in comparison to practical levels of disease transmission;
- Severity of possible negative health outcomes;
- Incidence and recent increases of arbovirus diseases on the surrounding area.

Further to the above mentioned key areas, and applying the qualitative risk assessment matrix, the projected level of health risk presented surrounding human populations, from proposed Project activities is **moderate**. This level of risk indicates unlikely probability of occurrence of negative health outcome however with moderately severe consequences, which require the application of practical and appropriate mitigation measures to prevent risk associated with projected increases in mosquito activities, contributing to an increase in negative health outcome. Such mitigation measures are recommended in **Chapter 7,** for implementation and maintenance throughout both the Construction and Operation Stages of the proposed Project.

6.8.11.15 ELECTROMAGNETIC FIELDS

The expected installation of transmission lines traversing in close proximity to sensitive human receptor areas are expected to present a chronic, non-carcinogenic health impact to communities located along the transmission line route.

Due to the difficulties in assessing accurate projected levels of exposure from electrical and magnetic fields anticipated from proposed transmission lines with, and in the absence of substantiated prospective quantitative assessment methodology in this area, it is not possible to conduct an accurate quantitative risk characterisation of the health risk presented to human populations exposed to such fields. However, the qualitative risk assessment matrix will be applied to provide an indication of levels of risk expected by receiving human populations.

In applying the qualitative risk assessment matrix, the following key areas are considered in determining the qualitative risk assessment outcome:

- Proximity of proposed transmission line alignments to sensitive receptors, including residential areas.
- Varying epidemiological data on alleged negative health outcome as a result of exposure to electromagnetic fields from transmission lines.
- Severity of possible negative health outcomes.
- Compliance with international reference values for electric and magnetic fields.

Further to the above mentioned key areas, and applying the WHO qualitative risk assessment matrix, the projected level of health risk presented surrounding human populations, from proposed Project activities is **moderate**. This level of risk indicates unlikely probability of the occurrence of negative health outcome however with moderately severe consequences, which requires the application of practical and appropriate mitigation measures to prevent risk associated with the electrical and magnetic fields projected from proposed transmission lines, contributing to an increase in negative health outcome. Such mitigation measures are recommended in **Chapter 7**, for implementation and maintenance throughout both the Construction and Operation Stages of the proposed Project.

6.9 SOCIAL MANAGEMENT PLAN

The Project Proponent must take his corporate social responsibilities seriously and implement a set of social relation activities. The bases for these are the social management plans included in **Chapter 7**:

7.4.14 Community Protection Plan

7.4.15 Community Health and Safety Plan

7.4.16 Cultural Heritage Plan

Chapter 7 also includes **Section 7.5 Community Engagement** where the general guidelines for community interaction are dealt with.

6.9.1 SEIA PUBLIC REVIEW

As required by the Environment Protection Department, the completed SEIA report is subject to public viewing whereby the report will be displayed in various strategic locations for review and comment from the public, normally district offices and libraries. The executive summary of the SEIA will also be available for viewing on the Environment Protection Department website.

Given that the community in the rural area is less mobile and less connected to the internet, presentation of the EIA findings as part of the consultation programme is recommended since villagers will not likely to travel or read the technical SEIA report.

As requested by one of the Kemabong Local Community Leaders (Pemimpin Kemajuan Rakyat Kemabong) a brief non-technical summary focusing on the statement of benefits, impacts of the dam and mitigation measures that will be taken to mitigate these impacts should be provided to the community, in particular the community leaders. In this manner, the community can provide an alternative mechanism for compliance monitoring.

6.10 SUMMARY AND CONCLUSION

The Human Environment. The Project – including the transmission lines – affects three administrative districts: Tenom, Beaufort and Sipitang. In Tenom the Padas River, with the proposed dam site and power station and the existing Pangi Hydroelectric Power Station, mainly runs through the sub-district Kemabong. The main areas, i.e. the reservoir and the catchment are part of the Forestry Department's Forest Management Unit number 07, Sipitang, which is licensed to the Sabah Forest Industries (SFI).

SFI has a license to convert the area to plantation forestry but is limited by environmental concerns such as slope limitations and river protection. These limitations plus other concerns have been incorporated into SFI's management plans and environmental impact assessments.

The areas to be converted are cleared and prepared in a manner that is chosen for its minimum long term negative impact: Non-commercial trees are crushed and left on the ground for decomposition, minimal controlled burning, planting in debris). Planting and silviculture is implemented with methodologies and choice of species that aim at fast canopy closure and protection of soils. The species used are exotics: Acacia and Eucalyptus from seeds and there is no thinning done as part of growth manipulation.

The two enclaves of small holder agriculture is dominated by traditional farming although conversion to rubber or oil palm is catching up. There are no environmental assessments or regulations covering such areas. The local farming areas will not be affected by the direct establishment of Project facilities or the reservoir. The communities do not use the river extensively for transport purposes but there is some degree of fishing in the rivers.

The transmission lines will affect rubber and oil palm schemes both on the Tomani-Tenom stretch and on the stretch connecting to Sipitang. There are, however, no settlements in the path of the transmission lines. Only plantations.

There is one small internal line connecting the secondary power house at the dam with the main powerhouse at Tomani, which will go through some remnant primary forest just like the first part of the segment that connects to Sipitang will go through some forest. There is, however, little choice for any alternative alignment.

Impact Assessment. The immediate socioeconomic impact will be limited to the loss of 600 ha concession area for the Sabah Forest Industries in the area where the reservoir will be inundated and land use limitations to land owners in the path of the transmission line. There is no realistic mitigation other than payment of compensation. However, the reservoir area is not fully productive due to steep slopes.

The inundation will cause the loss of 600 hectares of habitat in an area where natural habitat is increasingly scarce. Locally this may be felt but regionally, this is a small price to pay for the socio-economic benefits.

Even if the major part of the reservoir area is cleared and cleaned before inundation, there will be cause for concern for greenhouse gasses. A total equivalent of 1.6 million tons CO_2 is emitted over 20 years. Of this, 1.1 million tons CO_2 equivalent is emitted through 50,000 tons of Methane from the 200 hectares which are not cleared. The remaining 491,000 tons CO_2 from the 390 hectares cleared. The Project should consider off-setting this impact through active forest protection or forest planting elsewhere or in the catchment.

The 12 km of river that is converted from a free flowing fast, rapid but shallow rapid-filled river to a docile lake with a deep anaerobic zone will be a completely new habitat and scenery. The current load of suspended solids is likely to settle in the upper reaches of the reservoir thus clearing the water but also decreasing the active storage and thus buffer for the Project in a dry spell. What was before forest floor will slowly turn into a soft benthic layer which sometimes is inundated, sometimes exposed. The forest near the present river will be inundated creating a fossil like forest slowly but anaerobic decomposing and thus saturating the water with methane and some carbon dioxide plus possibly mercury and other compounds.

The 9 km of ‘bypassed channel’ i.e. the segment of the Padas from the dam to the main power house will be transformed to a small river, about one quarter of its present size. The water is likely to be clear but still with a high content of methane after most methane has been released when the pressurized water is released through the secondary turbines. The river bed will thus change, the benthic stratum and thus the pelagic fishes too may change in composition and distribution.

The main flow of water, about 75% of the normal flow, will be released to join the water from the bypassed channel at a point after the main turbines. The change of water here will be the same as at the secondary power house: The water will be clearer but there is a problem with dissolved greenhouse gasses and other chemical compounds from decomposition of soil and biomass in the reservoir. Much will be released when the internal pressure of the water is released and the remainder methane is expected to be released through the river surface over the next 20-40 km. The impact on the river will not be significant as the flow short after the power house is joined by Tomani river and other water rich rivers. The management of the release of water through the turbines will, however, to some degree prevent seasonal fluctuations, thus contribute to the alleviation of flooding problems downstream. The latter may be a theoretical wish as floods are likely to occur when the reservoir is filled and water already flows over the spillway.

CHAPTER 7 ENVIRONMENTAL MANAGEMENT

7.1 GENERAL

The Environmental Management Plan (EMP) outlines the environmental management system that will be implemented during the detailed design and construction works of the Project to manage minimization of deleterious effects and implementation of enhancement measures. The EMP also embraces environmental management issues following the implementation of the Project works to maximize the beneficial effects of the Project, and detect and ameliorate adverse long-term effects.

The Environmental Management Plan is based on the anticipated environmental impacts and mitigation measures identified and described in **Chapter 4** and **5**, but it would be developed and updated regularly as the progress of the Project implementation.

It is required, the Project Proponent imposes this Environmental Management Plan upon all levels of planners and implementers of the Upper Padas Hydroelectric Project including contractors and sub-contractors. Therefore, wherever in the plan the expression 'The Project Proponent' is used, it implies also a requirement on the contractors and sub-contractors.

The environmental management plan is structured to comply with several sets of requirements: The requirements of the Sabah State, The Federal State of Malaysia and international requirements such as the International Finance Corporation Performance Standards and the Equator Principles.

It should here be noted that Malaysian and Sabah requirements primarily are requirements for environmental impact assessments and subsequent monitoring and reporting while international requirements focus on Project management, where the environmental impact assessment is only one activity in the planning process.

It is in this document assumed, financing includes financing from Equator Principle Financial Institutions. There are therefore included references to the Equator Principles and to e.g. reporting requirements to such borrowers. Likewise, requirements in this report, which go beyond the national or state requirements may be excluded from the national (state) approval process.

7.1.1 OBJECTIVES OF THE ENVIRONMENTAL MANAGEMENT PLAN

The objective of the Environmental Management Plan is to provide a framework for the monitoring and management of environmental issues in a comprehensive manner. The EMP outlines the environmental management system that will be implemented to minimize deleterious effects and maximize the beneficial effects of the Project, and detect and ameliorate adverse long-term effects. The main aims of the Environmental Management Plan are to ensure that:

- All environmental safeguards are carried out correctly during the construction of the Upper Padas Hydroelectric Project.
- Relevant legislations and guidelines (both Malaysian and international) are complied with.
- A documented system for sound management and enhancement of the development is available.
- Site activities are well managed and controlled.
- Adverse impacts on the environment are taken into consideration and minimised.
- Mitigation and response procedures are followed and a proper monitoring of the Project implemented, which involves systematic reporting of environmental impacts and allows corrective actions to be taken are established.

7.1.2 TIME FRAMED COVERED

This Environmental Management Plan is designed to ensure that a satisfactory performance is achieved during the construction *and* operation of the dam and associated facilities and in the event that Project abandonment occurs. Any significant changes in nature, extent, or location of the Project site during this period shall be reported to the Sabah Environment Protection Department.

The activities assessed start with initial field investigations and awareness communication, through all construction activities, handing over from contractors to the Project Proponent and the assumed long period, where the Project Proponent operates and maintains the Project facilities.

7.2 MANAGEMENT PROGRAMME

7.2.1 CORPORATE POLICIES AND COVENANTS

The Management of the Upper Padas Hydroelectric Project must during implementation and operation of the Project ensure and take responsibility that its staff or subcontractors adopt and follow strict policies for Corporate Social and Environmental Responsibility, including:

- Compliance with all relevant national and state social and environmental laws, regulations and permits in all material respects.
- Compliance with the EMP Action Plan during the construction and operation of the Project in all material respects; and
- Preparation of periodic reports in a format acceptable to Equator Principle Financing Institutions with a frequency not less than annually. The reports will be prepared by in-house staff or third party experts, documenting compliance with the EMP Action Plan (where applicable), and demonstrate compliance with relevant local, state and national social and environmental laws, regulations and permits
- Commitment to decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.

- Adherence to the International Finance Corporation's Performance Standard 3: Pollution Prevention and Abatement. This statement shall be included in the legally binding agreement with the Environment Protection Department.
- Adherence to the International Finance Corporation's Performance Standard 2: Labour and Working Conditions. This statement shall be included in the legally binding agreement with the Environment Protection Department.

The Project Proponent will have to provide employees with information regarding their rights under national labour and employment law, including their rights related to wages and benefits. This policy will be made clear and understandable to employees and will be explained or made accessible to each employee upon taking employment.

Further, the Project Proponent must actively apply the four international core labour standards:

- Effective Abolition of Child Labour.
- Elimination of Discrimination in Employment and Occupation.
- Elimination of All Forms of Forced or Compulsory Labour.
- Freedom of Association and the Effective Recognition of the Right to Collective Bargaining.

and abide by all applicable international conventions to which Malaysia is a signatory. This statement shall be included in the legally binding agreement with the Environment Protection Department.

- Further, the Project Proponent has to pursue a procurement policy for this Project, which requires that all sand and stone products to be procured through verifiable, legal channels.
- All forestry and timber products to be procured through verifiable, legal channels, or from areas to be legally cleared for this Project. For permanent structures, timbers shall, as far as they are available in the market, be from sources verified by the MTCC schemes (Malaysian Timber Certification Council) or other, internationally recognised schemes.
- All non-timber forest products must be of legal origin and their procurement from local sources must take into account the sustainability of the procurement.
- The feasibility of installing a run-of-the-river turbine system and/or solar panels for replacing diesel generators for the provision of electricity during construction stage is investigated during detailed design.
- Equator Principles and International Finance Corporation requirements of free, prior and informed disclosures to the affected communities, who are to be actively involved in the decision making for all issues affecting their livelihoods will be implemented by the company and its contractors.

7.2.2 ORGANISATIONAL ASPECTS, PROJECT PROPONENT

The Project Proponent shall at all times oversee that the contractors adhere to the requirements for overall performance of the Environmental Management Plan (EMP).

Figure 7.2.1 below depicts the current overall organisation of the Project Proponent and how the current Project is included in this organisation.

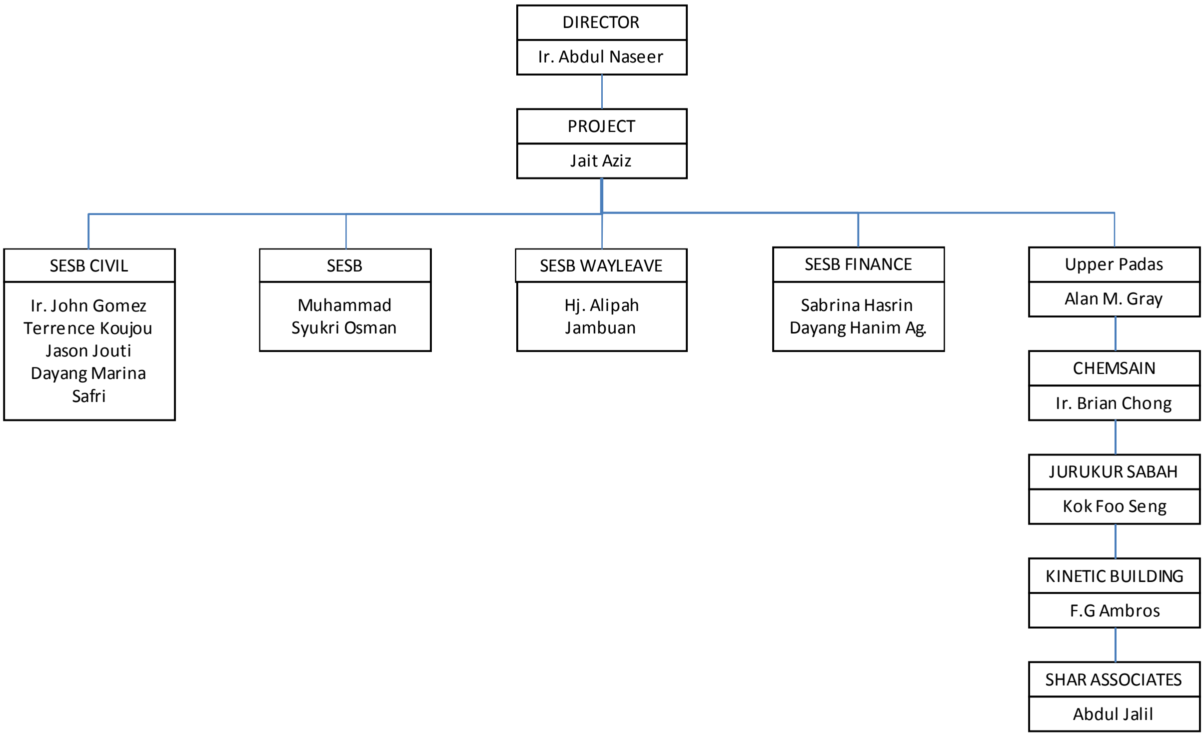

Figure 7.2.1 SESB Project Organization

The organization in **Figure 7.2.1** shall be adjusted to accommodate social and environmental focus. The following is a proposal for sector issues to be covered in the future but which may be further developed as the Project Proponent may wish to incorporate the mentioned activities and responsibilities into similar responsibilities for similar projects.

The responsibilities for undertaking specific required activities at design, construction and operation stages are listed in the following table.

Table 7.2-1 Responsibilities for Environment Management

Project Stage	Responsible	Responsibilities
Overall	Department of Environment (DOE)(Central)	Review Project EIA and provide Environmental Clearance for the Project; Review environmental monitoring report; Monitor and supervise compliance with legal requirements during program implementation and O&M stages
	Project Proponent (PP)	Guidance for environmental planning , mitigation, and monitoring and management of monitoring and evaluation data
	Project Consultants (PCs)	Support development of the capacity for environmental management in departments/institutions such as (including on-the-job training for ....)
	Project Environment Unit (PEU)	Overall review, monitoring, and reporting to DoE/PP including quarterly reports Monitoring, guidance, and auditing of PCs environmental management activities

Project Stage	Responsible	Responsibilities
Design	Project Proponent -- Consultants	Minimize non-avoidable losses in consultation with diverse stakeholders, and reviews/update/supplement Environmental Actions Plans (EAPs) by specifying mitigation and enhancement measures for engineering design, bid and contract documents, non-structure program plans, and periodic implementation plans
	Project Environment Unit – Consultants	Review and approve environmental mitigation measures reflected as EAPs and attached to documents mentioned above
	Project Environment Unit – Consultants	Strengthen local institutions capacities for monitoring (undertaken during program implementation stage as well); ensure coordination/resolution of conflicting interests with local stakeholders
Project Implementation	Contractors	Implement required environmental measures as reflected in EAP and attached to the contract documents
	Project Environment Unit – Environment Consultants	Supervise contractors' and service providers' implementation of EAPs, and enforce contractual and program requirements Monitor and report environmental indicators
	External Environment Consultants	Audit EAP activities. Submit quarterly/annual reports
	DoE/Environment Protection Department	Check the implementation of EMPs and monitor the environment to ensure negative impacts comply with EIA and identify any impacts not foreseen in EIA and controlled by EAPs
	Project Proponent	Provide budget to undertake environmental monitoring
Operation	Project Environment Unit	Carry out environmental monitoring and reporting to PP and DOE
	DOE	Review and approve environmental monitoring and reporting
	Project Proponent	Implement efficient Project operation, mitigating/reducing negative impacts and maximizing beneficial impacts according to EAPs

7.2.2.1 CONSTRUCTION SUPERVISION AND MANAGEMENT

Clearing and construction works will naturally be done by a network of contractors and sub contractors. However, this will not take the responsibilities of ensuring environmental sustainability and minimising negative impacts away from the Sabah Electricity SB.

The following main fields of environmental management will be in focus by the Project Environment Unit:

- Part of specific EMP Action Plan for Clearing of Biomass at the reservoir site. This will include ensuring clearing does not go beyond their designated boundaries, monitoring of access, methodologies (erosion prevention), intensity, burning, spillage of oils and fuels, (improper) use of chemicals. It will also include activities to save selected segments of the wildlife of the area.
- EMP Action Plan for Clearing of biomass at the transmission- lines. This will include monitoring of access, methodologies (erosion prevention), intensity, burning, spillage of oils and fuels, (improper) use of chemicals.
- These are specific construction works, no relation to environmental management mentioned: Civil works including roads, dams, tunnels, power house, transmission

pylons and lines, auxiliary installations such as sub stations, switch yards, transformers, offices, workshops and accommodation etc.

- Staffing of Project Environment Unit: Each of the three focal areas will require staff of its own with graduate level managers and technician level field staff and supervisors.

7.2.2.2 RESERVOIR MANAGEMENT

The Sabah Electricity Sdn Bhd must ensure its organisation includes a unit whose mandate covers to the management of the water reservoir and associated monitoring. There is currently no such unit within the organization.

Staffing issue: The unit must include graduate levels of expertise in monitoring and forecasts of water levels, water quality and aquatic wildlife (flora and fauna). Further, the unit must be capable of managing human utilisation of the reservoir whether for fisheries, recreation (tourism), consumption, irrigation or other forms of water use. This will include monitoring of water borne diseases and illegal use for dumping of wastes.

Staffing issue: The unit must be headed by a graduate natural resources management specialist, environmental engineer or similar supported by diploma level field supervisors and field inspectors.

7.2.2.3 CATCHMENT AREA MANAGEMENT

The catchment area management will require a permanent organisation to be set up representing the three major stakeholders: The Project Proponent, the Sabah Forest Industries and the communities living within the catchment area. The organisation shall be facilitated by the relevant government authorities such as the Environment Protection Department, the Department of Forestry, Department of Agriculture, and the Department of Irrigation and Drainage. The legal framework regulating the management will be environmental impact assessments, forestry management plans and district development plans. Environmental impact assessments may have to be imposed on small and medium scale development of private oil or rubber plantations [depending on the legal requirements under the Environment Protection (Prescribed Activities) (Environmental Impacts Assessment) Order 2005] in order to have a means to control methodologies and subsequent impact on the surface run-off to the reservoir.

Of particular concern are the representation of communities and the legal authority of their representatives. It must be ensured that this representation is free of any form of external interference or internal manipulation.

The catchment area management group is envisaged to be a committee, which convenes once or twice annually or upon request from one of the members. The committee does not require permanent staff or facilities but will carry out its coordinating role through the institutions' permanent structure(s).

Staffing issue: The catchment area management group must also include management level expertise on forestry, soils and community relations and have access to technician level field inspectors.

Cost of running a committee like this will be minimal. Unless otherwise agreed among the parties, the objective of the committee is to safeguard the feasibility of the Hydro Electric Project. Costs, which cannot be borne by the individual members must thus be borne by the Project Proponent.

7.2.2.4 *RIGHT-OF-WAY AREA MANAGEMENT*

The Sabah Electricity Sdn Bhd already has set ups to cater for management of right-of-way areas under transmission- lines. However, the organisation is not geared towards introducing diversified management regimes other than permitting certain forms of agriculture under the lines.

The unit may operate with its own supervisors and working teams for clearing, top tree pruning, planting and other activities or it may chose to carry out management and supervision of contractors and land owners. Such move does not relieve the organisation from its environmental responsibilities.

The right-of-way management may draw upon the same individuals and expertise as the catchment area management group. The management group must, however, be further strengthened by additional community relations officers and in case of the transmission- lines being drawn straight through the Crocker range National Park also by a wildlife officer, unless this aspect is contracted to a government institution such as the Wildlife Department or the Sabah Parks Department.

Temporary committee for compensation. The Project Proponent must set up a committee with representatives for the affected communities/businesses and relevant government agencies to assist in settling the questions on compensation for Project impacts.

Monitoring. The Project Environmental Unit will be entrusted with the task of performance and impact monitoring and subsequent reporting. The latter will include publicising the monitoring results. The monitoring exercises will involve engaging external parties for either the monitoring itself or for verification of the Project Proponent’s own monitoring results. In any case, this task will require professional staff at high standards and integrity.

7.2.3 PERSONNEL

The SESB organisation at the time of this assessment is shown in **Figure 7.2.1**. New staff and an adjusted organisational framework is anticipated by this plan.

The tasks and responsibilities of the personnel involved with the work on site are listed below. The tasks and positions may have other names or specific mandates. The important part of Chemsain’s proposal below is that the issues must be covered and that the responsibilities and mandates are ensured implemented.

Authorized Representative. The Authorized Representative of **Sabah Electricity Sdn Bhd** shall be supported by an advisory team consisting of 7-8 experts. The experts include an HSE Officer, a corporate social responsibility officer and an environmental compliance officer. The responsibilities of the Authorized Representative include:

- Overall planning of the Project to ensure operations are conducted safely and in accordance with statutory requirements.
- Adherence by contractors and other personnel to the requirements of all areas of environmental management set out in contracts and this Plan:
- Understanding, communication, training through site inductions, and delegate the Project environmental responsibilities to the project team.
- Communicate with the Environment Protection Department and / or Department of Environment (DOE) on environmental matters, highlighting potential problem areas and obtain agreement to proceed with the proposed work in environmentally sensitive areas, if any.
- Submission of an Environmental Management Plan (EMP), quarterly environmental reports and other management plans to the Environment Protection Department.
- Setting directions and monitoring the implementation of the Health, Safety and Environmental (HSE) management system and recommend any necessary changes to the system.
- Ensuring all sub-contractors as well as suppliers have all necessary insurances, certificates of competency, safety and environmental training, and that these are all current and valid.
- Provide direction to Deputy Managers particularly of the Construction Management Division, to help ensure the dam construction is conducted in a safe and environmentally-sound manner.

Deputy Manager (Construction Management Division). The Deputy Manager will:

- Ensure compliance with the contract and legislative environmental requirements.
- Have overall responsibility for ensuring that the functions defined in this Environmental Management Plan are carried out effectively.
- Be responsible for the coordination of procurement and quality control of equipment and materials, and construction activities as well as the implementation of construction policies and the Health and Safety, and Environmental policies.
- Ensure that all environmental protection procedures defined in the EMP are being adhered to.
- Report on performance of the system, certify that work is continuing in accordance with the EMP, ensure that all activities related to site preparation and construction works of the Project are completed in accordance with the environmental requirements.

Site Engineers/ Construction Supervisors. The Site Engineers/ Construction Supervisors will be the ones responsible for all groundwork at the Site Office. They shall have a team of Construction Foremen to assist them to carry out the daily tasks or works on-site. Supported by the Head Office, the Site Engineers/Construction Supervisors will report to the Deputy Manager. They will be assigned to:

- Undertake and/or coordinate the Project construction activities. They will maintain regular contact with contractors, personnel to ensure a safe working environment and the timely progress of construction works.
- Report to the technical division, or where possible resolve any technical issues at site pertaining to implementation of the Project.
- Responsible for the overall performance of construction and commissioning and related safety and environmental activities on their respective area. As such they are required to:
  - √ Ensure availability of a copy of the Environmental Management Plan at site office.
  - √ Promote and ensure compliance by workforce with environmental requirements on site.
  - √ Provide leadership to direct labour and sub-contractors in environmental issues.
  - √ Identify, report and record any actual or potential environmental problems on site.
  - √ Initiate or recommend solutions to those problems.
  - √ Control site activities until any environmental deficiencies are corrected.
  - √ Ensure environmental safeguards and protection as may be nominated or necessary are in place and enforced.
  - √ Specific responsibilities as delegated.
  - √ Ensuring all work crews are inducted in environmental and emergency procedures.
  - √ Ensuring all work crews are aware of any changes to the EMP and revised procedures.
  - √ Provide to the Deputy Manager to help ensure operations are conducted in a safe and environmentally sound manner.

Health and Safety Executive (HSE Officer). The HSE Officer shall advise the Authorized Personnel and the Deputy Managers on the establishment and implementation of health and safety Policies. He shall work alongside the Site Engineers/ Construction Supervisors to:

- Conduct safety induction and other related training to all workers.
- Advise the Deputy Manager and/ relevant person in charge on issues and/ measures to be taken related to safety in the interests of the workers.
- Inspect the Project area to determine whether any machinery, equipment and method used are liable to cause injury to any workers.
- Investigate any incidents (i.e. accident, near-miss accident, dangerous occurrence and occupational disease), which have happened at the place of work.
- Assist the Authorized Representative and Deputy Manager to abide all relevant government regulations.
- Collect, analyze and maintain statistics on any accident, dangerous occurrence, occupational poisoning or disease, which has occurred at the place of work.

- Carry on any other instruction made by the Authorized Representative or any person in charge of the place of work on any matters pertaining to safety and health of the place of work.

Corporate Social Responsibility Officer. The Corporate Social Responsibility Officer shall advice the Authorized Personnel and the Deputy Managers on the implementation of the Corporate Social Responsibilities Policies. He shall work alongside the Site Engineers/ Construction Supervisors to:

- Advise the Deputy Manager and/ relevant person in charge on issues and/ measures to be taken related to dealing with affected communities or individuals.
- Ensure early dialogues with the affected communities are conducted in a manner that disseminates all relevant information in a manner culturally and socially acceptable to the communities.
- Supervise and monitor the implementation of the social Responsibility Management Plan, which will be established at a later stage.
- Ensure points of opinion from the affected communities or individuals are taken seriously and realistically into consideration when formulating working plans and instructions for the company's workers and staff.
- Ensure sites of cultural, historical values are respected to the fullest possible. These include ancestral grave sites or sites which are considered sacred to the locals.
- Ensure negative impacts to the livelihoods of the affected people are mitigated or compensated in a manner that fully respects traditional sentiments as well as present legislation.
- Assist the Authorized Representative and Deputy Manager to abide all relevant regulations imposed by the authorities in relation to dealings with local communities.
- Carry on any other instruction made by the Authorized Representative or any person in charge of the place of work on any matters pertaining to dealings with local communities.

Environmental Compliance Officer. The environmental Compliance Officer shall advice the Authorized Personnel and the Deputy Managers on the implementation of the Environmental Policy. He shall work alongside the Site Engineers/ Construction Supervisors to:

- Advise the Deputy Manager and/ relevant person in charge on issues and/ measures to be taken related to environmental quality and protection.
- Assist the Authorized Representative and Deputy Manager to abide all relevant regulations imposed by the authorities in relation to environmental management.
- Supervise and monitor the implementation of this Environmental Management Plan.
- Instruct all concerned parties on implementation of the environmental conditions imposed as a result of the environmental impact assessment procedure and explain to them the background and reasoning for such measures.
- Take charge of the monitoring programme imposed upon the Company as a result of the environmental impact assessment procedure.

- Ensure all company staff and employees as well as subcontractors respect national and state environmental legislation including hunting ban and the use of illegal fishing methods.
- Carry on any other instruction made by the Authorized Representative or any person in charge of the place of work on any matters pertaining to dealings with local communities.
- The Environmental Compliance Officer shall have executive powers to issue stop orders when identifying works that are detrimental to the environment or which in any way does not comply with rules and regulations imposed by the authorities.

Site Workers. The site workers will:

- Attend site induction and other training sessions.
- Encourage environmentally sound work practices by adhering to the controls defined in the Project specific work instructions.
- Avoid work practices that are damaging to the environment and ensure that procedures are followed.
- Identify and report any environmental problems on site.
- Carry out specific responsibilities as delegated.

7.2.4 TRAINING AND STRENGTHENING OF THE ORGANISATIONAL CAPACITY

Manpower: The manpower required for the environmental management, supervision and monitoring of the Project will require training. The Project will include necessary in-service training of all human resources needed, whether at management, middle management or field level. Training will address planning; work force management; impact assessment; impact monitoring analysis as well as reporting. In addition, training will provide the relevant staff detailed knowledge of organisational and legal frameworks.

The Project must include sufficient budgets for training of Company staff to be assigned to the Project having inadequate skills in fields of operation new to them. Funds for institutional development, particularly in the fields of environmental planning and monitoring to the extent such planning and monitoring will be imposed/requested by this Project must be made available for the Sabah Forest Industries.

Communities: Training events must be offered by the Project to those local communities that will be required to take part in catchment area management. The training shall focus on sustainable management and on contractor management as these communities increasingly also use contractors for their small scale land conversions.

Logistics: Project funding must include sufficient allocations for equipment and transportation (land, water and air) to mobilise the environmental management groups under the Sabah Electricity Sdn Bhd.

Equipment will include access to mapping facilities including GPS, compasses, clinometers, binoculars; monitoring sensors including remote sensors; testing facilities and awareness facilities.

Institutional Organisation and Capacity: The Sabah Electricity Sdn Bhd must ensure, all staff members at management and middle management levels, i.e. including field supervisors, are properly trained in their individual duties as company executives. The training must include but will not be limited to:

- International, national and state legal frameworks.
- Internal company policies for social and environmental responsibility.
- EMP requirements and implication including procurement and staff supervision.
- Basic environmental impact assessment.
- Line of command for fast response to environmental challenges.
- Policies and processes for transparency and public participation.
- Project safety procedures.

Staff Training: Each staff and worker must receive personal instruction on:

- The environmental issues that may influence his work.
- Company policies for environmental and social protection.
- Reporting procedures for social and environmental issues and problems influencing his work or which he has become aware of otherwise.
- Project safety procedures.

Contractor Training: Contractors and their staff must undergo training similar to that of Sabah Electricity Sdn Bhd staff and management.

7.2.5 LABOUR ISSUES

The Project Proponent must throughout the implementation of this Project enforce the adherence to the International Finance Corporation performance Standard 2: Labour and Working Conditions.

Human Resources Policy: The Project Proponent must adopt a human resources policy that sets out his approach to managing employees consistent with the requirements of this the International Finance Corporations Performance Standard 2. Under the policy, the Project Proponent must provide employees with information regarding their rights under national labour and employment law, including their rights related to wages and benefits. This policy must be clear and understandable to employees and must be explained or made accessible to each employee upon taking employment.

Labour Source: The Project Proponent must source his labour force in accordance with the Federal and State regulations with a preference given to local Sabahan communities. The use of foreign labour must strictly adhere to the government regulations concerning sourcing, work permits, remuneration and other benefits.

Working Relationship: The Project Proponent and his contractors must document and communicate to all employees and workers directly contracted by the Project Proponent their working conditions and terms of employment, including their entitlement to wages and any benefits.

Working Conditions and Terms of Employment: The Project Proponent and his contractors must provide reasonable working conditions and terms of employment that, at a minimum, comply with national law.

Workers' Organizations: The Project Proponent and his contractors must enable means for workers to express their grievances and protect their rights regarding working conditions and terms of employment.

The Project Proponent or his contractors will not discourage workers from forming or joining workers' organizations of their choosing or from bargaining collectively, and will not discriminate or retaliate against workers who participate, or seek to participate, in such organizations and bargain collectively. The Project Proponent and his contractors will engage with such worker representatives. Worker organizations are expected to fairly represent the workers in the workforce.

Non-Discrimination and Equal Opportunity: The Project Proponent and his contractors must not make employment decisions on the basis of personal characteristics unrelated to inherent job requirements. The Project Proponent and his contractors must base the employment relationship on the principle of equal opportunity and fair treatment, and will not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, promotion, termination of employment or retirement, and discipline.

Retrenchment: The Project Proponent and his contractors must develop a plan to mitigate the adverse impacts of retrenchment on employees. The plan will be based on the principle of non-discrimination and will reflect the client's consultation with employees, their organizations and, where appropriate, the government.

Health and Safety: The Project Proponent must provide the workers with a safe and healthy work environment, taking into account inherent risks in this particular sector and specific classes of hazards in the work areas of the project, including physical, chemical, and electric hazards. The Project Proponent will take steps to prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards.

Provision of proper training (methodology), adequate technology and supervision as well as provision and utilisation of appropriate personal protective equipment/devices are all important to prevent the occurrence of accidents. The provisions included in the present plan apply to normal accidents related to the proposed development and traffic accidents during transportation of excess earth.

In case of accidents, safety of personnel is given first priority, generally followed by the property and then the environment. When balancing the priority for property and environment against each other, the question of scale and effect on livelihoods shall be taken into account.

7.3 SUMMARY OF MITIGATION AND ENHANCEMENT MEASURES

Table 7.3-1 lists a summary of the most important environmental impacts and associated mitigation measures. The activities needed for avoidance, minimisation or mitigation are further detailed in **Section 7.4**.

Table 7.3-1 Summary of Primary Mitigation and Enhancement Measures

Project Stage	Project Activity	Potential Environmental Impacts	Proposed Mitigation Measures
Pre Construction Stage	- Disclosure and communication - Land Acquisition, tenure and user rights - Site investigations	- Social uncertainties and inequities	- Compensation payment - Replacement areas
Construction Stage	- Procurement - Transfer and mobilisation	- Consequential impact on procurement lines	- Regulated, 'Green' procurement
	- Earthworks - Civil works - River diversion	- Soil instability, increased suspended solids in waterways: Habitat destruction - Waste generation - Labour safety hazards	- Soil stabilization, slope protection, Siltation control, Transport safety, waste disposal plans, Hazardous waste control, Personal protection equipment, Labour training, Compensation flow, Access to bypass the construction site for river transport.
	- Biomass disposal	- Loss of habitat - Greenhouse gasses	- Wildlife rescue, Off-set plantation or protection,
	- Decommissioning of temporary structures	- Waste generation - Soil instability	- Contractor control, clearing, revegetation
Impoundment Stage	- Closing diversion tunnels - Removal of cofferdams Flooding - Releasing compensation flow	- Flow disruption, impact on aquatic habitat and fisheries, Increased sedimentation (Cofferdams) - Greenhouse gasses - Loss of habitat	- Off-set (compensation) planting - Wildlife rescue - Timing of works
Operation and maintenance Stage	- Power generation	- Limitation to land use in catchment	- Catchment management - Compensation
	- Power transmission	- Limitation to land uses	- Right of way management support - Compensation
	- Periodic Maintenance	- Temporary access	- Compensation

7.4 ACTION PLAN: PROGRAM OF MITIGATION AND PERFORMANCE IMPROVEMENT MEASURES

An 'Action Plan' (AP) for environmentally responsible implementation of all aspects of the Project, whether during construction or operation, is included below. The plan consists, in line with the requirements of the International Financing Corporation's performance Standards and the Equator Principles, of a number of specific plans, each addressing a particular topic. Additional (sub-) plans may be included as the need arises and issues are identified. The current plans must likewise be subjected to constant review and improvement.

The present plan and sub-plans must be made known to all staff and contractors in languages appropriate for these groups.

7.4.1 SOIL AND SLOPE PROTECTION PLAN

Soil loss in the form of erosion or slope failure occurs whenever vegetation is cleared, whenever the existing soil surface is disturbed, when spoil is deposited in an unstable manner and when water is channelled through new routes. Such events are results of road building, quarry activities, dam building, tunnelling, establishment of camp and other facilities, river diversion, biomass disposal, right-of-way management.

All efforts must be made to ensure slope and soil stability. Landslides and erosion materials may eventually end up in the waterways increasing the load of suspended solids and creating banks of sediments. The result will be a chain of consequential impacts eventually killing fish populations and rendering the water difficult to use for human consumption and other household needs. The overall impact of soil loss is summarised and depicted in **Figure 7.4.1**.

Figure 7.4.1 Impact of Soil Loss

The Upper Padas Hydroelectric Project will operate in an area, where soil management is already a problem due to extensive land conversion schemes in the catchment. The problem is exacerbated by the cumulative effects soil erosion has on the natural waterways.

A particular form of 'soil' deposit in the waterway will be the deposits of dust and waste created by crusher plants.

Soil protection includes a number of simple precautions:

- Road gradients must be kept less than 10%.
- Steep sections of road, sharp road bends on hills or sections through fragile soils must be sealed.

- Culverts and bridges must be installed wherever roads and other clearings cross waterways, whether permanent or seasonal.
- No direct crossing of waterways shall be allowed with machinery or vehicles.
- Cut slopes shall be stabilised with benches, drains or other installations to prevent erosion and slope failure. Such features may include insertion of drainpipes to drain subsoil water, covering of the surface with mesh, concrete, stones, vegetation, or other material.
- Drains and silt traps must be installed at the bottom of all cut or cleared slopes.
- Drains and silt traps shall be installed at the discharge outlets of the contractor office and camps as well as spoil areas.
- Silt traps shall be de-silted periodically.
- Sedimentation ponds shall be provided at the quarry site for retention of eroded soil particles. The sedimentation pond shall be de-silted regularly to ensure its effectiveness.
- Riparian reserves shall be maintained along all major waterways, except at the dam site but including at the reservoir.
- During the construction of the internal connecting road between the dam and the powerhouse, earth spoil shall be carted straight away after cutting and store at a designated spoil area.
- Pushing of earth spoils over road shoulder and into waterways shall be totally prohibited.
- All cleared areas must be covered with vegetation as soon as the denuded state no longer is required.

7.4.2 WATER QUALITY PROTECTION PLAN

Chemical and biological pollution of waterways will endanger wildlife and human health alike and decreased wildlife health will in addition affect human health too. The overall water quality pollution and its effects is presented in **Figure 7.4.2**.

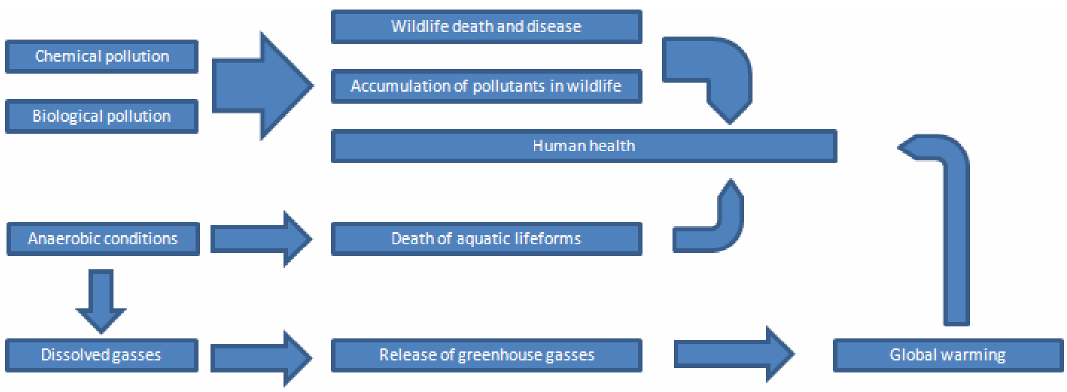

Figure 7.4.2 Water Quality Pollution

Chemical pollution happens when oils, grease and fuels are improperly handled and stored, when hazardous wastes such as agro chemicals, cleaning agents, cooling agents etc. are accidentally or through ignorance spilled or disposed of in the water ways or seeps from improper disposal in soil pits.

The inundation of the reservoir will create its own set of water quality issues or changes of the water's chemical properties: Decomposition of the biomass will deplete the water of oxygen and it will cause carbon dioxide and methane to be dissolved in the water. Other gases and chemical substances will be released into the reservoir water by decomposing biomass. Hydrogen Sulfide (H_2S) gas forms and persists when biomass decomposes in oxygen depleted water. Mercury is naturally present in a harmless inorganic form in many soils. Bacteria operating in deoxygenated soils of new reservoirs can transform inorganic mercury into methyl-mercury, a central nervous system toxin. Methyl-mercury (CH_3Hg) accumulates in fish and other aquatic life, reaching elevated levels that present serious health risks to humans and other life forms (including humans) that consume them.

A particular chemical alteration of the water quality is the formation of a large anaerobic water body below 5-10 meter's depth.

A particular form of water pollution is the spillage from batching plants and other sites, where concrete and other materials such as fly ash are mixed. Here, the material that reaches the water ways have many qualities similar to soil and they will also contribute to TSS loads and siltation but they will also be of a chemical composition, which potentially may be harmful to living organisms.

The following measures will contribute to the protection of the water resources against chemical and biological pollution or serve to decrease the level of depletion of the water's dissolved oxygen upon which most aquatic life depends:-

- Depots for oils, fuels and hazardous materials shall be not less than 50 meters from watercourses.
- Skid tanks and fuel depots shall be bunded to contain any spills. Bunding must be constructed of concrete, with concrete flooring and a sump to collect spillage and rainwater. The bunding shall be able to contain a minimal of 110% of total tank volume.
- Contaminated soils shall be removed from the site and treated or disposed in approved off-site location in accordance with the requirements of the Environmental Quality (Scheduled Wastes) Regulations, 2005.
- Waste oils must be collected and disposed of in accordance with local district or state regulations. Spent machine parts must be regularly collected and transported to re-cycling collectors or plants.
- Scheduled Wastes must be sent for final disposal by a Department of Environment (DOE) approved contractor. Generation of any scheduled wastes shall be notified to the Director General of Department of Environment (DOE) in writing. The notification shall be completed in the form prescribed in the Second Schedule (Notification of Scheduled Wastes).

- All crushing plants, batching plants and other sites where concrete and building materials are mixed shall be equipped with necessary siltation ponds and treatment system to treat water to less than 150 mg/L of suspended solids and pH to neutral level before effluent is released to the receiving waterway.
- Construction waste and biomass must be stacked in a safe distance minimum 50 metres away from rivers and may at no time be pushed into or discarded into any form of watercourses, whether natural or man-made.
- Permanent yards and pollutant holding facilities shall have lined interior besides having perimeter drains. Floors for equipment service facilities must be sealed. Spill containment systems or concrete bunding shall be installed and maintained for all fuel and chemical storage facilities.
- Field crews handling oils and fuels must be given proper tools for handling and storage in order to avoid spillage.
- Water used in washing and cleaning of concrete surface during the dam construction shall be channelled into silt retention pond for sediment settlement before discharge into the downstream receiving waterways.
- Work involving grouting near water, or involving the use of strong cleaning agents, acids, resins and hazardous materials near water bodies shall be done with adequate spill mechanisms in place.
- Clearing of biomass must be in accordance with the biomass disposal plan.
- Intake structures shall be operated below the aerobic (oxygenized) stratum (10 m depth) of the reservoir to mitigate the otherwise stagnant conditions in these layers and insufficient water renewal in the lake.
- Re-aeration devices shall be included in the design of spillway and outlets from the primary and secondary hydropower structures.

7.4.3 WILDLIFE PROTECTION AND RESCUE PLAN

In Sabah, ‘wildlife’ is defined as wild fauna as well as flora and their protection falls within the mandate of the Wildlife Department. Wildlife is dependent on a fine balance between species, including humans.

It is the responsibility of the Project Proponent and his contractors to ensure all staff and workers are briefed about i.a. the wildlife protection regulations of the state and that breach of such regulation will be seen as a breach of contractual terms and thus subject to disciplinary action.

The Project related activities in the area will bring disturbance, the traffic will fragment the area and also pose direct threats to roaming animals and the clearance and inundation will directly remove habitat and territories. The reservoir itself will pose as a barrier to animal movement as well as spreading of vegetation.

At the other end of the scale is the threat to the natural species composition from introduced species, whether plants or animals. See overall wildlife impact in **Figure 7.4.3**.

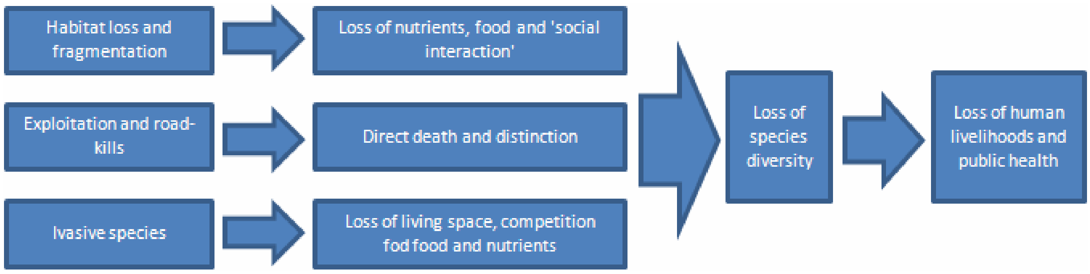

Figure 7.4.3 Wildlife Impact

To mitigate the potential negative impacts on wildlife, it is important for all workers at the Project and support structures to show responsibility and play their role.

- Wildlife protection shall be included in subcontracts and employment contracts.
- Posters depicting protected wildlife of Sabah must be displayed at prominent places where staff, workers and their families easily see them.
- Information on wildlife protection and regulations must be given to all staff.
- Procurement of wildlife, e.g. bush meat, fish, must only be done after considering legality and sustainability.
- It is assessed that no temporary islands will be created while the reservoir is being inundated. However, during filling the situation has to be monitored, and should protected animals be trapped, actual rescue and translocation must be carried out under the supervision of the Wildlife Department.
- Areas that have been temporarily cleared must immediately after use be re-vegetated with non-invasive, local species that are deemed to allow for natural succession of vegetation.
- Strict control must be exercised with domestic species, whether plants or animals in order to prevent them from spreading into the reservoir area or other surrounding areas.
- Drivers shall be instructed not to use their vehicles as tools for killing animals crossing the roads and to do their utmost, within the limits for safe driving, to prevent road-kills of all species including snakes and other ‘unpopular’ species.
- Procurement of timber must only be from the area to be cleared or from otherwise verifiable legal sources.
- No herbicides, pesticides or other agrochemicals shall be applied in order to control vegetation or animals other than within camps as approved by the competent authorities for control of vector borne diseases.
- An area of similar biodiversity potential as the one to be cleared for this Project must be protected to balance for the losses incurred.

7.4.4 BIOMASS REMOVAL PLAN

In order to recover biomass of value, to maintain water quality and to reduce the emissions of greenhouse gasses as much biomass as technically and economically possible should be removed before inundation of the reservoir.

The following three steps in the biomass removal plan are foreseen (refer to **Figure 7.4.4**):

- **Step 1**: Large diameter timber that can be utilized in production of wood based products, shall be salvaged from the entire 590 ha reservoir area. These timbers may be used for raw material by local wood processing industries (e.g. Sabah Forest Industries) for production of long-term wood products. Carbon from these products will be oxidized over a period of 1 to 20 years. The large commercial species are estimated to make up 50% of the standing volume.
- **Step 2**: Small diameter trees and trees of non-commercial species from the area to be periodically inundated* shall be felled, crushed and left on site to deteriorate[62]; or piled in windrows and burned under controlled conditions – over a 2 year period prior to inundation. Local communities shall be encouraged to harvest and collect timber and other products without being seen as encroaching into Sabah Forest Industries' or the Project Proponent's area. A pre-condition for burning is that the timber has been left for drying for a minimum of one year. This will contribute to a complete burn with a minimum of CO or visible smoke. Preconditions for natural on-site decomposition are 1: A thorough crushing so all biomass has contact with the soil, and 2: clearing is done at least 2 years before inundation. The latter will unfortunately allow new secondary growth to emerge but the volume of this growth is estimated to be insignificant.

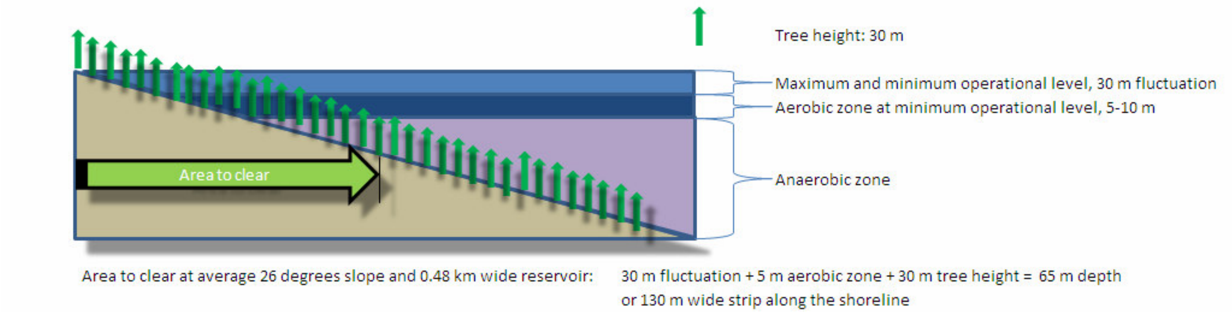

Figure 7.4.4 Biomass Clearing

- **Step 3**: While it is environmentally desirable to clear the entire area completely, it is acknowledged that this may be technically impossible. It may be necessary and thus acceptable to leave some vegetation standing in the inaccessible areas. Since this wood is permanently inundated (not exposed to oxygen) it will decay over a very long period. Local communities shall be encouraged to harvest and collect timber and

[62] a strip of land approximately 130 m wide, around the 30 km shore-line of the reservoir (app 400 ha) between low water (430 m elev) minus aerobic depth (5 m) minus a tree height (30 m) = 395 m elev. and high water (470 m elev). Biomass decomposition in this area will be rapid in Ulu Padas' tropical, moist climate, with high temperature and high rainfall.

other products without being seen as encroaching into Sabah Forest Industries' or the Project Proponent's area.

In addition, the following rules shall apply:

- Biomass from reservoir clearing, which has not been decomposed or burned, shall be removed away from the inundated area. A biomass stockpile area 50 m outside the reservoir shall be established for temporary storage of biomass wastes.
- Smokeless incineration to combust all unusable biomass under high temperature is recommended.
- No open burning of biomass, construction wastes, etc. shall be allowed at the Project site unless with written permission from the Environment Protection Department.
- Total clearing of construction sites and roads.

In order to prevent or minimise soil erosion, following shall be incorporated into all work procedures:

- Removal of vegetation cover only when there is immediate earthwork activity.

7.4.5 TRAFFIC SAFETY PLAN

It is the legal duty of any driver to ensure his vehicle is in safe running condition and that he himself is in a health condition to drive safely. It is also the legal duty of the vehicle owner that the driver, the employee normally is capable of driving the vehicle safely and legally.

The following measures – in addition to national and customary laws and regulations –shall be incorporated in all traffic and transportation instructions:

- Adequate road warning signage and devices at construction or road maintenance sites shall be provided at all times and roads shall be maintained regularly to ensure providing a safer and better transportation routes for all road users.
- Use of head-lights is at all times a requirement on as well as off site.
- All vehicles must be equipped with fire extinguishers, hazard triangle (see **Figure 7.4.5**) and first aid kits. Drivers and their helpers shall be trained in the proper use of this equipment and in general first aid.

Figure 7.4.5 Hazard Triangle

- Outside national and state roads, heavy traffic shall not be permitted through school areas and villages during periods when school children meet or return from school. Such periods and areas for waiting shall be negotiated with schools and traffic police.
- Wheel and vehicle rinsing facilities must be installed at all exit points.

- Dusty material must be covered with canvas or tarpaulin sheet during transport.
- Water spraying tankers must be deployed during dry spells to unsealed road sections that pass villages, markets, schools and other community centres.
- Overloading, use of defect vehicles, disregard of general traffic regulations shall in addition to public prosecution be dealt with as an internal disciplinary matter that in severe cases or repetition may lead to dismissal.
- Heavy traffic must stop and not drive on unsealed roads during rain and wet conditions.
- Regular servicing and maintenance of vehicles to ensure compliant gaseous emission.
- Drivers must within the scope of common safe driving do their best to avoid harming animals of all species.

Additional requirements may be found under the heading of hazardous substances:

- The containers shall be compatible with their contents and be equivalent to regulatory specifications for the material being shipped.
- Shipping placard shall be used as required by law for shipments on public roads.
- Smoking will not be permitted during loading and unloading of hazardous materials like fuels, etc.
- Incompatible materials shall be segregated.
- Containers especially containing flammable material shall be loaded such that contact between containers during transit does not occur.

7.4.6 WORKERS HEALTH AND SAFETY PLAN

The safety of workers and employees must at all times take precedence over economic considerations and over construction schedules.

The Project sites are inherently dangerous as work includes work with heavy equipment, work at great heights, work with high voltage electricity, blasting, tunnelling (work in confined spaces). Each of these requires their own safety rules. The text below sets out the general principles for such rules.

Workers' Safety:

- All workers must be adequately covered by health and accident insurances.
- All shifts in all work sites must have a safety representative, elected by the workers but trained by the Company or contractors. The site management must have safety development meetings with these safety representatives not less than quarterly including with safety representatives from contractors.
- No worker must be left for prolonged periods to work alone with dangerous activities.
- Emergency communication equipment must be installed or otherwise available at strategic places throughout the work sites.

- Safety instructions and instructions for emergency response must be displayed prominently throughout the work site.
- Safety regulations must be rigorously be enforced, also towards management representatives and visitors.
- Approved safety gear including eye and ear protection must be provided to all workers in accordance with Malaysian and International Labour Organization (ILO) legal requirements. Safety gear must be specifically adapted to the work site of the individual worker, e.g. work at heights, heavy equipment, dangerous substances, electricity etc.
- No workers to be exposed to noise exceeding 115 dB(A) and impulsive noise at or above 140 dB(A).
- A medical facility catering for minor emergencies and general health including child and maternal issues must be established.
- All workers handling hazardous substances including oils and fuel must have proper training in handling such substances.
- Healthy living quarters with easy access to water, sanitation, air and light must be provided to workers living on the Project site. The quarters must be built in areas protected against dust, noise, flood (including general muddying during rains).
- All migrant workers shall be screened for communicable diseases such as tuberculosis, leprosy, AIDS and venereal diseases.
- All workers shall be medically examined upon employment and subsequently every year including screening for malaria parasites, tuberculosis, AIDS and venereal diseases.
- All foremen and supervisors must undergo and pass an approved first aid course before taking up their duties on the work site.
- Social activities that may act as awareness, substitute or deterrent to excessive drinking, gambling and immoral activities shall receive company support.
- Disregard of safety regulations shall in addition to public prosecution be dealt with as an internal disciplinary matter that in severe cases or repetition may lead to demotion or dismissal.

Workers' Health:

- All workers employed during the Construction Stage of the proposed Project prior to commencement of employment are to be tested for exposure to mosquito borne disease, as a baseline indicator of prior exposure to mosquitoes at the site. Furthermore, periodical surveillance of the disease exposure to workers is to occur throughout construction of the proposed Project. In the event an increase is indicated, further efforts in preventing exposure in accordance with the following mitigation measures are to be undertaken.
- Regular fogging and larval spraying is to occur around construction related areas. Areas of focus for fogging and spraying activities include areas of high population (workers quarters, canteen, key construction locations), and immovable areas of

stagnant water and vegetation (verge areas of rivers and reservoirs). Fogging and spraying is to occur during dawn and dusk times only, and using product which is effective, but not impacting to occupational health. Where possible, non chemical based larval spraying product, such as BTI (Bacillus thuringienis israelensis), should be used.

- Regular inspections are to be carried out across the construction area for the limitation of artificial stagnant water bodies created by rubbish, ground depressions, materials storage, and bunding. These areas are to be highlighted and either removed or managed to prevent the proliferation of mosquito larvae.
- Workers quarters and facilities where possible are to be located away from any naturally occurring stagnant water body, which may currently or will exist during the course of construction. Examples include the filling reservoir, and smaller upstream subsidiary rivers of Sg. Padas.
- All water (drinking or other) stored at the workers quarters and associated facilities are to be adequately protected from mosquito breeding. Tank inlets and overflow outlets are to be covered with mosquito netting. Netting and the presence of larvae in water is to be regularly checked and rectification action taken where necessary.
- Workers are to be educated in personal protection techniques in safeguarding against mosquito contact and the potential for mosquito born disease. Techniques include the regular daily application of effective mosquito repellent (containing DEET - *N*,*N*-Diethyl-*meta*-toluamide), the avoidance of high mosquito activity areas during dawn and dusk, and the wearing of long-sleeved shirts and pants.
- Mosquito repellent is to be provided as part of the PPE (Personal Protective Equipment) for workers on the site.

7.4.7 SEWAGE AND DOMESTIC WASTE MANAGEMENT PLAN

Uncontrolled disposal of raw sewage or unsorted domestic wastes will affect the environment and thus humans in two ways. These types of waste contain agents or substances that are directly harmful to humans or wildlife. These may be parasites, bacteria, fungi, chemicals etc. The wastes will also attract rats, flies and other disease vectors.

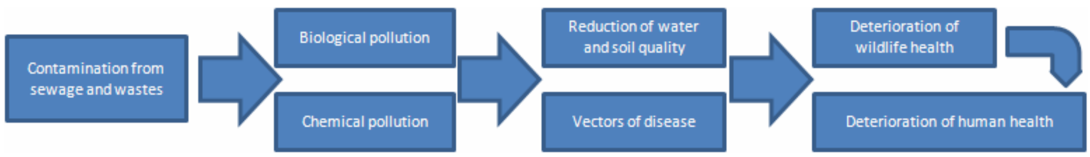

Figure 7.4.6 Pollution from Sewage and Domestic Wastes

Irresponsible disposal will thus quickly threaten the most valuable asset the company or the contractors have: The human capital including families, visitors and surrounding communities. The overall impact resulted from the pollution from sewage and domestic wastes are depicted in **Figure 7.4.6**.

To maintain a healthy work force in a healthy environment, it is thus pertinent to manage the wastes responsibly. The points below set out some general guidelines from where specific regulations may be extrapolated.

- No household waste or untreated sewage may be disposed of in waterways or in uncontrolled areas of the environment.
- Workers' quarters and site offices shall be provided with treatment system capable of treating the sewage to Standard A of the Environmental Quality (Sewage) Regulations, 2009.
- Service yards and work sites shall be provided with portable toilets (mobile toilets) and shall be de-sludged regularly.
- All septic tanks (elsewhere in the Project site, if any) shall be de-sludged at regular intervals (at least once a year or whenever the discharge does not meet Standard B requirements) to maintain in the tanks efficiency.
- Sewage sludge including that from mobile toilets shall be disposed off at approved treatment plant or dump site.
- All food preparation area and eating outlets shall be provided with oil and grease traps.
- Segregation of wastes should be promoted. All recyclable materials shall be sorted out for reuse. The Project Proponent will facilitate collection of items for recycling either directly or through 3rd parties.
- The Contractor shall provide waste receptacles and arrange for regular garbage collection and disposal service.
- A landfill shall be provided for the disposal of domestic wastes for the Project site in accordance with the government guidelines for the landfills.

7.4.8 CONSTRUCTION WASTE MANAGEMENT PLAN

The Project is bound to generate large amounts of construction related wastes: Spent scaffolding, excess building materials, discarded machine and building parts, fencing and the largest amount the materials from dismantling coffer dams, camps and other facilities that are not to be handed over to the Project Proponent at the end of the construction stage.

To minimise the amount of wasted materials and thus also to cut costs, as much material shall be re-used as possible.

Apart from being an eye-sore, construction wastes may also become harmful to humans and wildlife alike as they often contain sharp objects or act as traps. Piles of wastes may accumulate stagnant water and thus be a source of vector borne diseases or attract other pests such as rats, snakes, scorpions etc. See **Figure 7.4.7**.

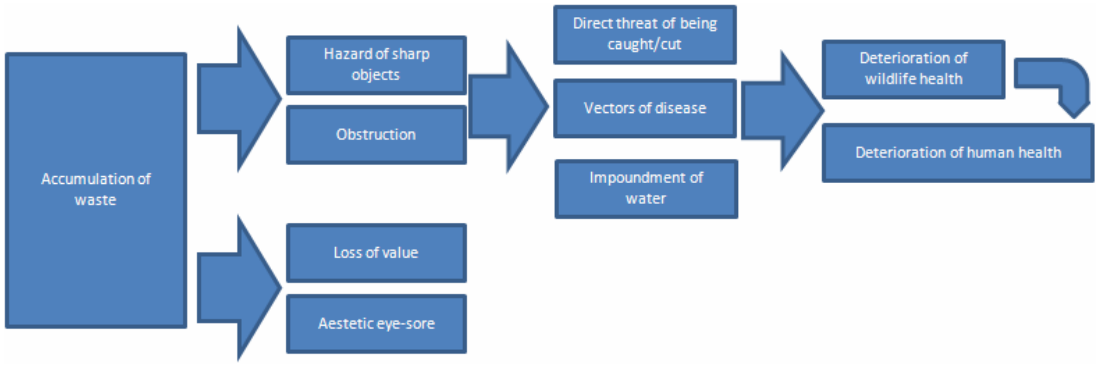

Figure 7.4.7 Construction Waste Impact

A general outline of waste management is listed below.

- All construction waste shall be sorted so disposal can be optimised.
- Construction wastes shall be temporarily stored at a spoil area or other temporary stockpiles near the construction site.
- Construction wastes with economic/ engineering value shall be recycled internally or sold to outside, responsible parties. Those without economic/ engineering value shall be transported out to approved landfill area.
- Recycling of non biodegradable, non hazardous waste may be in the form of utilising the waste for fills.
- All construction waste must be removed from the area or disposed of in covered pits as directed by the competent district authorities at the end of the construction stage.

7.4.9 Scheduled Wastes Management Plan

Known hazardous wastes are included in the Environmental Quality (Scheduled Wastes) Regulations 2005. The Project Proponent and his contractors must, however, be aware that some wastes, which are not scheduled wastes may be hazardous anyway and will be treated as such.

All personnel and others affiliated with this Project, including contractors, must adhere to the regulations laid down by the Environmental Quality act and subsequent regulations.

- All scheduled wastes (oil and grease, etc) shall be stored in containers which are durable and are able to prevent spillage or leakage into the environment. Containers of scheduled wastes shall be clearly labelled in accordance with the Third Schedule of the Environmental Quality (Scheduled Wastes) Regulations, 2005 (See **Appendix 5-4: Recommendations for the Management and Disposal of Waste Oil and Grease at Construction Sites**).
- Areas for the storage of scheduled wastes containers shall be designed and constructed as confined wall and base to serve as spill containment area to contain any accidental spillage. The spill containment area shall be maintained adequately to prevent spillage or leakage of scheduled wastes into the environment.

- Oil and Grease trap shall be installed at all workshops and scheduled wastes storage areas.
- Skid tanks and the fuel depot shall be bunded to contain any spills. Bunding must be constructed of concrete, with concrete flooring and a sump to collect spillage and rainwater. The bunding shall be able to contain a minimal of 110% of total tank volume.
- Contaminated soils shall be removed from the site and treated or disposed in approved off-site location in accordance with the requirements of the Environmental Quality (Scheduled Wastes) Regulations, 2005.
- Scheduled Wastes must be sent for final disposal by a Department of Environment (DOE) approved contractor. Generation of any scheduled wastes shall be notified to the Director General of Department of Environment (DOE) in writing. The notification shall be completed in the form prescribed in the Second Schedule (Notification of Scheduled Wastes).

7.4.10 FIRE CONTROL PLAN

Fires may, roughly speaking, be of two kinds: Bush fires and construction site fires. In both events, fire control consists of three stages: prevention, detection and suppression failing which, evacuation may be the final option.

Most fires, if not all, are sparked by human activities. Some are ignited purposely for constructive reasons, some for irresponsible reasons. Others are the results of accidental but unwilling reasons. Finally some – especially bushfires – are the result of pure ignorance and irresponsibility.

Main reasons for fire outbreak include:

Storage of explosives: Unexpected ignition due to heat and unstable explosives. Unsafe condition of the storage area, for instance near sources of heat, and unsafe acts for instance smoking.

Setting the explosive for blasting: Improper handling of explosive. Misfire.

Food preparation and burning: Presence of flammable/ combustible materials nearby. Human negligence or equipment failure.

Transfer, handling and storage of fuel/ oil/ lubricant near to wooden materials, buildings, etc.: Breaching of safety procedures in place such as smoking. Unexpected ignition. Human negligence.

Site clearing, transportation: Burning of waste. Disposal of cigarettes. Faulty equipment. Lightening.

- To the extent, public fire services are deemed insufficient in terms of manpower, logistics or response time, a fire organisation must be established and logistics be provided.

- **Fire Prevention:** All supervisors must inculcate an attitude of fire prevention with all staff. Fires threaten lives, property and the environment as bases for all life. All skills training must therefore include fire prevention and safe working methodologies.
  - √ Any used oil or lubricants must be stored safely away from heat and ignition sources.
  - √ Smoking must be totally forbidden near fuel depots and other places where fuels or easily ignitable materials are used.
  - √ Electric installations must be approved by a qualified technician.
  - √ Cooking, welding and other use of indoor use of fire may only take place when clear escape routes are secured.
  - √ Work sites and transportation/vehicles must be equipped with fire extinguishers.
  - √ Fire rating signs (See **Figure 7.4.8**) and educational posters for fire detection, prevention and combat must be erected at prominent places. The ratings must be adjusted minimum weekly.

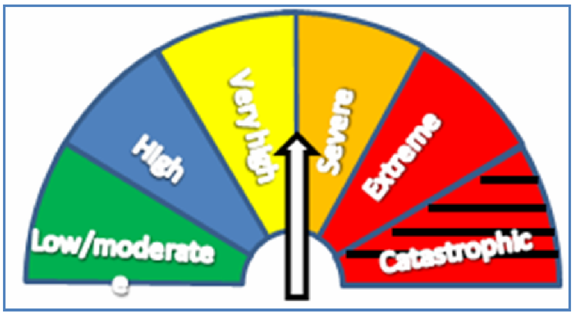

Figure 7.4.8 Fire Danger Rating Sign

  - √ Open burning outside camp areas shall be totally forbidden – other than controlled and approved burning of biomass for land clearing or waste disposal - and clear instructions shall be given as to disposal of cigarettes.

- **Fire Detection.** At times when the fire risk rating is deemed high or at sites where the risk realistically exists, permanent controls and patrols must be established.
  - √ All staff and resident families must be inculcated the attitude that fire detection and reporting is everybody's responsibility.
  - √ All workers and resident families must be made aware of alerting procedures and communication to the organisation responsible for fire suppression.
  - √ Any personnel discovering any unforeseen fire should immediately alert every employee at the site to evacuate the place for safety reason.
  - √ Notify designated person of the HSE Committee (usually the HSE officer) immediately.
  - √ Occurrence of fire within Project area must be informed IMMEDIATELY to the authorities.

- **Fire suppression.** Fire suppression takes precedence over construction
  - √ A fire organisation shall exist of the supervisors and workforce on duty plus a reserve brigade, which can be mobilised with minimal delay.
  - √ Fire extinguishers and other material must be made available at strategic sites.
  - √ In the event of any fire, effort should be emphasised on putting out the fire (if it is not out of control), failing which, evacuation of personnel becomes mandatory.

7.4.11 RESERVOIR MANAGEMENT PLAN

The reservoir management primarily has the objective of providing energy to the turbines. The Project Proponent, however, must also ensure the reservoir is useful to others and that it does not represent any unnecessary danger to any party.

On the contrary, if opportunities present themselves for utilising the reservoir constructively for any purpose, which does not impede power generation, such options must be considered for support.

Dam Failure: In order to protect people in the downstream catchment a monitoring and warning system has to be set-up. The monitoring system shall be able to provide warnings on the needed, sudden release of flood water during heavy rains in the catchment, as well as give warnings of the possible risks of dam failure and extent of downstream flooding. An Emergency Response Plan is described in **Section 7.4.17**.

- **Environmental protection**: A minimum environmental flow of not less than the 90% exceedance flow must be released from the anaerobic layers of the reservoir to ensure water movement in those layers of the water body is maintained.

- Debris and parts of remaining vegetation which may form an obstacle to the water intakes or boat traffic must be removed.

- **Public health**: Where possible, the regular (weekly) significant fluctuations in the reservoir are to be conducted to upset any mosquito larvae growth along the shallow reaches of the reservoir.

- The development and implementation of an effective program of effective shoreline maintenance, for vegetation growth control between the high and low operational water levels, and drift removal after the reservoir has been filled, (WHO, 1988).

- **Opportunities management**: Access to the reservoir must be made at a safe distance from the dam. At this point a permanent landing site must be prepared for leisure boats as well as a permanent mooring site for boats serving the local communities. A similar mooring facility for the local communities must be made at a safe place downstream of the powerhouse, so river traffic can end/resume here. There must be a road connecting the two sites.

- The options of fish (re-) stocking above the dam site shall be realistically and positively considered if fish stocks are depleted and realistic alternatives exist. However, water quality must be monitored to ensure pollutants such as mercury do not accumulate in fish stocks at levels that render it unsafe for human consumption.

- The option for utilising the reservoir for flood management and protection must be incorporated into the management of water releases. Forecasts shall be utilised to ensure the reservoir has available storage capacity before expected floods.

7.4.12 CATCHMENT AREA MANAGEMENT PLAN

The objective of the Catchment Area Management plan is to ensure soil erosion in the catchment area does not threaten the feasibility of the Project through increased and uncontrolled sedimentation. To implement the plan it is proposed to set up a joint catchment area management with representatives from the local communities and the Sabah Forest Industries under the legal supervision and guidance of the Environment Protection Department and the Forestry Department.

Initially joint monitoring of soil erosion and water quality will have to be implemented. To this effect, reports from Sabah Forest Industries' annual working plans and areas must be made available to the Project Proponent so he is aware of areas to be cleared, roads to be constructed, drainage measures (culverts, drains, bridges) to be constructed, agrochemicals to be applied, planted areas to be established (species, spacing, silvicultural regime), harvest and other silvicultural activities in natural forest areas etc, Monitoring reports showing impounded water, erosion occurrence or risk areas must also be made available, either directly from Sabah Forest Industries to the Project Proponent or via the government authorities, i.e. Forestry Department and the Environment Protection Department.

Currently Sabah Forest Industries' stated management ideologies and activities in the field indicate that the company does what is within its powers to introduce environmentally sound management and to minimise occurrence of soil erosion. Only the future will show if this is sufficient. The legal instruments for imposing additional requirements are the concession licence agreement and additional environmental impact assessments.

The catchment area management will have to investigate legal ways to implement additional riparian reserves within the catchment area:

- Additional riparian reserves within the Sabah Forest Industries concession to cover also non-permanent water courses water courses with surface area less than the present limits.

- Riparian reserves may be requested to be replaced by reserved strips along contours on long or steep slopes or where soils are considered particularly fragile.

- The existing system of riparian reserves in the Sabah Forest Industries concession must be extended to cover the areas within the catchment area which are planned to be under natural forest management. This includes compartments P02, P13, P18, P21, P25, P38, P39, P43, - P45, P48 - P65. See **Map 6.6- 3 SFI Proposed Strategic Management Plan**.

- The existing system of riparian reserves in the Sabah Forest Industries concession is extended into the state land and kampong areas.

The cooperating partners in the joint catchment area management may also, with the professional assistance of relevant government agencies such as the Department of Irrigation and Drainage, install a joint surface water monitoring system for monitoring of seasonal distribution of water quantity as well as water quality. The system may also provide early warning for floods and other hydrological issues of importance.

Through this cooperation, the Project Proponent shall have the opportunity and authority to request alterations to methodologies and site selections for the work of Sabah Forest Industries provided the request is well justified to a level approvable by the involved government agencies.

The catchment area management shall include the communities currently carrying out agricultural and other activities in the pockets not under Sabah Forest Industries management or who carry out fisheries activities in the area to be inundated.

This involvement is likely to require the support from the local government authorities and from the Environment Protection Department, who may consider imposing environmental impact assessment requirements on the community activities.

Should the current management of the activities in the catchment area prove to be threatening the Upper Padas Hydroelectric Project through siltation, added prevention and mitigation measures in the form of larger riparian reserves, cascading silt traps (Weirs and small dams) on water ways, limitation to size of contiguous areas to be cleared may be considered.

The joint efforts shall prevent settlements and other activities by outsiders to occur in the immediate vicinity of the reservoir.

The joint cooperation may consider ways for the Project Proponent to offset its greenhouse gas emission from the reservoir by protecting or establishing similar areas of protection forest, possibly with added benefits for the local communities. Not only will this offset greenhouse gas emissions but properly managed, it will protect the slopes leading towards the reservoir and promote the Project as environmentally balanced.

7.4.13 SECURITY PLAN

Prior to commencement, the Project Proponent shall establish a plan for its security concerns and how to protect itself from internal or external threats, at the same time, the security plan must also cater for the prevention of harm or accidental injury to outsiders and to provide a constant monitoring of potential dangers including threats to the environments.

The plan must include provisions for how to avoid the potentially adverse effects on the resident communities of such arrangements and in particular how to avoid resident communities accidentally are caught in the arrangements. The plan will ensure appropriate disclosure to the communities of risks associated with the Project, the security arrangements and ensure security personnel are properly screened and trained before deployment. The plan will also ensure, there are clear guidelines for the use of force within the limits of the law and that such use of force is well known and understood by the resident communities and by visitors.

The Project Proponent must ensure relevant sections of the security plan are publicly displayed in a socially appropriate manner so as to avoid unnecessary confrontations, misunderstandings or accidents.

7.4.14 COMMUNITY PROTECTION PLAN

The Project Proponent must ensure communities in the area are well protected from negative effects of the Project, whether in their dwellings or roaming in the area as part of pursuing their livelihoods or for leisure.

<u>Grievances</u>: If any individual lodges a complaint that his user or ownership rights are interfered with without prior settlement, work must be stopped in the disputed area and a report lodged with the site management. The site management must advise the complainant on his rights and options of filing complaints through the grievance mechanisms of the Project. Work may only proceed once the grievance process is duly settled or the Project management receives a permission to proceed from the relevant public authorities, based upon a judgement by such authority that the matter may be settled within the law. The local communities must be clearly informed about the grievance mechanism.

<u>Deterioration of quality of water, soil and other natural resources important to their livelihoods:</u> The Project Proponent must map and monitor all existing water intake points used by local residents and which may be negatively affected by the Project. If needed, appropriate protection measures must be implemented to protect the water sources from negative impacts from the Project. If it is not possible to avoid deterioration of water sources entirely, alternative potable water supplies must be provided.

Likewise, where soils become unstable, demonstratively due to the Project activities and management and this instability threaten the livelihoods or safety of local communities, preventive measures must immediately be carried out or mitigation in form of alternative (temporary) livelihoods provided. This may apply to roads, right-of-way and water courses alike.

<u>Disclosure of risk:</u> The Project Proponent must ensure all known risks and possible negative impacts to local communities are appropriately disclosed to these communities at the earliest time possible. Such risk may be environmental, they may be threatening the livelihoods or general health of the communities, or they may be associated with the general enforcement of Project security.

Support to communities and local authorities for their emergency preparedness: The Project presents an inherent level of risk for the local communities. The risk may be spreading of fires, risk from increased heavy traffic or dam failure The Project Proponent shall make the local communities and authorities aware of such risks and assist them in their preparation for dealing with such risks. Fire fighting, evacuation procedures, alert signalling must be elaborated for al implicated partners and where necessary, specialised equipment and logistics must be provided.

In particular, community emergency organisations must be supported and they must take part in information and training events arranged by the Project Proponent and his contractors.

Disclosure of emergency response plan: The Project Proponent must ensure full transparency surrounds the Project's emergency response plan and that all segments of the affected communities have been briefed about the details of the plan.

7.4.15 COMMUNITY HEALTH AND SAFETY PLAN

The transmission lines are planned to avoid proximity to any settlements, schools or other developments. There will be restrictions imposed on further development within the right-of-way.

The Project Proponent shall cooperate with the local municipality for regular mosquito related interventions in Tomani. Interventions can include the regular fogging and spraying of residential and commercial areas, breeding area inspections, and ongoing community education regarding the prevention of breeding areas, personal protective techniques and the health risks associated with contact with mosquitoes.

Recreational water users are to be restricted from using the water areas directly downstream of the proposed dam and outfall area. Similarly, the reservoir area closest to the dam is to be restricted from recreational water activities for user safety.

Warning signs are to be erected on all downstream recreational water use areas that have the potential to be affected from the release of water from the reservoir. Signs are to warn of possible sudden changes in water flow dynamics and water quality in the area.

Fishing and other recreational water use vessels are to be restricted from using the water areas directly down-stream of the proposed dam and outfall area.

7.4.16 CULTURAL HERITAGE PLAN

There are indications that there is a single grave site and a site of a murder near the proposed site, where the dam will be constructed. The precise sites are not fully known but the families paying respect to these sites must be given access to the sites if these are outside the reservoir site or the actual construction. If the sites are proven to be within the reservoir site or the site for actual construction, the families will be given ample time for relocating the grave if they so wish. Compensation must be given subject to recommendations from Native Court or other authorities.

There are currently no indications that there should be any other sites of particular cultural importance in the areas to be affected by this Project. Should workers or contractors, however, by chance discover such sites following regulations apply:

- Workers, contractors and subcontractors must immediately stop working in an area, where cultural or historical values may be identified, i.e. when the workers, contractors and subcontractors themselves notice such features or if local residents point such features out to them. Existence of such features of potential cultural value must immediately be reported to the site management, who, in cooperation with the community representatives from the water catchment management group and Sabah Museum, will decide how to proceed.

- Burial grounds should be relocated if necessary, based on local cultures and traditions, and after consultation with the communities concerned.
- Every effort shall be given to preserve all aesthetic, cultural and historical sites.

7.4.17 EMERGENCY RESPONSE PLAN

An Emergency Response Plan has been established and is included in full in this report as **Appendix 2-12: Emergency Response Plan**.

The response plan is generic but is primarily focused on the risk of dam failure. Other emergencies such as threats of terrorism, chemical spills, response to environmental incidents, serious injuries and fatalities not related to dam failure are not directly included in the plan.

The plan contains a detailed description of an emergency response organisation with staffing and function description, description of logistics and equipment.

The Plan continues to describe response procedures in case of dam breach including alarms to government functions, the public and relations to the media.

The emergency response plan includes recommendations for immediate implementation of an emergency preparedness and response programme. A summary of the most essential recommendations are listed below.

Emergency Classification: When detected, emergencies will immediately be classified into one of three levels, which dictate alarm and alert levels and further action.

Organisation: The emergency response organisation to consist of four levels within the Project itself. These four levels liaise with external government agencies and centres.

- The Emergency Preparedness Council is made up of the senior management representing a wide range of sectors within the Project. Their tasks include maintenance of the Plan, training, awareness and drills. They are in charge of keeping the Project alert and prepared for emergencies, which may happen very rapidly.

- The Emergency Operation Centre Staff is made up of executive managers representing field oriented and communications sectors of the Project. They are mobilised in case of major emergencies that require extraordinary management approaches and support.

- The Emergency Response Team headed by the Emergency Site Manager consists of the initial staff to be scrambled in case of emergencies. 6-10 people from each shift make up this team, which is headed by an engineer. The team is field oriented towards practical initiatives of rescue, containment and protection. This team will for their activities draw upon operations and maintenance staff which are on-shift or who may quickly be mobilised. The Emergency Response Team and the Emergency

Operation Centre Staff have prepared operation facilities available with sufficient equipment and materials for the initial response and management.

External Centres and Organisations. In case of extreme emergencies at the Upper Padas Hydro Electric Power Project, national and state authorities will have to be involved. It is therefore important, procedures are well known throughout relevant organisations even outside Sabah. The emergency procedures proposed for Upper Padas are therefore closely aligned to the procedures in place for Bakun and proposed for Murum and Baleh Dams in Sarawak. Major emergencies such as dam breach require government involvement. The key entry point for this will be the Sipitang and Tenom District Office, and emergency centres in Keningau and Kota Kinabalu.

Communications and Alarms: Emergency response is to a large extent dependent upon reliable communications and alarm systems. The emergency response plan advocates communications systems independent of normal networks and power supplies.

The Emergency Response Plan strongly recommends openness and transparency both when there is no imminent emergencies and during emergencies. Well informed people and communities with a realistic knowledge of what to expect are less prone to hostilities or panic and will therefore, during emergencies, be easier to manage.

Available reaction times may be short in the unlikely event of a major emergency at a tall dam. Alerts for mobilisation of the emergency organisations and alarms for warning communities are therefore described in the Emergency Response Plan. Again, these systems must be independent on public power supplies, ground based communication lines or communication systems, which may be overloaded by the public.

7.4.18 DECOMMISSIONING AND ABANDONMENT PLAN

General

Decommissioning of temporary site facilities shall be carried out during handover of the Project from the contractors to the Project Proponent but similar activities shall take place in the event of abandonment whereby the construction works are stopped permanently or otherwise. Decommissioning works involve withdrawal of personnel, equipment and dismantling of temporary site structures, and in abandonment, the halting of operation and dismantling of all structures and facilities.

In order to a: improve and restore the aesthetics of the cleared and worked areas as a whole, b: to remove hazardous conditions, c: to protect the environment and the health of workers and public during and after the abandonment of the site and c: to ensure that the abandoned site will be suitable and passable for traffic a number of activities must take place:

- Three months prior to decommissioning of temporary site installations and to hand over to the Project Proponent for Project operation, a comprehensive decommissioning plan shall be forwarded for the evaluation and acceptance of the Environment Protection Department for evaluation and approval.
- Upon completion of construction works, all temporary structures such as workers' quarters, site office, skid tanks, etc. must be removed.

- All machinery and equipment (bulldozers, excavators, trucks, etc) shall be removed from the Project site.
- All quarry and borrow areas shall be rehabilitated. Unsuitable/ surplus spoil dumps shall have erosion and sedimentation control measures installed.
- The area of decommissioned installation shall be cleaned up. All wastes shall be disposed of properly to pre-assigned and managed landfill or to an approved off-site location. Under no circumstance should waste material disposed into watercourses.
- Burning of wooden material may only take place after approval of the Environment Protection Department and competent fire authorities.
- Landfill(s) shall be closed as per the closure plan approved by the Environment Protection Department.

In case of abandonment, the following additional activities must take place:

- A rehabilitation plan must be submitted to the Environment Protection Department at least 6 months before abandonment.
- All denuded areas must be re-vegetated using local species.
- Any open pits, borrows are to be rehabilitated and if necessary to be re-vegetated. Unsuitable soil dumps must have erosion and sedimentation control measures installed, and to be re-vegetated if necessary.
- All constructions, which cannot be removed must be secured and protected.

In case of a prolonged delay or postponement, a plan for securing the area must similarly be submitted to the Environment Protection Department for approval. The Project Proponent must immediately, when the possibility for such delay is first mooted contact the Environment Protection Department in order to agree on a time schedule for the arrangements.

7.5 COMMUNITY ENGAGEMENT

7.5.1 SCOPE

The Project will have a multitude of engagements and interactions with a variety of communities:

- Acquisition of land and user rights for transmission- lines and other facilities.
- Acquisition of user rights along the river, which will become a reservoir.
- Environmental impacts related to river issues downstream (during construction and residual impacts).
- Environmental impacts related to operation of the transmission- lines.
- Catchment area management.

The engagements and interactions require that the Project Proponent and the communities can meet as equal partners. This, on the other hand requires 1: that the communities are organised under a leadership, 2: that the communities are well informed and, 3: that the communities believe and feel that their opinions and fears are genuinely respected.

7.5.2 ORGANISATION

The Project Proponent must accept impartial representatives of the communities. The representations must be free of personal bias or interest and must enjoy the trust of the communities they represent. Government services, the Sabah Forest Industries section for Corporate Social Responsibilities and to some extent NGOs may assist in the identification. These representatives must subsequently be involved as full partners whenever activities involve communities. They must be involved in information dissemination, training, joint management and planning and in community monitoring.

The option of the communities aligning themselves with civil organisations cannot be dismissed.

A temporary commission will be established by the Project Proponent to review any claims of damages to crops, buildings or any other assets of residents during construction works.

7.5.3 DISCLOSURE

The Project Proponent must disclose all information relevant to affected communities at the earliest possible time so as to give the communities time to reflect upon the information and take their own precautions. Plans and schedules as well as impact assessments must be disclosed timely and in a manner, that is appropriate for the communities concerned.

The present Special Environmental Impact Assessment will, before being considered as final, be made publicly available through posting at the Internet, in state libraries, district offices and at the offices of the Project Proponent. The postings will be advertised in Sabah newspapers and public comments invited.

7.5.4 GENERAL PUBLIC CONSULTATION

Comments and suggestions to the Special Environmental Impact Assessment study and the Project planning will be invited from all segments of the general public, whether local or international, whether individual or organisations. Comments will be recorded, registered, assessed and subsequently included in the final version of the Assessment as deemed appropriate by the Consultant. The public will be invited to submit comments within six weeks.

7.5.5 DIALOGUE

Of importance, the dialogue shall be free, prior and informed. This implies that the dialogue must be without any shadow of manipulation, carried out in a culturally appropriate manner, that it must give the parties ample time for considerations or for seeking additional assistance and that information given is transparent and complete.

7.5.6 JOINT MANAGEMENT

Community representatives must be involved before any significant decision, which has an impact on the livelihoods of the communities, is taken. The representatives must in a culturally appropriate manner be explained the issue and the desired result and then be brought into the consultation on finding realistic solutions. Utmost care shall be taken, not to outline very narrow desirable results, which in fact include methodologies, before consultations have taken place.

The community representatives must be full-fledged members of the committees, which make the decisions and their signatures are as important as anyone else's.

7.5.7 HANDLING OF COMPENSATION

The handling of compensations to communities is primarily in connection with the establishment of an ara of "way leave" or "right-of-way" 20 metres on either side of a transmission line. The provisions under Electricity Supply Act 1990 are used for the acquisition of the associated rights, and as from September 2003 the Sabah Land Ordinance, Section 30(1)(b) is also being used. The way leave area will not be totally acquired from the land owners but a compensation is normally paid for the crops that are destroyed. A 30% compensation has historically been paid for the areas directly under the pylons.

People who are directly affected by the transmission line routing, given their proximity to the line, will have their assets and impacts evaluated. The Lands and Surveys Department, Assistant Collector of Land Revenue, State Attorney General, Jabatan Hasil Bumi and State Secretary Office are also to be involved in this process. Additional details on the way leave procedure may be found on http://www.sesb.com.my/faqs3.cfm.

Compensation must be handed over directly to the legal plaintiff without any middlemen or intervening organisations.

Standard rates of compensation are not available as the rates are subject to local assessment, negotiation and adjustment.

7.5.8 USE OF LOCAL LABOUR FORCE

Priority must be given to employment of local labour at all levels. Where possible, the SESB and his contractors must set up training events and facilities to assist local residents qualify for available jobs.

Second priority must be given to Sabahan citizens from outside the Project districts.

Third priority must be given to Malaysians from other states.

Only where it proves impossible to source labour and employees from the above three priority groups shall the Project Proponent and his contractors use foreign labour. When foreign labour is used because the technical skills do not exist locally, such transfer of skills shall be built into work schedules and employment contracts.

The Project shall give equal access to jobs based upon skills and ability to handle the responsibilities and without any prejudice based on gender, religion, ethnicity or culture.

7.5.9 GRIEVANCE MECHANISMS

A grievance mechanism must be set up including organisation and procedures.

Effective community representation in the grievance mechanism organisation will contribute to minimising serious conflict and a respect for the process.

Names of members of the organisation must be publicly known and place and procedure for submitting complaints clearly published too. The process must allow for oral submission as it cannot be expected the complainants all are capable of filling forms or otherwise expressing themselves in written form even though they do have an honest and serious complaint to file.

All submissions must be responded to in writing and with an offer of an oral explanation too.

7.5.10 REGISTER OF EVENTS

The Upper Padas Hydroelectric Project management must maintain a register of all communication events held between the Project Management and the affected communities.

7.5.11 PRIORITY DEVELOPMENT

The SESB will give priority to communities affected by this Project – reservoir, dam, powerhouse, transmission lines, roads, rivers – when developing local electric grids.

7.6 MEASURES TO ENSURE CAPACITY SUFFICIENCY OF GOVERNMENT INSTITUTIONS

Section 2.1 includes an assessment of the government institutions that may be given roles in the planning, implementation or supervision of this Project.

In general, all government agencies may be understaffed and in want of logistics, especially means of transportation. However, the professional level of the government agencies concerned is high, at least at headquarters level. Most branch and field offices could benefit from additional raising of the educational and professional level.

The role of Government staff is *i.a.* to monitor and supervise work and at a later stage be involved in the catchment area management as facilitators.

7.6.1 INSTITUTIONAL ASSESSMENT

7.6.1.1 SABAH ELECTRICITY SDN BHD

The Sabah Electricity Sdn Bhd is the Project Proponent for this Project. The company is thus responsible for all implementation and associated impacts. Currently, the Upper Padas Hydropower Consultants (UPHC) have been contracted as advisors to the Sabah Electricity Sdn Bhd for this Project.

Sabah Electricity Sdn Bhd (SESB) is an 80% owned subsidiary of the national electricity company, Tenaga Nasional Berhad (TNB), and 20% owned by the State Government of Sabah. It is a vertically integrated utility providing generation, transmission and distribution services in the state of Sabah and the Federal Territory Labuan.

SESB generates, transmits and distributes electricity. It is the only power utility company in Sabah supplying electricity to 413,983 customers distributed over a wide area of 74,000 sq.km. 82.8% of the customers are domestic customers contributing only 28.8% of the sale. The total generation capacity is 866.4 MW, 50.3% of the total units generated are purchased from the independent power producers.

The SESB installed capacity (excluding the independent power producers) of the Sabah Grid which supplies electricity for major towns from Federal Territory Labuan to Tawau is 430.9 MW and the maximum demand is 642 MW.

The East Coast Grid 132 kV Transmission Line connecting the major towns in the East Coast has an installed capacity of 333.02 MW and the maximum demand is 203.3 MW.

The forecast demand growth of electricity is in a region of 7.7% per annum up to the year 2010. In order to support the growing demand, various generation, transmission and distribution projects will be implemented.

A fully integrated grid connecting the West Coast Grid to the East Coast Grid was completed on 28 July 2007, and about 90% of the customers are now connected to this integrated grid.

Currently, the main method of power generation is from diesel powered plants (213 MW) while hydropower counts for 74 MW.

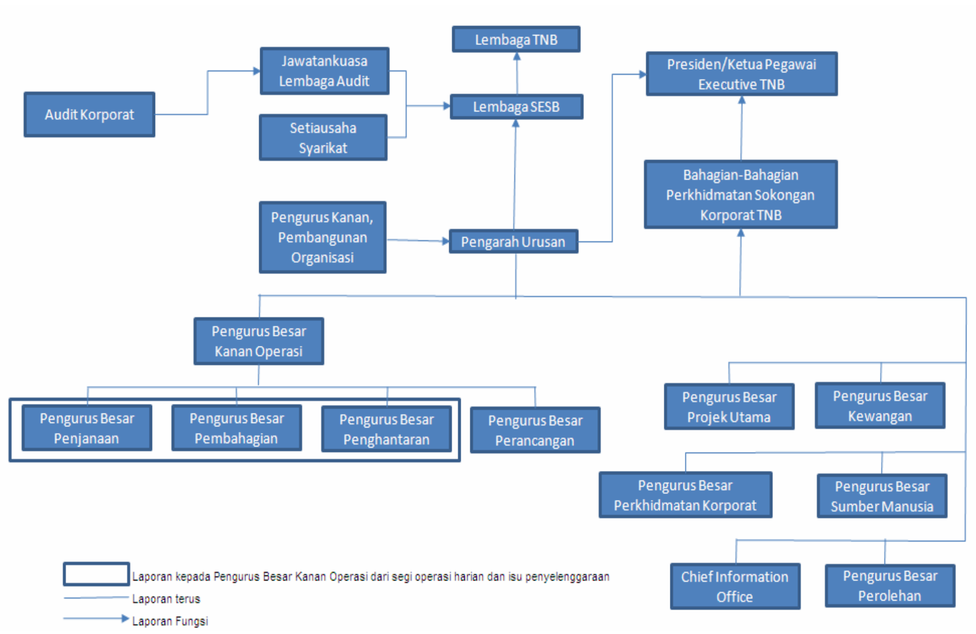

Figure 7.6.1 SESB Organization Chart

The company's grievance mechanism is mainly geared towards its ordinary customers and their complaints concerning electricity bills and power disruptions. The company is, however, also concerned about its social impact from wayleave areas. The company has a section for wayleave management and operation and it publishes explanations on wayleave acquisition and management on the internet. The Land and Survey Department, the Assistant Collector of Land Revenue, the State Attorney General, the Jabatan Hasil Bumi and the State Secretary Office are also involved in these processes.

Human resources. As of 2009 the SESB employed 2391 staff, 38 of which were classified as on 'Major Projects'. There are no staff or organisational section, which currently is charged with reservoir management of large scale catchment area management.

7.6.1.2 SABAH FOREST INDUSTRIES

Objective: The overall objective of the SFI 288,623 ha concession is to provide a reliable source of raw material for the SFI pulp and paper industries in Sipitang. Large areas are therefore set aside for conversion to industrial tree plantations, mainly with *Eucalyptus grandis* and *Acacia mangium.* Remaining production areas are maintained as assisted mixed natural forests under sustainable forest management.

Policies: The company has advanced positively in its efforts to improve its relations to the local communities and the public as a whole. There is an increased level of transparency and an attitude to early dialogues with affected communities. The Company has thus established a section for 'Corporate Social Responsibilities, headed by an individual at manager level. With the change of ownership, there has also been a shift towards emphasis on environmental and sustainable management with increasing field supervision and respect for legal requirements as well as commonly accepted practices for sustainable forest management.

Expected role in the Project: The water supply to the Upper Padas HEP reservoir will almost entirely originate from the SFI concession area, wherefore the SFI operational procedures will be the major determinant for water quality and periodic distribution (apart from rainfall distribution in itself). The Sabah Forest Industries will thus be the main executor of catchment area management. The Company also has an interest in the area set aside for the reservoir as this will have to be excised from its concession even though there are only few commercial interests there. It would seem logic if Sabah Forest Industries was considered for clearing of biomass from the reservoir prior to the impoundment stage or at least that the company, through its annual work plans, is requested to salvage forestry resources in the area to be covered by the reservoir before inundation.

Legal base: Sabah Forest Industries manages the forest resources in Forest Management Unit (FMU) 7 (Sipitang and Ulu Sg. Padas Class II Forest Reserves), under the following licences:-

- Industrial Tree Plantation: 168,796.85 ha JP(KSG)107/96(CO) and
- Natural Forest Management: 107,826.15 ha JP(KSG)108/96(CO).

Organisation: This Company, which previously was part of the Lion's Group of Companies, now partners with the Ballarpur Industries Limited of India.

Sabah Forest Industries has thereby been through a change of ownership, which has caused needed changes in management organisation and practices over the recent years. Field supervision is being intensified with a Sabah Forest Industries field manager for every 10,000 ha supervising both Sabah Forest Industries operators and contractors.

The issue of contractors has in the past been a problematic area as there has been little tradition in Sabah for direct supervision of contractors. This is actively being changed in the Sabah Forest Industries.

However, the company does not – yet – have an environmental section with authority to alter technologies and methodologies, to issue stop-orders and with a monitoring function. A joint activity in this field between the Sabah Forest Industries, the Sabah Electricity Sdn. Bhd. and the government agencies will require establishment of an environmental organisation with executive powers and policy influence.

Human resources: The Company is increasingly relying on foreign expertise at management level in order to improve the Company's national capacities. This has clearly improved corporate social and environmental understanding and responsibility. The company indicates that there are plans to institutionalise environmental management at executive level.

Development needs: The level of environmental monitoring and reporting required by the Environment Protection Department is a burden to the Sabah Forest Industries. Outsourcing may be the answer as the company already possesses the capacity to manage external assistance in this field.

As the company is developing its environmental organization there will be a need for staff trained in environmental assessment and sustainable forest management. The Company already possesses capacity for providing logistics for such organizational change but will in the future need to provide specific environmental training for its staff. The Company is fully capable of sourcing and procuring such training but will need government dialogue to determine scope and legal requirements.

The Company needs to focus on entering legally binding environmental conditions into its subcontracts and to strengthen its field supervision of compliance from the side of the contractors.

7.6.1.3 ENVIRONMENT PROTECTION DEPARTMENT

The Environment Protection Department was established as the *Environmental Conservation Department* under the Ministry of Tourism and Environment in 1998 in line with the constitutional delegation of powers over land related matters to the State. Later, the name was changed to the Environment Protection Department in line with the passing of the Environment Protection Enactment 2002 to replace the Conservation of Environment Enactment 1996.

Objective: The Department focuses on the integration of environmental issues as main stream and cross cutting issues in all aspects of planning, development and natural resources utilisation throughout the state.

The Department thus includes planning, assessment, monitoring and enforcement in its core activities.

Expected role in the Project: The Environment Protection Department will play a central role during planning, construction and operation of this Project. The Department is the controller of environmental issues at the planning stage, wherefore it requires a Special Environmental Impact Assessment to be conducted and submitted to the Department. The Department is subsequently responsible for coordinating a cross sectoral panel to study the impact assessment and as a result impose environmental conditions upon the Project. The Department is thereafter responsible for receiving monitoring results, for periodic monitoring by own staff and subsequent enforcement/advice to the Project Proponent in order to minimise negative impacts.

The strength of the Environment Protection Department is its mandate to assemble multi-sectoral panels including governmental as well as non-governmental representatives. Through this, the Department is capable of receiving expert advice from almost any quarter where it does not have internal expertise.

The Environment Protection Department will also play a leading role in defining and coordinating a multi-stakeholder approach to catchment area planning and management.

Legal base: The Environment Protection Enactment (Amendment) 2005. There are no immediate plans or identified needs for further amendments.

A number of guidelines have been written, based on the above enactment. In particular, a number of environmental impact assessment guidelines have been produced. However, there is no specific guideline yet for large scale river management, for dams or for catchment area management and associated Environmental Impact Assessment procedures. The Department would benefit from external assistance in establishing such guidelines.

Organisation: The Environment Protection Department is a department under the Sabah State Ministry of Tourism, Culture and Environment. The complete organisation of the Department with its four technical and one management related divisions is shown in the **Figure 7.6.2** below. In addition, the Department operates three ‘Regions’: East Coast, West Coast and the Interior. The East Coast and the Interior Regions are managed from Kota Kinabalu while the West Coast is managed from Sandakan.

Director

Extension	Evaluation	Development	Enforcement	Management Services
Conducting the state environmental protection council meeting	Environmental screening of development activities	Environmental development projects	Monitoring of compliance to environmental conditions, orders and regulations	General administration
Managing the department resource centre	Implementation of EIA system	Environmental surveys	Inspection of environmental complaints	Personnel management
Conducting and taking part in environmental exhibition	Registration of environment consultants	General monitoring of environmental quality	Investigation of environmental offences	Procurement and store
Environmental talks	Licensing	Environmental management information system	Issuance of orders, summons and compounds	Finance
Initiating and coordinating environmental awareness programmes	Advisory role on environmental issues	Preparation of environmental management plans	Prosecution	
Producing environmental awareness materials	Preparation of environmental guidelines and procedures		Formulation of environmental policies and regulations	
Producing EPD bulletin				

Figure 7.6.2 EPD Organisation Chart

The EIA procedure and control of Project planning and development is with the Evaluation Division while environmental management plans are with the Development Division and the recurring monitoring and enforcement of environmental compliance and impact rest with the Enforcement Division.

Human resources: The Environment Protection Department has a staff of about 20 professionals supported by 15 administrative staff.

The professional staffs cover a wide scope of professional fields such as physics, biology, zoology, forestry, environmental management, chemistry and environmental engineering. There are no hydrologists or specialists in soil science among the staff.

Each division and each region is thus only manned by one or two professional staff. Staff therefore work across organisational borders and help each other in different divisions. When additional expertise is needed, such expertise is requested from relevant government institutions.

For assessing environmental impact assessment reports, multi-sectoral panels are formed with participants from a variety of institutions and the civil society.

The limited number of staff is a problem when processing impact assessments etc. Maximum response time is set by the Department's ISO certification, wherefore reception of multiple larger assessment reports can pose a severe stress on staff availability. This again will have an impact on availability for other work such as monitoring, enforcement, procedures development and general public service.

The Environment Protection Department has been the focus of foreign donor (DANCED) assistance for environmental management and has benefitted from this development across the organisation. This assistance has mainly concentrated on the state systems for environmental impact assessment.

Logistics: The Environment Protection Department is suffering a shortage of logistics at all levels as it is seen as a non-revenue earning department rather than a department that ensures long term sustainability and public service. There is a lack of vehicles, computing power, GIS facilities, field testing equipment, office space etc.

Vehicles in particular seem a bottleneck as the Department possesses only five vehicles to serve all staff in the entire State.

The Environment Protection Department draws upon the services of the Department of Chemistry for laboratory analysis and testing.

Development needs: The Environment Protection Department is steadily increasing its professional level to deal with the complex issues under its jurisdiction. The major problem is 1): shortage of manpower or budget/mandate for outsourcing and 2): lack of transport.

Supervision and monitoring of the present Project will ideally require a constant presence of two assistant officers/technicians at the Project site. These would need some training in field assessment methods and they must have full time access to office facilities, transport and communication, field measurement equipment and basic mapping facilities.

General training in dam and reservoir related issues is also needed for the Department's headquarters staff. Such training could be provided by a consultant guiding the present staff through writing a guideline for Environmental Impact Assessment and management of such projects.

Increased governmental decentralisation would facilitate improved response, improved monitoring expertise and authority to deal with the solutions locally.

7.6.1.4 FORESTRY DEPARTMENT

Objective: The Sabah Forestry department has traditionally been focussing upon the regulation of commercial exploitation of forest resources through a system of concessions and associated levies and management options. The department is, however, increasingly concerned with the role as custodian of a resource and thus with environmental issues and sustainability. The Department has subsequently developed sufficient expertise in these fields. Most of this expertise is based in the head office in Sandakan.

Expected role in the Project: As the regulator of the land use within the forest reserves in the catchment area, the Forestry department will play a major role in determining the land use pattern and methodologies within the catchment area. This role extends beyond just imposing regulations upon a third party as the regulations will also have implications for the revenues to be earned by the Department on behalf of the State. The Department will in many ways be the liaison between the catchment area management and the Hydroelectric Power Project as the Department will have the knowledge and expertise to implement the required management activities. The Department will also be in a position to direct land conversion in manners so as not to present the Project with unacceptable levels of solids in the run-off water.

Legal base: The Forestry Department, which is established directly under the Chief Minister's Department, bases its mandate upon the Forest Enactment of 1968. This enactment primarily deals with the gazettement of forest reserves and the management of timber for commercial purposes in such reserves. The Forest Enactment does, however, also regulate the utilisation of forest resources on state land whereas the Land Ordinance deals with the alienation of such lands.

Organisation: The organisation of the Forestry Department reflects its mandate as the controller of the major part of the state's forest resources. The Department has an organisation, which, provided there are sufficient qualified staffs, can cater for most foreseeable events and issues. Environmental concerns are not considered an issue in itself but rather a cross cutting issue, that is embedded in all other aspects of the organisation. See **Figure 7.6.3**.

Director

Dep Dir Development	Dep Dir Planning	Dep Dir R&D	Dep Dir Sector Planning

Divisions

Forest Resource Management	Project Management and General Services
Sustainable Forest Management	Public Relation and Publicity
Forest Management Enterprise	Personnel Services
Economy, Industry & Statistics	Human Resources Development
Forest Research Centre, Sepilok	Finance and Expenditure
Forestry Training Institute	ICT Studies and Services
Enforcement and Investigation	Quality Management
Legal	

District Forestry Offices		Monitoring, Controlling, Enforcement & Evaluation	
Kudat	Sandakan	Kudat	Sandakan
Pitas	Beluran	Tawau	Kota Kinabalu
Kota Belud	Telupid	Keningau	
Kota Marudu	Tongod		
Tawau	Deramakot		
Kunak	Kota Kinabatangan		
Tibow	Kota Kinabalu		
Lahad Datu	Beaufort		
Semporna	Sipitang		
Kalabakan	Ranau		
Serudong	Keningau		
Ulu Segama-Malua	Nabawan		

Figure 7.6.3 Forestry Department Organisation Chart

The Forestry Department has traditionally operated through district offices, of which one is situated in Sipitang. These district offices have in general sufficient authority to deal with issues within their districts, but are, at least in the case of Sipitang, understaffed. The details of Sipitang Forestry office is shown in **Figure 7.6.4**.

DAERAH SIPITANG			
1	Forest Officer, Sipitang	En. Mohamad Hj. Abu Bakar	
2	No. Tel & Fax	No. Tel: 087-821448/821479 No. Fax: 087-822172	
3	Address	Pejabat Perhutanan Daerah Sipitang PO Box 37, 89857 Sipitang	
4	Forest area	273,249.69 Ha	
5	Number of staff	27	
6	Forest reserves	Name of forest reserve(s) Class Area (Ha) Maligan Virgin Forest Reserve 9,240.00 Basio Virgin Forest Reserve 213 Mengalong Virgin Forest Reserve 1,008.00 Mesapol Virgin Forest Reserve 35.5	
7	Recreational Forest (eg. Nature reserves)	Nil	
8	Concessions		FMU 7 Licence: Sabah Forest Industries S/B (SFI) Area ITP - 168,796.85 ha JP(KSG)107/96 (CO) NFM - 107,826.15 ha JP(KSG)108/96 (CO) Name of forest reserve(s) Hutan Simpan Sipitang (Class II) Hutan Simpan Ulu Sg. Padas (Class II)

Figure 7.6.4 Details of Sipitang Forestry Office

Human resources: The Forestry Department employs a number of graduates in forestry related fields and represents thus in Sabah the forestry expertise together with the institutes of higher learning. The Department also employs a large number of technical staff and carries out training courses at its own forestry school.

The professional level of the department is further developed through its own research and development activities.

While the department in principle is highly decentralised, staffs are still concentrated at the headquarters in Sandakan from where districts can request support.

Logistics: As a revenue generating department, the Forestry Department is reasonably equipped to the tasks it faces. Some deficiencies may be encountered at district level.

Development needs: Discussions with Sipitang Forestry Officer revealed that although the office is equipped with proper office and filed tools (GPS, binoculars, mapping tools, reporting facilities, aerial survey allocation etc.), but also that the Sipitang District, in view of the magnitude of the tasks ahead would benefit from additional staff to be transferred from Sandakan. The activity may present an excellent opportunity for the Department to introduce community based impact monitoring addressing issues pertaining to the reservoir as well as issues pertaining to the surrounding forest operations.

The staff will need to be supported by field and office equipment and tools (GPS, clinometers, binoculars, mapping tools, reporting facilities, communication) as well as transportation.

7.6.1.5 DEPARTMENT OF IRRIGATION AND DRAINAGE

Objective: To ensure optimum land utilization and more efficient management of the State's water resources through engineering services in the field of irrigation, agriculture and urban drainage, river and coastal engineering, and general water resources management.

Expected role in the Project: The Department of Irrigation and Drainage does not foresee a primary role for this Project as the Project area is mainly managed under one single entity, the Sabah Forest Industries, and this entity is already subjected to the regulations of the Forestry department through its license agreement and the management plans and of the Environment Protection Department through the approval conditions from the Environmental Impact Assessment for the logging activity. Only if neither of these regulatory tools is sufficient can the Department of Irrigation and Drainage use its authority.

The Department of Irrigation and Drainage could gazette the catchment as a catchment area but does currently not see any need for this due to the State Government contractual arrangements for management of the area with the Sabah Forest Industries.

Legal base: The legal base for the establishment and workings of the Drainage and Irrigation Department is '

- Drainage And Irrigation Ordinances, 1956
- Drainage and Irrigation Enactment (Amendment), 1983
- Sabah Water Resource Enactment, 1998

The legislation is considered sufficient.

Organization: The Department of Irrigation and Drainage, Sabah is headed by the Director and assisted by its Deputy Director and has 9 sections and 12 district branches. See **Figure 7.6.5**.

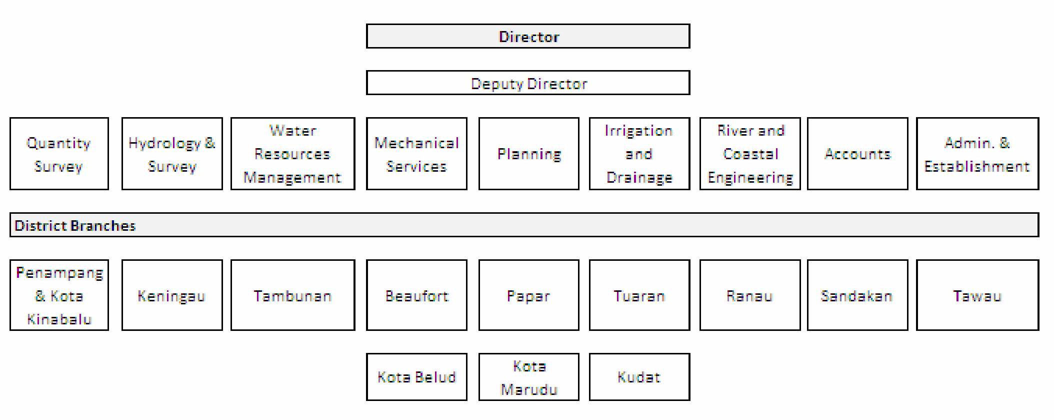

Figure 7.6.5 Drainage and Irrigation Department Organization Chart

Human resources: The Department of Irrigation and Drainage currently plans for staff expansion which is expected to be completed within the next 3-5 years using normal government procedures. With such expansion, the Project will not pose any particular stress to the staffing situation. The Department has been the target for foreign development projects (DANCED/Danida) and has benefitted from these concerning i.a. basin wide management.

Logistics: The Department of Irrigation and Drainage is sufficiently equipped to fulfil its obligations towards this Project.

Development needs: There will be no particular extra requirement from the Department of Irrigation and Drainage in order to fulfil its obligations towards this Project.

7.6.1.6 TOWN AND REGIONAL PLANNING DEPARTMENT

Objective: The objective of the Town and Regional Planning Department is to ensure proper and well balanced land use planning in the state considering the resources available, the development objectives (social and economic) and the balances between development benefits and environmental costs.

Expected role in the Project: The Town and Regional Planning Department has already been involved in the early stages of the overall planning of energy provision in Sabah and in the selection of the Project site. The Department is not expected to be directly involved in detailed implementation but will through its advisory functions ensure overall planning conforms to the State development objectives.

Legal base: The Town and Regional Planning Department bases its mandate on the Town and Country Ordinance as amended by the Town and Country Planning Enactment 2002.

Organisation: The Department has five sections with two district branches in Sandakan and Tawau. The sections implement technical work through the branch offices and organize their work in accordance with five geographical zones. See **Figure 7.6.6**.

Human resources: The Town and Regional Planning Department has been the focus of foreign donor (DANCED) assistance for the Integrated Coastal Zone Management (ICZM) and has benefitted from this development across the organisation. Staffs are highly trained and considering the low level of further involvement in the present Project, no further strengthening is needed for this purpose.

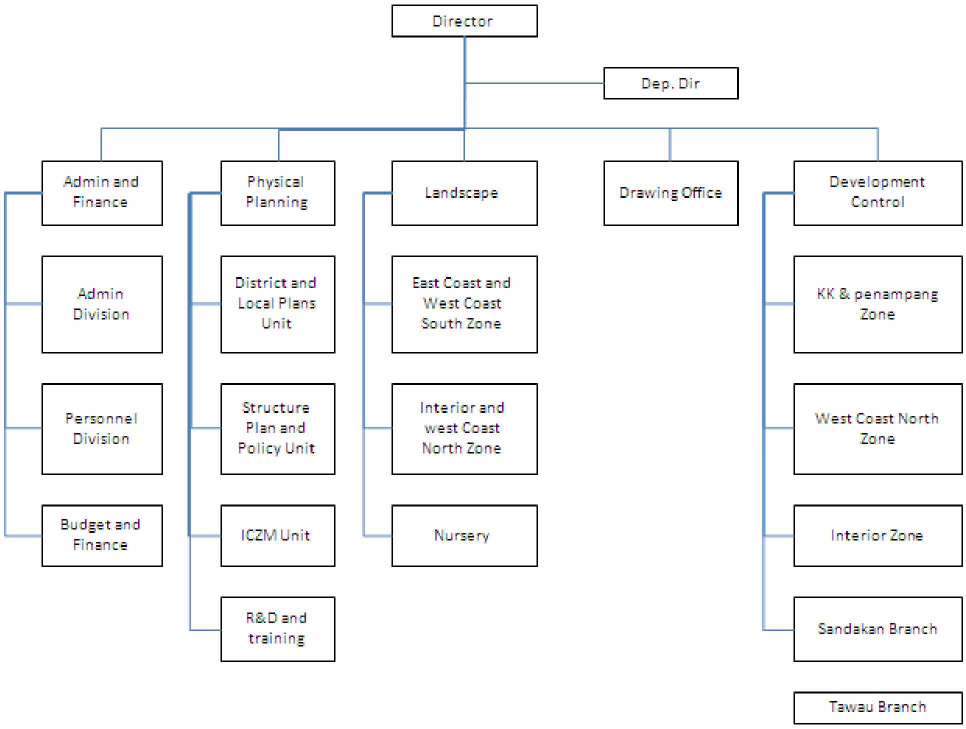

Figure 7.6.6 Town and Regional Planning Department Organization Chart

7.6.1.7 SABAH STATE WATER DEPARTMENT

Objective: The operational objective of the Sabah State Water Department is to supply treated water to the Sabah State community

Expected role in the Project: The Water Department operates an intake point near Beaufort, downstream of the proposed dam. The Department therefore has a vested interest in ensuring a high level of water quality in the Padas River, particularly concerning parameters, that are not easily corrected/treated. The Water Department will thus have an interest in biomass disposal prior to reservoir filling and in subsequent monitoring and enforcement functions.

Legal base: Sabah State Water Department is an agency under the Ministry of Infrastructure Development. The Department operates under the state ordinance (Water Supply Enactment 2003).

Organisation: There are 39 water treatment plants operating throughout the state. There are 9 Water Divisional Offices and 18 Water District offices throughout the State. See **Figure 7.6.7**.

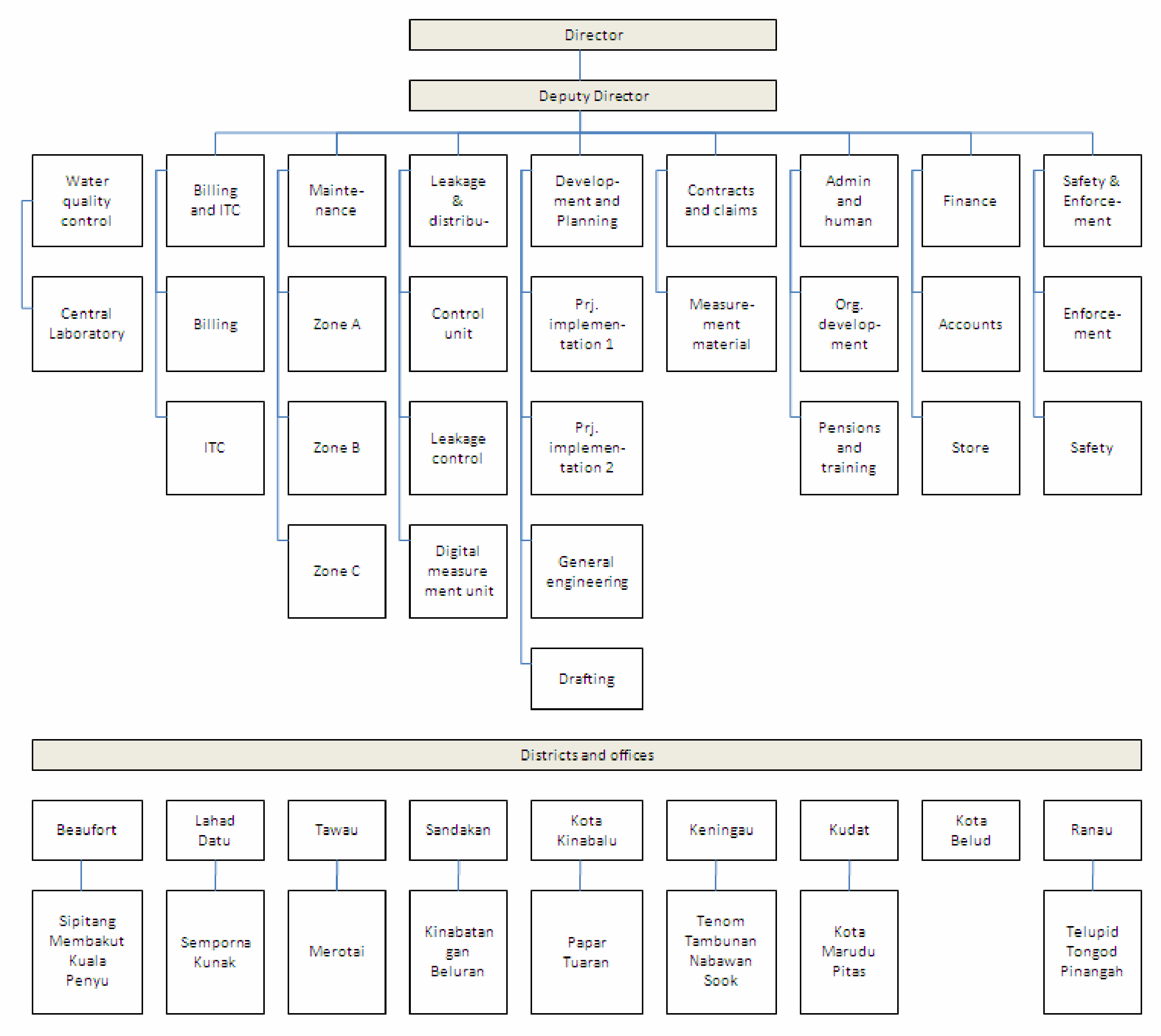

Figure 7.6.7 Water Department Organisation Chart

7.6.1.8 *WILDLIFE DEPARTMENT*

Objective: Wildlife in Sabah is defined as fauna as well as flora. The Sabah Wildlife Department is thus responsible for all issues concerning natural habitats and biodiversity. The department, which was once a part of the Forestry Department, has traditionally started from the top of the food chain and developed itself downwards: from the large mammals and birds there is an increasing attention on herpetofauna and insects but still only little on aquatic invertebrates.

Flora protection is centred around rare species, that need protection from international trade, whether medical or for gardening.

This emphasis is reflected in the staff expertise.

Expected role in the Project: The Department will be involved in case protected wildlife (flora or fauna) is in the line when inundating the reservoir or clearing for transmission- lines. The Department does not see that there are serious issues at stake within the Project area and does therefore not foresee being placed in any form of institutional stress.

There may be a need for additional patrols to regulate and control hunting as a result of the influx of large work forces.

Legal base: Sabah Wildlife Conservation Enactment, 1997.

Organization: The Department is established under the Sabah Ministry for Tourism, Culture and Environment. The Wildlife Department head office is in Kota Kinabalu but it also has a number of district offices, centres and stations throughout the State. The Project area lies partly within the West Coast Wildlife District, which is managed from a district office in Kota Kinabalu and partly within the Keningau Wildlife District.

Human resources: About 229 staffs work in the Wildlife Department. They are highly experienced for the tasks that may be expected from them in case protected species must be translocated. The staff will, however, benefit from following closely biological studies related to changes of the aquatic environment.

Logistics: The Wildlife Department is reasonably equipped for its present workload but faces shortages when carrying out rescue and translocation missions. Such missions require lengthy stays in the forest areas for large crews and the use of heavy equipment for transportation. The Sepilok Orang Utan Centre will normally be involved by providing veterinary services. The likelihood of translocation exercises for this Project is remote. The inundation of the reservoir is not expected to create any islands, where wildlife may be trapped, and there are none of those species, which normally benefit from rescue operations.

Development needs: The Department is not expected to stretch its resources beyond its limit for the tasks.

7.6.1.9 DEPARTMENT OF FISHERIES

Objective: The objective of the Department of Fisheries is to develop the fisheries industries of the state by effectively introducing management, planning and methodological innovations. The Department is concerned with all aspects of fisheries, whether it concerns catching fishes in their natural environment or by breeding them in various forms of aquaculture.

Expected role in the Project: The Department's role in the present Project is not expected to be significant, although the presence of a large reservoir will present new challenges and opportunities to the department.

Legal base: The Fisheries Act 1985 (Revised 1993), The Sabah Inland Fisheries and Aquaculture Enactment 2003.

Organisation: The Department of Fisheries, Sabah is established under the Ministry of Agriculture and Food Industries, Sabah. See **Figure 7.6.8**.

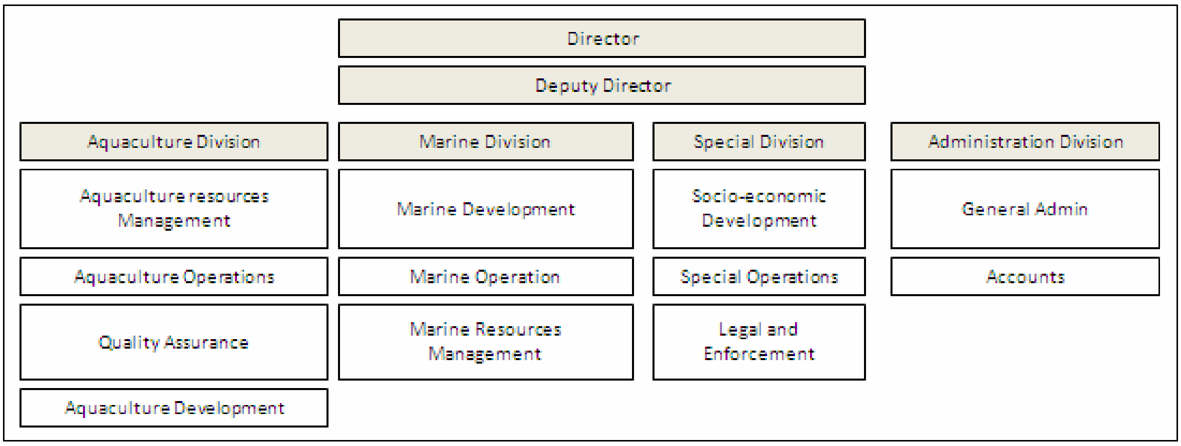

Figure 7.6.8 Fisheries Department Organisation Chart

Human Resources: The Department employs several staff with minimum bachelor degrees in fisheries, fisheries management, agriculture, psychology, food science etc.

Development needs: With the changed aquatic environment in Padas River as a result of the existence of that large reservoir, the Department will need to develop expertise in the relation between water quality, fisheries and food safety. The Department will be the institution to advise local fishing communities whether the fishes in the reservoir are safe to consume or whether the water quality will cause harmful substances to accumulate in the fishes to a level deemed unsafe for consumption.

7.6.1.10 LOCAL AUTHORITIES

The Upper Padas Hydroelectric Project will be operated within two local district council areas: Tenom and Sipitang. The district councils are not expected to be actively and directly involved in the Project operation with the exception of certain levels of social issues (grievances) and as a first instance in case of emergencies.

The role of the local authorities is mainly spelled out in the Local Authorities Ordinance of 1961, which in fact delegates a wide array of powers concerning public health and environment to the local authorities. Section 49 A and B lists a number of ‘Public Nuisances’ to be dealt with by the District Council including air and water quality issues, unclean workplaces, lack of sewage, fire and burning of refuse, deposit of refuse etc.

With the influx of large number of workers from outside the districts, such control may pose a burden to the local authorities, which may be in need for additional staff and logistics unless such control is taken over by the Environment Protection Department or the Department of Environment.

7.6.1.11 DEPARTMENT OF MINERALS AND GEOSCIENCE

Objective: The Department is entrusted with providing information useful for the utilisation of the nation’s geological resources. The Department also supervises the enforcement of the country’s mining laws.

Expected role in the Project: The Department will play a key role at the planning stage of the Project by assisting the Project planners with geotechnical information and advice. Later, the Department will be involved in quarry planning and licensing and the control of the use of explosives. The main issue, however, will be the support to geotechnical investigations.

Legal base: List 1 under the Ninth Schedule of the Federal Constitution regulates mineral resources to fall within the Federal authority. This does not directly imply any involvement with or jurisdiction over the present Project but gives the base for the general activities of this department at the state level.

Organisation: The Department falls under the Federal Natural Resource and Environment Ministry.

Development needs: The Department is not expected to be stretched beyond its present capacity for this Project.

7.6.1.12 DEPARTMENT OF ENVIRONMENT (SABAH)

Objective: This federal Department is established at state level in accordance with the Environment Quality Act, 1974. The department is particularly involved in pollution from industries, from mobile pollution sources, trans-boundary issues and other issues in accordance with the Ninth schedule of the Federal Constitution.

The Department's vision is expressed to be to ensure that the uniqueness, diversity and environmental quality are maintained to ensure the health, safety and comfort of people living in the present and the future.

Expected role in the Project: The Department of Environment is a main partner for the Environment Protection Department in Environmental Impact Assessment approval procedures. The Department of Environment controls hazardous substances, aspects of environmental impact assessment procedures, air and water quality standards and implements a nation-wide river water quality monitoring programme. All usage of gensets >15 kw/hr, setting up of batching plants, etc. must obtain prior written approval from the Department.

Legal base: Environment Quality Act, 1974.

Organisation: While being a federal department, the Department of Environment is also established at State level in order to implement the Environment Quality Act, 1974 at state level. The Department has its main office in Kota Kinabalu and branch offices in Tawau, Sandakan and Sipitang.

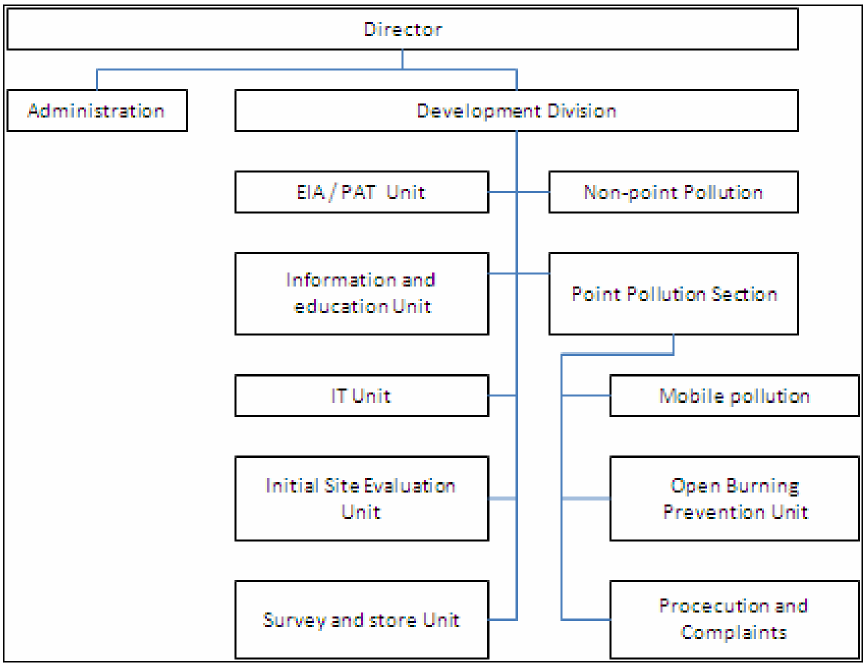

Figure 7.6.9 Department of Environment Organization Chart (Simplified)

Human resources: The staffs of the Department of Environment are highly specialized but limited in numbers by federal regulations. The Department does not foresee any particular manpower or capacity bottlenecks arising from the present Project.

Logistics: The Department is sufficiently equipped for the tasks entrusted to it.

7.6.2 TRAINING

The Project Proponent is expected to carry out several training events for his staff and contractors. These events are of technical, environmental and safety nature. The Government agencies must be invited to participate in these training events free of charge as and when appropriate.

7.6.3 LOGISTICS

While a Project like this cannot sponsor additional government staff directly, the Project can – and should – provide logistics for a constant government presence at the Project site. The Project should thus establish office space and accommodation for 6 government staff representing 2 staff permanently from the Environment Protection Department; 2 permanently from the Forestry Department plus space for two from various other departments on a rotational basis. The government staff shall be given access to communication, transportation and basic field and office equipment including mapping facilities and basic water quality testing equipment. The level of government staffing at the site is likely to be decreased to two or three after the construction stage.

The Government staff will carry out monitoring and supervision work and at a later stage be involved in the catchment area management. They will perform the function of liaison between the Project field site and the agencies' main offices.

7.6.4 STAFF

Department of Environment, Environment Protection Department and Forestry Department offices in Sipitang would benefit from additional staff at professional and technical level being allocated to them.

While it is not possible to sponsor staff increases for government organisations, options of outsourcing specific tasks can be considered. Such tasks may be anything from monitoring residual impacts, hydrological monitoring and catchment area planning to initial verification of reports and plans.

7.7 SUMMARY

The present assessment report includes a proposal for an environmental management plan. The plan recommends the establishment of an organisation within the Project Proponent to deal with catchment area and reservoir management. It emphasizes that it is the responsibility of the Project Proponent to ensure contractors and sub contractors oblige by the environmental conditions and implement the environmental management plan. This includes a number of policies on social and environmental corporate citizenship and responsibility and adherence to national and international requirements and to establish regulations for green procurement to prevent environmental or social degradation as a result from the Project's procurement.

The plan further contains an 'Action Plan' based on the requirements of the international banks. The action plan is therefore made up by a series of separate plans for *i.a.* soil protection, biomass removal, wildlife management, workers' health and protection, wastes management plan, community related plans, cultural heritage management plan and a plan for catchment management.

Catchment Area Management: The latter is a particular issue as the Upper Padas Hydroelectric Project will require minimum siltation of the active storage and relatively clean water to go through the turbines. This results in a requirement for the Sabah Forest Industries and the communities in Long Pa Sia and Kg. Maligan to manage their areas with this in mind. One could compare this with the right-of-way management under the transmission lines. The impact of the Project is a limitation to the land owners in choosing their preferred land use regime.

Communication and Disclosure. A communication and disclosure series of dialogues has already been initiated by the Project Proponent. This process shall be continued and made permanent through the organisation that establishes joint catchment area management and through a grievance mechanism. The assessment stresses the importance of free, prior and informed dialogue, whereby affected parties are given a fair opportunity to express their views and proposals before final decisions are made.

CHAPTER 8 RESIDUAL IMPACTS, RISK, MONITORING AND REPORTING

8.1 RESIDUAL IMPACTS

8.1.1 GENERAL

This chapter discusses potential residual impacts that arise from the implementation of the Project. Residual impacts are environmental impacts that remain after all mitigating measures are successfully implemented. These residual impacts may remain due to the natural limitations (such as effects of weather) or technical limitations of the methods adopted.

These residual impacts represent a risk to the affected parties that can be categorised as low through to extreme, based on the likelihood and consequence of the impact in accordance with the **Table 8.1-1**.

Table 8.1-1 Classification of Project Risk

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Severe 5
5 (almost certain)	Moderate	High Risk	High Risk	Extreme Risk	Extreme Risk
4 (likely)	Moderate	Moderate	High Risk	High Risk	Extreme Risk
3 (moderate)	Low Risk	Moderate	Moderate	High Risk	Extreme Risk
2 (unlikely)	Low Risk	Moderate	Moderate	Moderate	High Risk
1 (rare)	Low Risk	Low Risk	Moderate	Moderate	High Risk

Source: www.dpmc.gov.au

Most residual impacts from this Project concern water.

The flow of the Upper Padas will be altered, consequently:

- During the impoundment period only 16 m^3 will flow past the dam site per second compared to normally around 70 m^3 per second.
- During the operational period, only 16 m^3 per second will run in the river section between the dam and the power house.
- Flows during the operational period will be almost constant throughout the year.
- There will be a deep lake (reservoir) stretching about 15 km upstream from the dam.

The water quality of the Upper Padas will be changed:-

- Sedimentation will take place in the reservoir so the water released from the Project will be clearer than before.

- If not properly aerated, water released from the reservoir may be depleted of oxygen and may contain large concentrations of carbon dioxide and methane. There may also be other chemical compounds originating from the impounded soil or from decomposing biomass in the water.

Socially, the Project is expected to bring benefits to the people of Sabah in the form of reliable, relatively clean energy. It comes, however, at a cost for those who have to give up land for the Project installations, either the Sabah Forest Industries for the dam and reservoir sites or the many landowners, who will have management limitations imposed upon them where the transmission- lines pass their lands.

The Project will contribute to the climate change by emitting greenhouse gasses originating from the biomass in the reservoir area. It will also cause some permanent loss of biodiversity and habitat.

Table 8.1-2 lists the risk assessment for residual impacts. The assessments are repeated in the sections for individual impacts below.

Table 8.1-2 Risk Assessment for Residual Impacts

	Likelihood	Consequence	Risk
Physical Environment			
- Seismicity	1	4	Moderate
- Soil	Dealt with under water quality		
- Air			
- Greenhouse Gasses	5	2	High
- Dust and Noise	4	2	Moderate
- Water Flow and Quality			
- Water Quality, Reservoir	2	2	Moderate
- Sedimentation of Reservoir	2	4	Moderate
- At the Dam Site	4	2	Moderate
- Bypassed Channel	4	2	Moderate
- At the Power Station	4	2	Moderate
- Padas Downstream of the Power Station	4	2	Moderate
- Effect on Floods in Tenom, Beaufort and on Klias Peninsula	4	3	High
Biological Environment			
- Terrestrial Flora	2	2	Moderate
- Terrestrial Fauna	3	2	Moderate
- Aquatic Flora	4	3	High
- Aquatic fauna	4	3	High
Human Environment			
- Public Health	3	3	Moderate
- Dam Break	1	5	High
- Aesthetics	4	1	Moderate

8.1.2 PHYSICAL ENVIRONMENT

8.1.2.1 SEISMICITY

Reservoir loadings alone are not a cause of reservoir-induced seismicity (RIS); dams of 50 m height can produce earthquake events as large as dams of 200 m height. Reservoir induced seismicity typically requires an environment that is already highly stressed. When impounding of a reservoir occurs, this raises the pore pressures in the underlying and ambient rock masses and consequently reduces the effective stresses along favourably orientated discontinuities in the rock. If the rock mass is in a condition of incipient failure, through the magnitude of the in-situ stress condition, rupture along a discontinuity may occur, causing an earthquake.

The folded rocks of the present dam site/reservoir suggest that these have been subjected to high horizontal stresses in the past. However, without monitoring it is not possible to predict the intensity of any reservoir induced seismicity that might result from impounding here, or whether the area will remain seismically quiet. If a micro-seismic network is set up, this should be done before well before impounding, in order to establish background conditions. Normally, the absence of micro-seismic activity over a period of six months to a year (before impounding) indicates that reservoir induced seismicity will not be a problem.

Since there are no known active faults, and the generally impermeable and plastic greywacke and argillite rock mass have no residual stresses of significant magnitude, reservoir induced seismicity is unlikely. However, the shape of the reservoir may favour stress concentrations, and together with rapid impounding of the reservoir may produce conditions favouring reservoir induced seismicity.

A new study by Universiti Sains Malaysia, Sabah (USMS) emphasizes on the significance of reservoir induced seismicity. In a worst case scenario, the estimated reservoir induced seismicity. of m_b=4.5[63] located 3 km from the dam site at a depth of 10 km, gave an estimated peak ground acceleration (PGA) of 0.18 g, which is a rather high value. On the other hand, USMS states that the possibility of reservoir induced seismicity with $m_b \geq 4.5$ is very low, since there were no records of seismic events in the reservoir area.

Likelihood = 1 (rare), Consequence = 4 (Major) Risk = Moderate

8.1.2.2 SOIL

There will, during the construction stage be a considerable amount of soil erosion, particularly around the dam and powerhouse sites.

Soil erosion, however, is not a particular problem in itself. The problem lies in the consequential impacts such as increased sedimentation, increased turbidity, increased levels of total suspended solids (TSS) and their consequential impact on wildlife and human livelihoods.

The issue of soil erosion is therefore dealt with under water quality.

[63] *On the Ricther Scale, M_b magnitudes reflect waves that have travelled through great depths, and M_s magnitudes, waves that travel along the surface (the symbol for magnitudes on Richter's scale is M_L).*

8.1.2.3 AIR

8.1.2.3.1 GREENHOUSE GASSES

The Project will clear or inundate large areas of primary forest. The biomass of these forests will one way or the other, through biological activity or fire, be decomposed.

The Project Proponent is totally in control over the climate change effect, and willing to compensate. A total clearing of biomass and offset by re-forestation elsewhere will balance this impact. Otherwise, there will be residual impact by greenhouse gas emissions.

Under aerobic degradation of the carbon of the biomass will form carbon dioxide (CO_2). Under an-aerobic degradation, methane (CH_4) will be formed. For every 12 weight units of carbon (Carbon's atomic weight is 12), 44 units of carbon dioxide (Oxygen's atomic weight is 16) will be formed or 16 units of methane (Hydrogen's atomic weight is 1). Methane's potential for heat absorption is more than 20 times that of carbon dioxide. However, free methane in the atmosphere will eventually react with oxygen and create carbon dioxide and water. The half-life of this process is on average seven years.

Biomass that is cleared will either

- Be used for timber (25%) or paper (25%) after which it will be discarded and left to decompose. The lifetime of timber is estimated to be 20 years while paper is expected to last only 2 years.
- Be left for natural decomposition (50%-0%) aided by insects, bacteria and fungi. The decomposition process is estimated to last ten years.
- Burn. This process is instantaneous (0%-50%).

Biomass that is not cleared will be inundated. The anaerobic decomposition is in this estimate fixed to 20 years but may take longer. Whether it is 20 years or longer does not have any impact on the final total emission, only on annual emission rates.

The dry weight biomass per ha is estimated to be 100 tonnes (See **Section 4.6.2** for details of the biomass inventory).

The reservoir will be 590 ha with a shore-line of 30 km.

A band, 130 m wide along the shore-line will be cleared. The area of this cleared strip is 390 hectares leaving 200 hectares to be inundated.

Appendix 2-2: Climate and Air includes details on calculations of emissions of greenhouse gasses based on the above criteria.

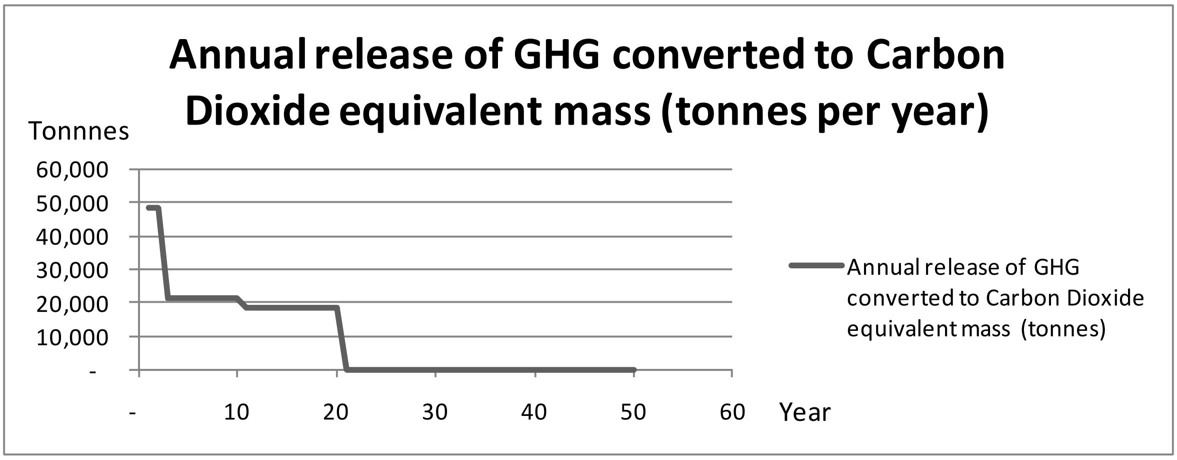

Figure 8.1.1 Greenhouse Gas Emission

Figure 8.1.1 depicts the resulting emission in CO_2 equivalents. A total equivalent of 450,000 tons CO_2 is emitted over 20 years. Of this, 314,000 tons CO_2 equivalent is emitted through 50,000 tons of methane from the 200 hectares which are not cleared. The remaining 140,000 tons CO_2 from the 390 hectares cleared.

The CO_2 from burning or aerobic decomposition will disperse directly into the atmosphere, while the methane under pressure will be dissolved in the reservoir. From here it will slowly be released through the reservoir surface or through the releases from the water passing the two powerhouses.

The internal pressure in the water will be released immediately after the tail race and most of the methane will escape into the atmosphere. The remaining methane in the water will be released from the river over the next 20-40 m depending on rapids (water level) and temperature.

The consequence is considered Minor only because the area and thus the amount of gasses are relatively small compared with other clearings in the region. Otherwise, the effects of climate change are considered moderate to major.

Likelihood = 5 (almost certain) Consequence = 2 (Minor) Risk = High

8.1.2.3.2 DUST AND NOISE

There may, during the construction period, be some dust nuisances from the construction sites and in particular the increased traffic. This will impact humans and wildlife alike.

Likelihood = 4 (Likely) Consequence = 2 (Minor) Risk = Moderate

8.1.2.4 WATER FLOW AND QUALITY

8.1.2.4.1 RESERVOIR

The creation of the reservoir will cause a change of the river from a fast moving river to slow moving lake environment. The lake environment will be stratified with cold waters near the bottom and rising temperatures near the surface.

Decomposition of vegetation within the reservoir will contribute to lower dissolved oxygen levels in the bottom layer of the reservoir below the thermocline. The implementation of a biomass removal plan will mitigate this impact to a large degree. However, organic material transported into the reservoir, or produced in the upper layers of the reservoir by algae will still sedimentate and decompose in the bottom layer. The bottom layer will remain anaerobic. However this is a situation seen in natural, deep lakes and does not affect the productivity and natural lake environment. However, due to the an-aerobic conditions in the bottom layer, water released from here will have no oxygen content. Instead contain carbon dioxide and/or methane, depending on the depth from which the water is taken. The bottom water may be aggressive having an impact on generator components. Further, when released, the water may have impact on downstream river communities, if not properly mitigated through aeration.

Likelihood = 2 (Unlikely)   Consequence = 2 (Minor)   Risk = Moderate

8.1.2.4.2 SEDIMENTATION OF RESERVOIR

The current and planned future land use activities in the upstream catchment have the potential to mobilize large quantities of soil which will be carried into, and stored in the reservoir. This sediment is mostly deposited in the upper reaches of the reservoir from where it eventually moves to the deeper parts near the dam. It is unlikely that the sedimentation will reach the water intakes but may block lower outlets if such are installed.

Likelihood = 2 (Unlikely)   Consequence = 4 (Major)   Risk = Moderate

8.1.2.4.3 AT THE DAM SITE

16 m^3 of water will be released as environmental or compensation flow through the secondary powerhouse per second. This water will be clearer than before the Project as most suspended solids, if not all, have settled within the reservoir. The water may contain methane, most of which will escape to the atmosphere immediately upon leaving the powerhouse.

The released water will cause a mist in the immediate surrounding thus creating a possibility for the local habitat to change to a forest type thriving in extreme moist conditions.

The river will be aerated in this splash and mist and the river will quickly re-gain its healthy levels of dissolved oxygen.

Likelihood = 4 (Likely)   Consequence = 2 (Minor)   Risk = Moderate

8.1.2.4.4 BYPASSED CHANNEL

The clear water released from the secondary powerhouse as environmental flow will have an ability to pick up new soil from the riverbed or banks, thus creating new bank instability while clearing the riverbed. The effect will, however, not be severe as the water volume in the river will be only one third of normal flow. The bypassed channel will in effect change from a fast flowing river to a more calm, but clear stretch of river, where most likely fishing will be good and the environment healthy.

Likelihood = 4 (Likely)   Consequence = 2 (Minor)   Risk = Moderate

8.1.2.4.5 *AT THE POWER STATION*

There will be a release of about 54 m^3 water per second at the main powerhouse. This release will happen under two kinds of pressure:

- The water will go through the turbines driven by a pressure of 10-12 atmospheres due to the height difference between the intake and the power station. The splash will also create misty conditions in the vicinity causing habitat changes to forest types thriving under such conditions. On the positive side, the river water will be aerated in the splash thus contributing to a quicker return to normal oxygen levels in the water.
- Since the water intake is at about 30 meters depth, there will be about 4 atmospheres pressure within that water. When this pressure is released, a large proportion of the dissolved carbon dioxide and methane will escape to the atmosphere.

The water released at the main power station will, as the water at the secondary power station, be clearer than before the Project since the reservoir will act as a huge and effective silt trap.

Likelihood = 4 (Likely) Consequence = 2 (Minor) Risk = Moderate

8.1.2.4.6 *PADAS DOWNSTREAM OF THE POWER STATION*

The quantities of water flowing through the river system below the main power house will be as before the Project except there will be very little seasonal variation. The total, however, will remain the same (adjusted for the increased evaporation from the reservoir surface) as the Project does not 'consume' any water, it only utilises its kinetic energy.

Initially the water will be clearer as the reservoir has acted as a silt trap for all the eroded soil from the catchment area. The river will, however, now have the potential to pick up new material from the riverbed or the banks.

This effect will be short lived as the river only after a few kilometres is joined by the Tomani river and later by the Telekosang. Downstream from the Telekosang confluence, changes will be hard to notice and when reaching Tenom, where the Padas is joined by the Pegalan river, all water quality changes will have gone.

Likelihood = 4 (Likely) Consequence = 2 (Minor) Risk = Moderate

Effect on Tenom Pangi

There will be an advantage of the Upper Padas Hydroelectric Project for the Tenom Pangi power station. This station is a run-of-the-river station and has as such no large reservoir to even out seasonal fluctuations. The station cannot run at full power during dry spells and suffers flooding in extreme years.

The Upper Padas Project will be able to alleviate these problems to some degree, thus increasing the effectiveness of Tenom Pangi.

Effect on floods in Tenom, Beaufort and on Klias

Like for Tenom Pangi, the Upper Padas dam management may be able to exercise some degree of flood control to the benefit of the people in Tenom, Beaufort and on Klias. However, the Upper Padas catchment only represents a small proportion of the total area, that causes the floods and it is likely that the reservoir also will be full and in need of spillway release at the time when the citizens of Tenom and Beaufort request flood control. Full utilisation of flood forecasts will enable this positive option.

Likelihood = 4 (Likely) Consequence = 3 (Moderate) Risk = High

8.1.3 BIOLOGICAL ENVIRONMENT

8.1.3.1 TERRESTRIAL FLORA

The creation of the reservoir and site installations will cause the disappearance of about 600 hectares of healthy, primary forest with all it contents of biodiversity and habitat for wildlife. On the other hand, the catchment area management requirements from the Project will cause an increased focus upon the protection and sustainable management of the remaining Maligan and Sg. Basio Virgin Forest Reserves, the natural forest areas of Sabah Forest Industries and even impose sustainability criteria on the Sabah Forest Industries industrial tree plantation areas.

Overall, that increased management focus may be worth the loss of 600 ha forest even though this forest is of particularly good quality and not likely to be exploited otherwise due to the terrain conditions.

The riparian flora will be particularly affected when the river suddenly expands and makes a lake shore-line far from where there used to be river banks. It will take some time but eventually, a permanent riparian vegetation will establish here.

As mentioned earlier, the misty conditions at the release of water at the two power stations will cause a change of habitat to one that thrives in the misty conditions. Lichens and other epiphytes are likely to flourish.

Likelihood = 2 (Unlikely) Consequence = 2 (Minor) Risk = Moderate

8.1.3.2 TERRESTRIAL FAUNA

Fragmentation of Wildlife Habitat

The 70-km transmission-lines mostly follow boundaries between forests (plantations) and the agricultural or estate landscape. By doing so, it does not significantly contribute to fragmentation of habitats.

The reservoir, on the other hand, will form a barrier for passage over the river and in and out the protected, natural forest in Sabah Forest Industries compartment P08 on the East side of the reservoir. A broad buffer all the way around the reservoir will mitigate this by providing a corridor for wildlife movements.

Likelihood = 3 (Moderate) Consequence = 2 (Minor) Risk = Moderate

Hunting and accidents

Even if the Project management is very dedicated in controlling hunting by their staff during the construction stage, it is unlikely, they will be in a position to totally prevent additional hunting pressure. The pressure will be from Project staff but also from those, that should be concerned with the sustainability of hunting in the area: The local communities. These communities, who have been instrumental in eradicating most of the wildlife in the area are already likely to hunt bush meat and offer it for sale at the camps.

Also, it will not be possible to totally avoid road kills from the increased traffic.

8.1.3.3 AQUATIC FLORA

The aquatic flora will, in response to the changed flow and water quality, undergo permanent changes in the reservoir area and the bypassed channel. The changes are not necessarily negative. In the reservoir, the flora has to establish itself in a 30 km new shore-line where the bottom is soil and remains from earlier terrestrial vegetation compared with the rocky conditions of the river. The succession will, however, be natural and a balance will be reached. The prospect of algae blooms in a reservoir like this is not likely.

The flora in the bypassed channel, i.e. the river section between the dam and the main power house, will to some degree benefit from increased light due to less suspended solids but may also over a short stretch suffer from decreased dissolved oxygen and increased levels of methane and other compounds. The consequences, however, are suspected to be only moderate.

Downstream of Tomani River, there is not likely to be any impact.

Likelihood = 4 (Likely) Consequence = 3 (Moderate) Risk = High

8.1.3.4 AQUATIC FAUNA

The creation of the reservoir will permanently change species composition and distribution of the aquatic wildlife in the area. Fishes will not stay in the deep of the lake but will find territories along the new 30 km long lake shore. Here water will be reasonably clear compared to before the Project but the water movement will be slow. Not all the existing species will be able to adapt to this change so if the species composition is not improved by the humans, the area will be poor in aquatic life forms for a long time.

There is potential for introducing new species and for caged aquaculture. However, any introduction of new species must be subjected to assessment of environmental impact to avoid invasive species threatening local populations.

The local species are expected to benefit from improved water quality in the bypassed channel.

Downstream of Tomani River, there is not likely to be any impact.

Likelihood = 4 (Likely) Consequence = 3 (Moderate) Risk = High

8.1.4 HUMAN ENVIRONMENT

Each heading includes 'and consequential impact'. E.g. deteriorating water quality leads to destruction of fisheries, which is no good for human consumption

8.1.4.1 PUBLIC HEALTH

There are potential impacts to public health through introduction of diseases, enhanced conditions for disease vectors, and changes to environmental conditions for the very few, - if any - who may opt for relocation due to the transmission line alignment, and temporary working communities coming into the region. Mitigation measures recommended will help to contain these impacts but residual impacts will inevitably remain.

Likelihood = 3 (Moderate) Consequence = 3 (Moderate) Risk = High

8.1.4.2 DAM BREAK

No roller compacted concrete dam has so far failed anywhere in the world even though they have been subjected to earthquakes, seiche waves, over topping and other threats. All efforts have been invested in making safe designs of the dams and in the event of an emergency, an emergency response plan has been provided.

Dam failure would be catastrophic but as none has failed, no one knows the risk probability.

The risk of an event of a dam breach, how unlikely it may be, will always be there. It is a risk, where the consequences would be of enormous proportions, but where the multiplier, the probability is near zero.

The uncertainty and fear of a dam breach is a psychological factor that should not be underestimated. It may be dampened by thorough and open information but some will always be there as a residual, social impact.

Likelihood = 1 (Rare) Consequence = 5 (severe) Risk = High

8.1.4.3 AESTHETICS

The dam and the transmission- lines will to many be a frightening but intriguing and educational sight during construction. Many people would rate the completed dam and the lake a beautiful sight due to its tranquillity and beautiful settings once it is in operation and the dam may become a tourist attraction. There will of course be others, for whom the dam and its installations are a demonstration of environmental defeat on the altar of economic interests.

While the dam may be an engineering beauty, and the lake romantic, few will agree that the transmission- lines improve the aesthetics of the landscape. The lines are, however aligned so as to minimise the landscape scarring and fragmentation from the transmission- lines.

Likelihood = 4 (Likely) Consequence = 1 (Insignificant) Risk = Moderate

8.1.5 CUMULATIVE IMPACT

8.1.5.1 *ASSOCIATED FACILITIES THAT ARE NOT FUNDED AS PART OF THE PROJECT*

The quality of the Padas River's waters is to a large extent dependent upon the silvicultural practices of the Sabah Forest Industries as this company controls virtually the entire catchment above Tenom.

The effect is cumulative. But while the Upper Padas Hydroelectric Project during the construction stage will contribute to the level of suspended solids in the river, the Project will rather act as a huge silt trap during operation. The Project is expected to lower the level of total suspended solids but will also add problems of carbon dioxide and methane.

8.1.5.2 *CUMULATIVE IMPACTS FROM FURTHER PLANNED DEVELOPMENT*

Apart from the Sabah Forest Industries forestry operations, there are no further planned developments in the area.

The availability of stable electricity for further development elsewhere in the state will cause its own set of environmental and social issues to be dealt with in separate assessments.

The issue of greenhouse gasses is globally cumulative. While the Project does not contribute to lowering Malaysia's greenhouse gas emissions *per se*, it does represent a lower emission rate than would otherwise be the case if Sabah's power generation entirely depended on conversion of fossil fuels.

8.1.5.3 *IMPACTS FROM UNPLANNED BUT PREDICTABLE DEVELOPMENTS CAUSED BY THE PROJECT*

The construction of the Upper Padas Dam will create access to the area and attract further settlements of both urban and rural character. This may cause significant environmental problems if not properly controlled.

8.2 ENVIRONMENTAL RISK TO THE PROJECT

8.2.1.1 *CLIMATE CHANGE*

The potential for increased frequency of extreme events, including rainfall, typhoon activity and persistence of regional weather systems due to climate change is uncertain. Predictions from IPCC 2007 are disturbing; in particular, increased frequency and severity of El Niño events can have significant consequences on the climate in Malaysia. It is unclear what (if any) consequences global warming will have on monsoonal activity in Asia. The various circulation patterns that influence climate in the region are affected in different ways, but one of particular relevance is a projection that the role of the Pacific Ocean becomes more dominant and that of the Indian Ocean becomes more secondary. This could result in more variability in the region as a consequence of a stronger influence of El Niño variability.

Climate assessments Project a future warmer climate, which is considered to cause more intense and heavy episodic rainfall events with high runoff amounts, interspersed with longer relatively dry periods. The South East Asian region is expected to experience more extreme wet seasons. There is a less pronounced projected decrease in extreme dry seasons, however these predictions contain a number of uncertainties, particularly relating to the strength of the monsoons and El Niño.

Likelihood = 3 (Moderate) Consequence = 3 (Moderate) Risk = High

8.2.1.2 SEISMICITY

There is a residual risk of seismic activity in the region that could destabilise construction materials or excavations at a time when they are more vulnerable to collapse than when the Project is completed. This risk has been included in the design of the dam but cannot be totally removed.

Given the recorded instances of significant seismic events in the region, the likelihood is considered very low. Nevertheless, the consequences can be major and thus the risk to the Project can be considered high.

Likelihood = 1 (rare) Consequence = 4 (Major) Risk = High

8.2.1.3 SEDIMENTATION

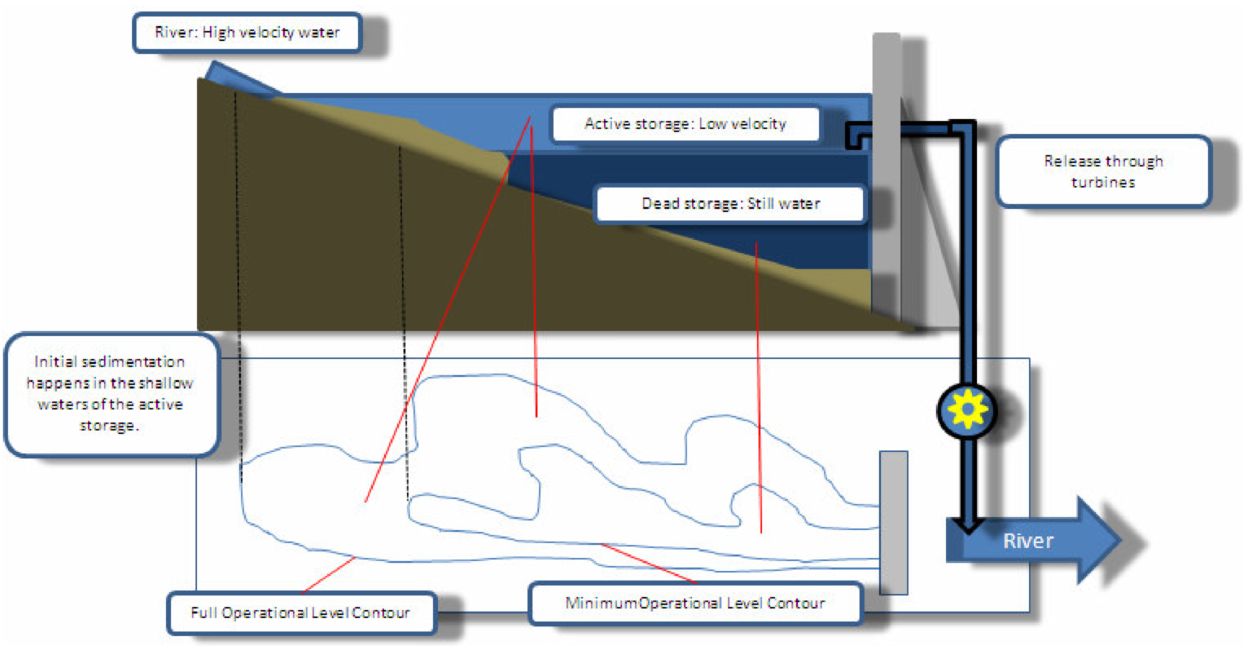

Figure 8.2.1 Principles of Sedimentation

8.2.1.4 RESERVOIR SEDIMENTATION

The Upper Padas dam will act as barrier to the movement of these sediments downstream with sediment accumulation in the reservoir. **Figure 4.4.3** shows approximate source erosion rates across the Upper Padas catchment.

Sediment accumulation from the two river catchments is predicted not to spread uniformly across the reservoir (**Figure 8.2.2** and **Figure 8.2.3**). Initial sediment accumulation will occur within the upper reaches of the reservoir due to a reduction in flow as the river enters the reservoir; this is where deposition of suspended sediments onto the bed occurs as grains drop out of suspension. The bed load and coarser fraction e.g. fine sand will deposit near the very top of the reservoir while finer sediments e.g. silt and clay are transported further downstream. Most of this deposition will occur within 1 km of the Padas River mouth. **Figure 8.2.2** shows the distribution of sedimentation rate along the reservoir centreline. Across much of the reservoir there is very little deposition (<5 mm per year).

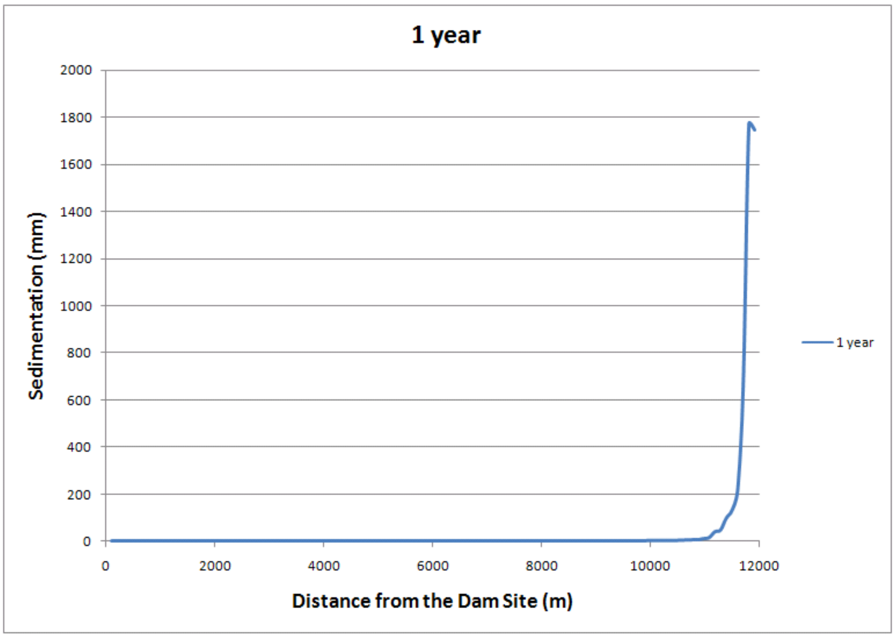

Figure 8.2.2 Annual Sedimentation Rate along the Reservoir Centreline (Dam Site to Upper Padas River (Based On 2006 And 2007 Simulation Periods)

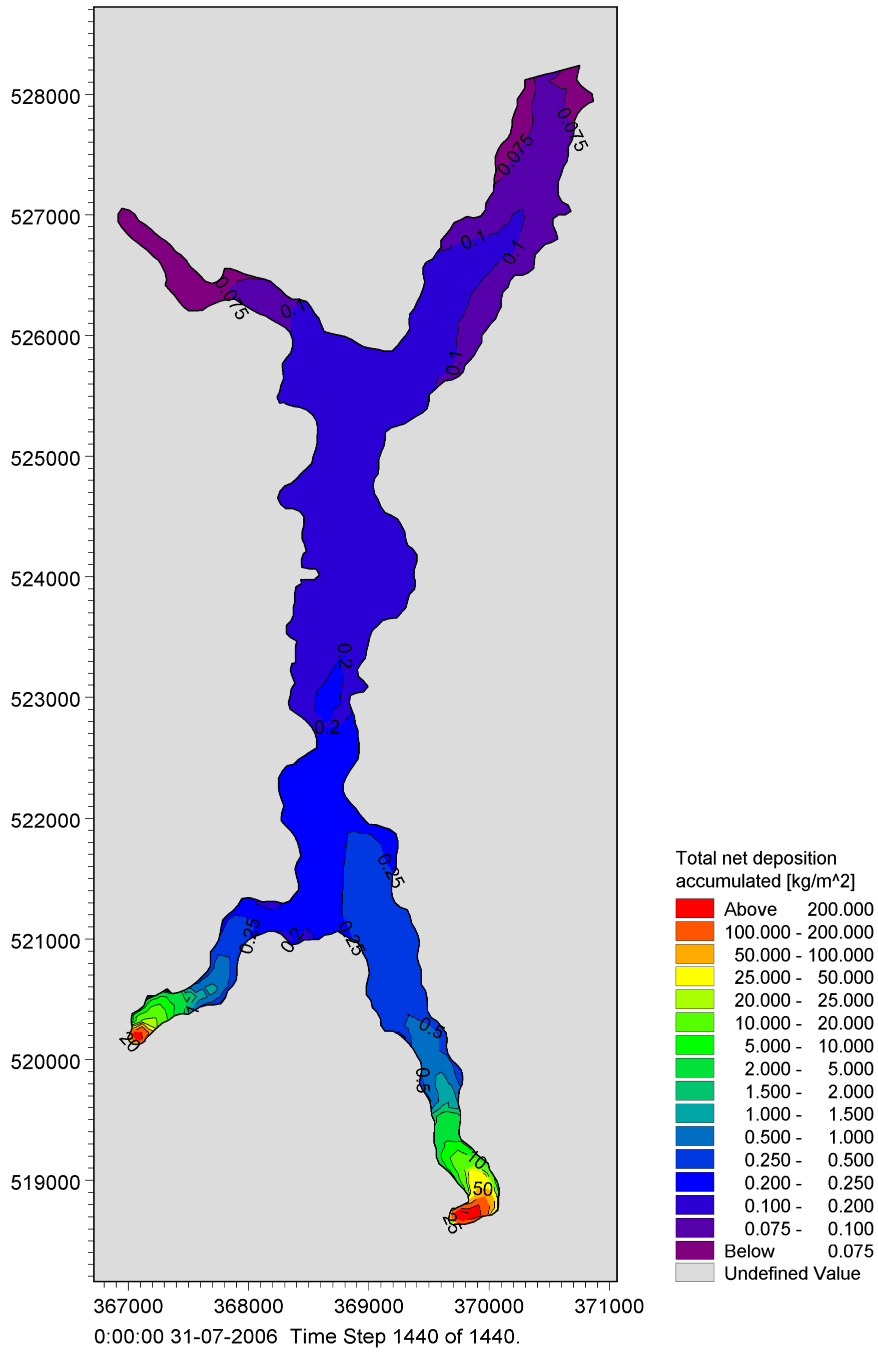

Figure 8.2.3 Distribution of Sedimentation in the Reservoir after a Two Month Simulation Period

8.2.1.5 SUSPENDED SEDIMENT CONCENTRATIONS

Average suspended sediment concentrations during mean river discharge are shown in **Figure 8.2.4**. Suspended sediment concentrations vary from 70 mg/l near the mouth of the entry point of the Padas River, to less than 5 mg/l near the dam wall. Such suspended sediments levels are well within those deemed suitable for fresh water fin-fish aquaculture i.e. Tilapia and/or fish species that may be introduced into the reservoir for recreational/food supplement purposes.

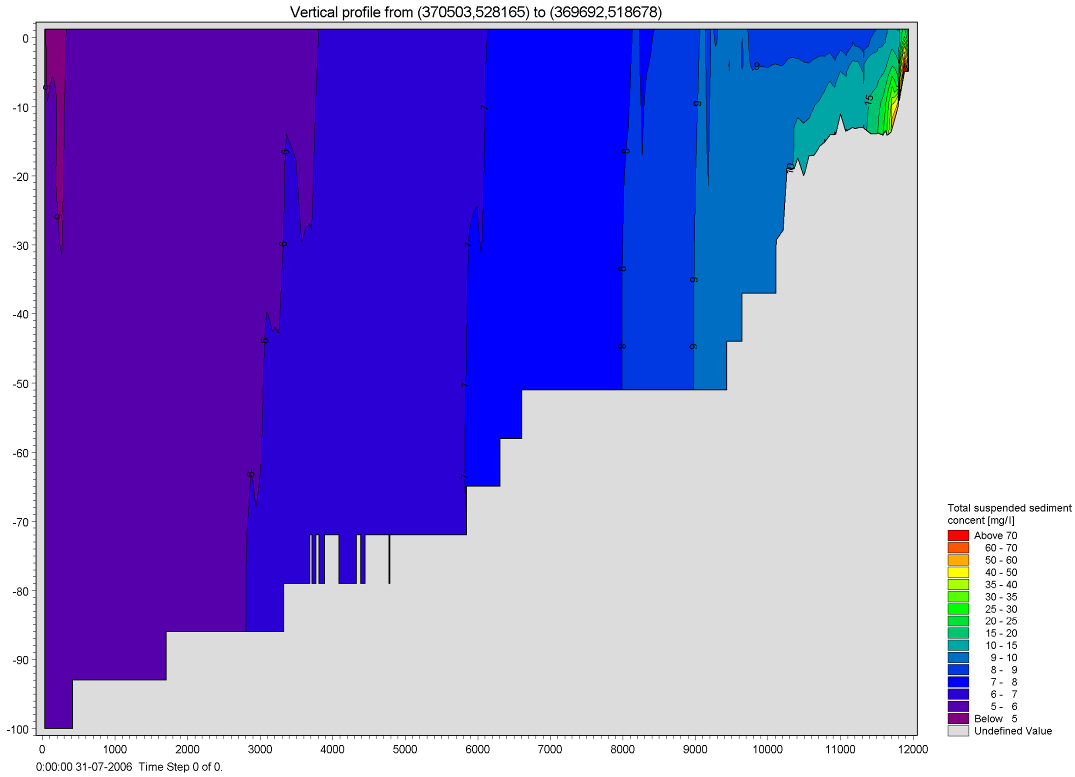

Figure 8.2.4 Vertical Profile Of Suspended Sediment Concentration Along The Reservoir Centreline (Dam Site To Upper Padas River) During Mean Flow Conditions

8.2.1.6 SEDIMENT DEPOSITION RATES AT HIGH DISCHARGES.

As with the normal conditions scenario sediment accumulation from the two river catchments is predicted not to spread uniformly across the reservoir (**Figure 8.2.5** and **Figure 8.2.6**). Initial sediment accumulation will again occur within the upper reaches of the reservoir. Unlike the normal conditions scenario there are two main peaks in the deposition. The smaller peak representing the deposition during the flood event (850 m^3/sec), which forces finer silts and clays further into the reservoir before being deposited approximately 1-2 km from the river mouth. During the normal flow period the bed load and coarser fraction e.g. fine sand will deposit near the very top of the reservoir while finer sediments e.g. silt and clay are transported further downstream. Most of this deposition will occur within 1 km of the Padas River mouth.

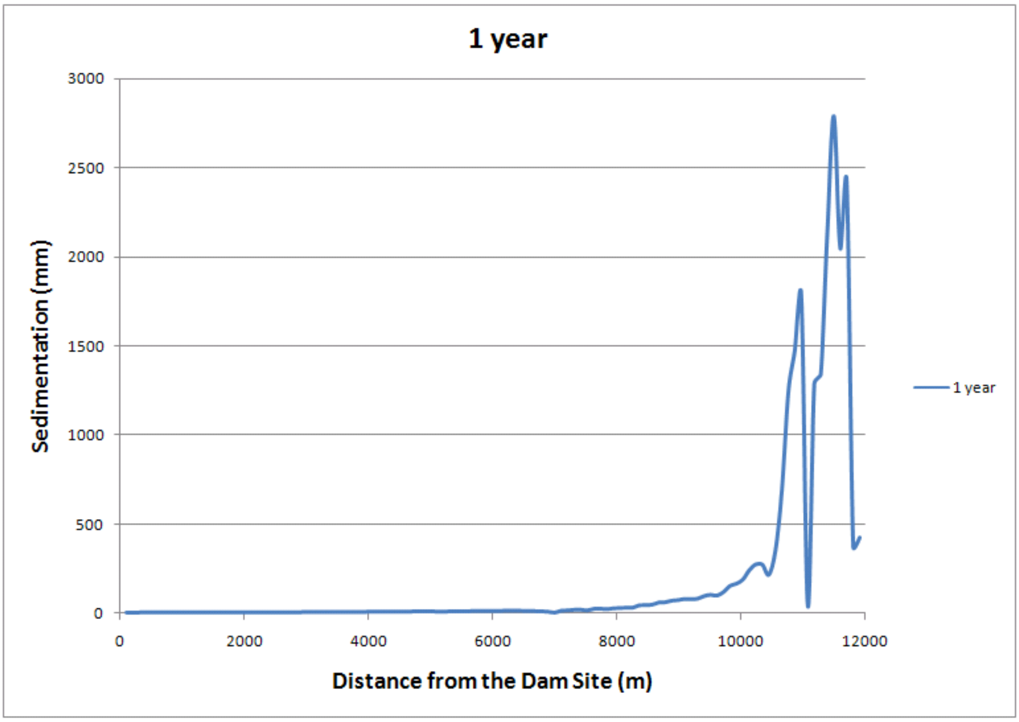

Figure 8.2.5 **Annual Sedimentation Rate Along The Reservoir Centreline (Dam Site to Upper Padas River (Based on a 1 year Simulation Period with High River Discharges)**

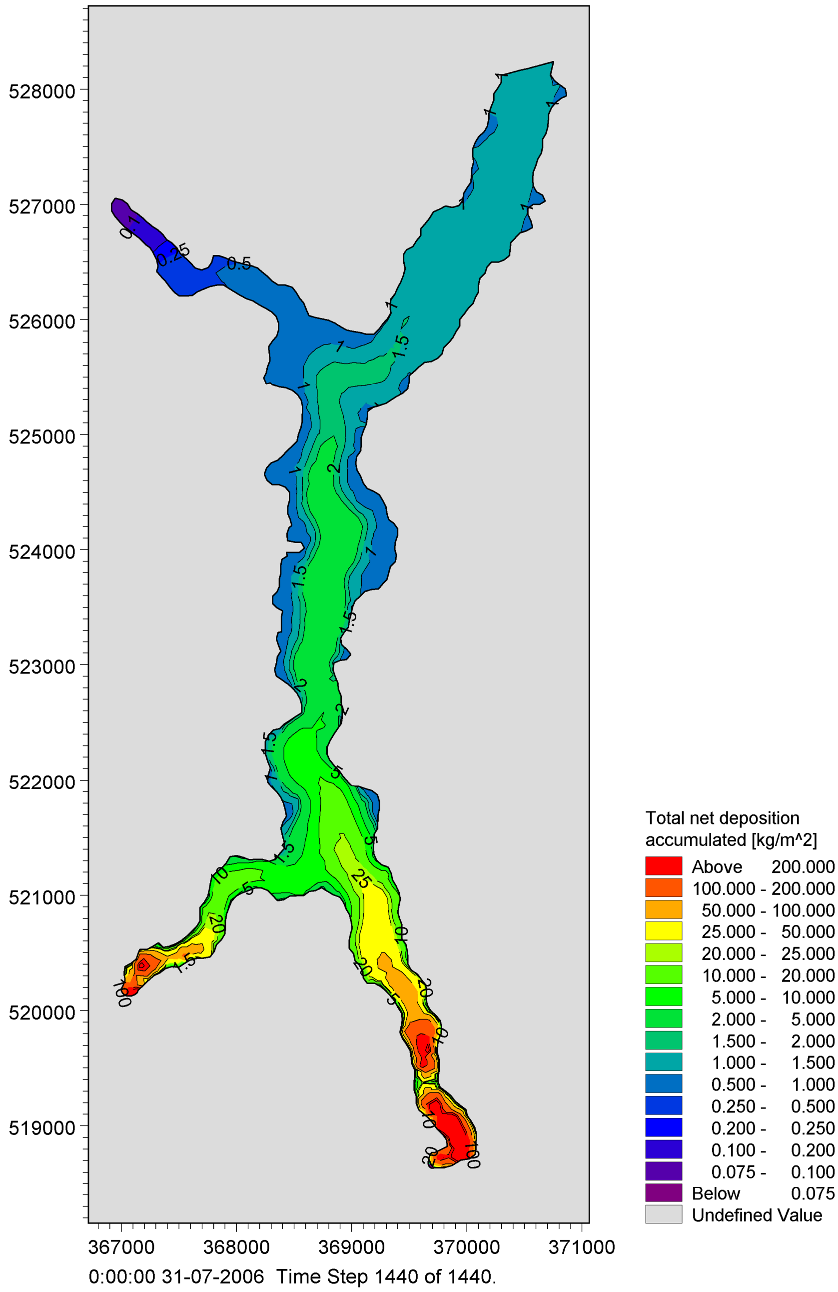

Figure 8.2.6 Distribution of Sedimentation in the Reservoir after a Two Month Simulation Period

In addition, model results extrapolated over a 50 year period, indicate that the total reservoir volume is much greater than total sedimentation accumulation, even after 50 years of deposition (**Figure 8.2.7** and **Figure 8.2.8**). **Figure 8.2.8** shows sediment deposition within the reservoir after 1 year, 5 years, 20 years and 50 years of deposition along the cross sections shown in **Figure 8.2.7**. These volumes are based on the current 2009 sediment load of the Padas river, as supplied by DID. While the upstream end of the reservoir will fill in relatively quickly, the remaining reservoir volume is vast and well beyond the life span of the dam itself. Currently the model indicates that after 50 years there will be approximately 18 million cubic meters of sediment deposited into the reservoir (**Figure 8.2.8**).

For an extreme worst case and improbable scenario; an order of magnitude increase in the sediment transport rate has been assumed. This would result in 180 million cubic meters of sediment deposited into the reservoir after 50 years. The total storage volume of the reservoir is approximately 221 million cubic meters, leaving some storage space even after assuming an almost impossible 10 fold increase in the current sediment transport rate of the Padas River.

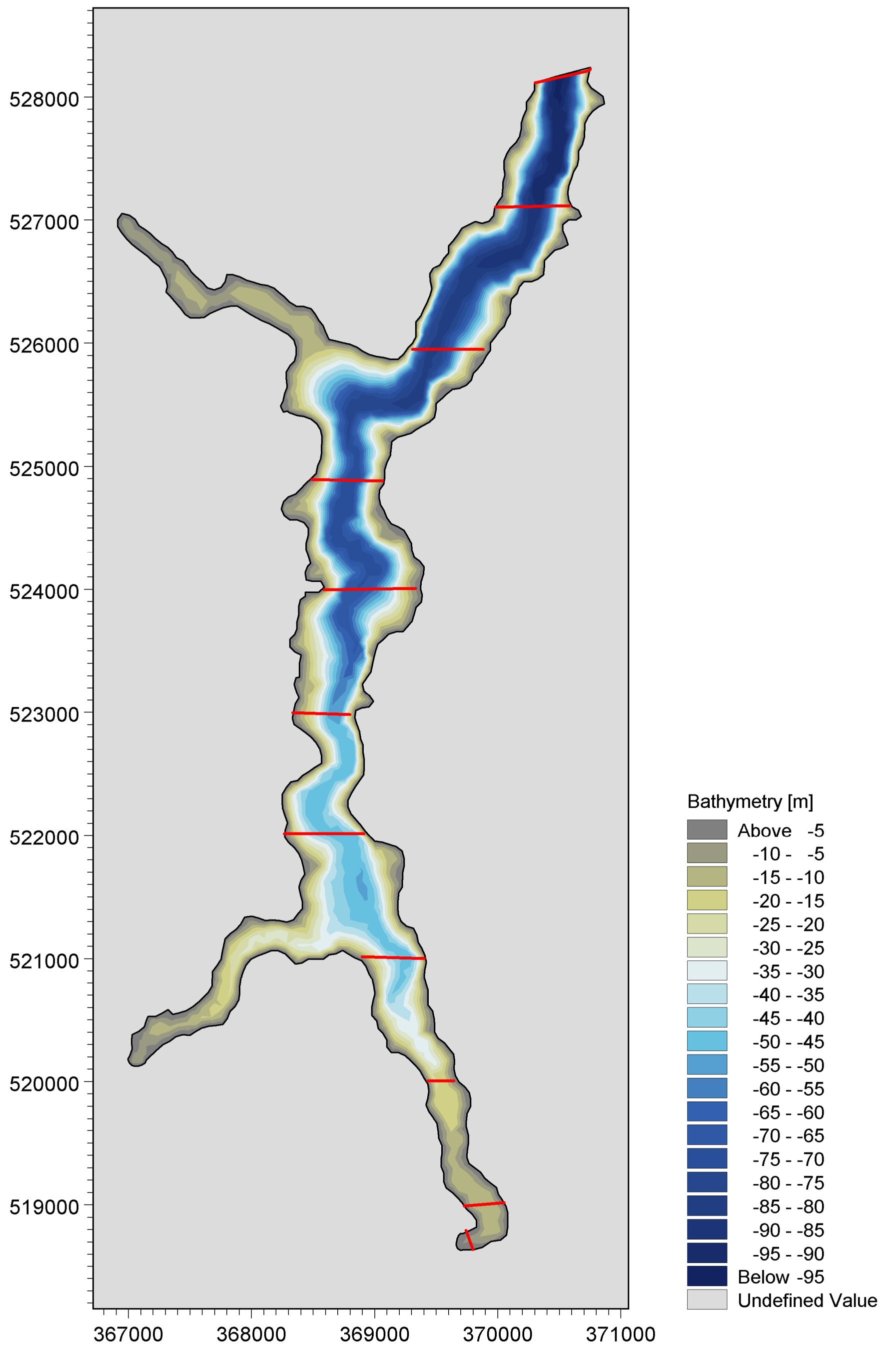

Figure 8.2.7 Cross Section Locations for Calculating Total Volume within the Main Reservoir Channel

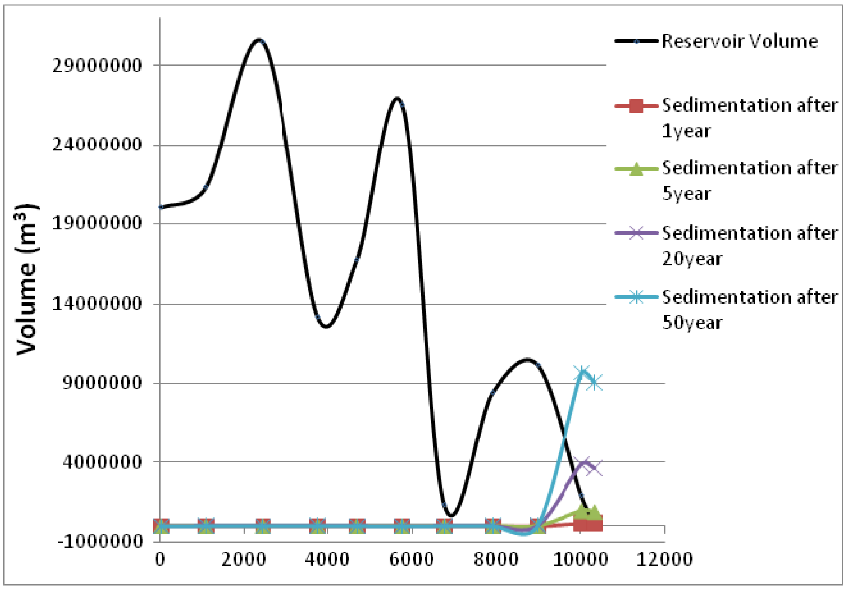

Figure 8.2.8 Cross Section Showing Total Sediment Accumulation After 1 Year, 5 Years, 20 Years and 50 Years

8.2.1.7 *SUSPENDED SEDIMENT CONCENTRATIONS AT HIGH DISCHARGES.*

Average suspended sediment concentrations during high river discharge periods are shown in **Figure 8.2.9**. Suspended sediment concentrations vary from 55 mg/l near the mouth of the entry point of the Padas River, to more than 15 mg/l near the dam wall. Suspended sediment concentrations near the river mouth are similar to those predicted during normal flow conditions, concentrations near the dam wall are significantly higher than those predicted during normal flow conditions. While they are considerably higher than those predicted during normal flow conditions they are still within levels deemed suitable for fresh water fin-fish aquaculture. These higher TSS levels are also infrequent and do not represent typical conditions expected in the reservoir.

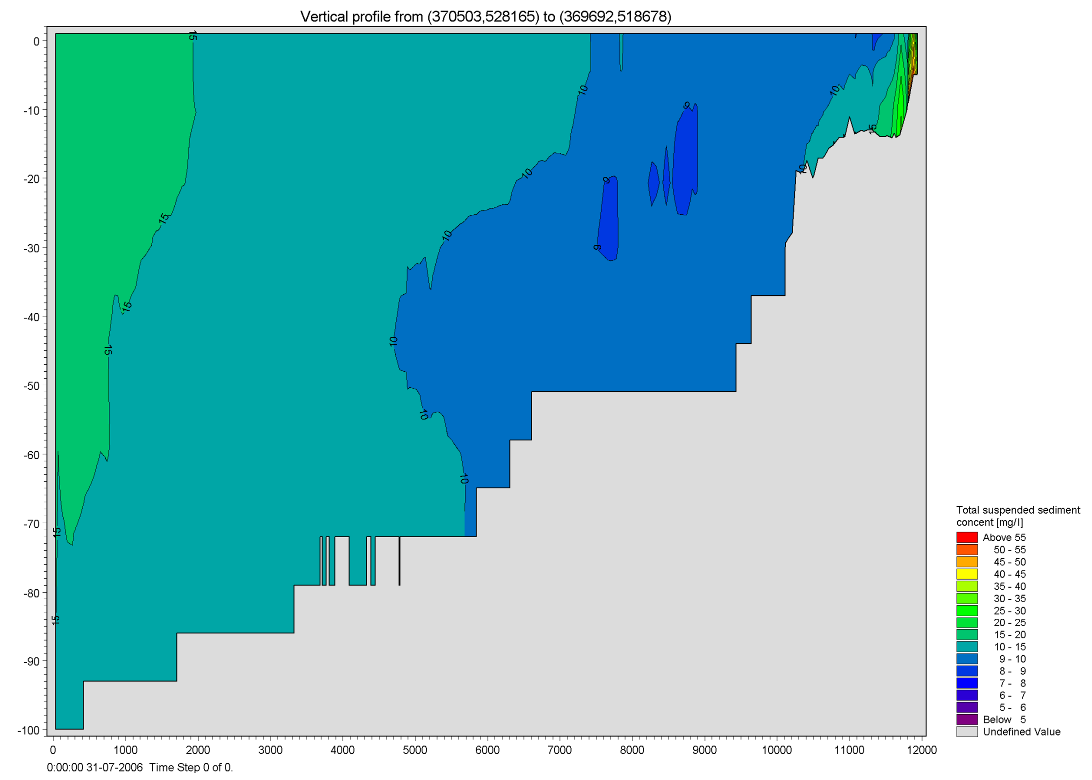

Figure 8.2.9 Vertical Profile of Suspended Sediment Concentration along the Reservoir Centreline (Dam Site to Upper Padas River) During High Flow Conditions

The potential effects of sediment capture and through flow include:

- A progressive reduction in active storage capacity, which would serve to reduce the capability of the reservoir to generate hydropower in the long-term.
- The flood response in the reservoir can change, albeit by only a small amount in this case (were it to be more pronounced, this could affect dam operation and safety).
- Turbines and other underwater structures can be damaged due to the abrasive action of silt carried through the reservoir.
- A change in the downstream sediment yields, with a corresponding impact on river morphology and potentially river entrance conditions.
- A potentially beneficial effect, albeit of quite small proportions, on the sediment problems experienced at the Tenom Pangi hydro station.

Likelihood = 1 (rare) Consequence = 4 (Major) Risk = High

8.3 Monitoring

This section exclusively deals with self monitoring activities. The monitoring schedule by government agencies or communities is considered outside the scope of this SEIA.

Self monitoring may be outsourced to an external specialist consulting company or individual or it may be carried out by in-house staff. In the latter case, an external consultant must be engaged for verification of monitoring results and reporting.

However, a note on community implemented monitoring is necessary as it in some cases may be seen as part of the joint management and participation of the communities as equal partners. As such, training in community implemented monitoring must be included in the Project activities and funding.

This report differentiates between monitoring and reporting. Monitoring is the recording of issues and events while reporting is the scheduled or contractual delivery of monitoring results to external parties or within the organisation. While monitoring always shall be reported internally, it is not necessarily all monitoring results that will be reported to external parties. The internal reporting will go upwards in the hierarchy but may also go downwards as information or as part of corrective instructions.

While reporting to external parties such as government agencies and financial institutions may follow a strict contractual schedule, monitoring shall be a constant state of alert to changes and unexpected events. The monitoring organisation shall be ready to receive monitoring information from any party at any time and it shall be capable of reaching the appropriate executives without delay in case the monitoring alert discloses issues that require urgent attention.

Monitoring may be divided into two categories: Compliance monitoring, which focuses on monitoring whether the organisation is following regulations and guidelines and monitoring of residual impacts, which deals with field measurements of expected and unexpected impacts that occur in spite of all the efforts put into avoiding such impacts.

The Consultant proposes that the monitoring schedule for the operation phase of this Project is taken up for review by the authorities after one year of operation.

8.3.1 COMPLIANCE MONITORING

The management of the Sabah Electricity Sdn Bhd has declared its dedication to pursue a policy of environmentally sound management and is thus determined to comply with all requirements as agreed with government agencies. Internally, non-compliance is therefore a disciplinary issue between employer and employees and in the case of contractors it shall be dealt with as breach of contract / non-compliance with the contract.

Compliance monitoring serves as a tool for analysis when the relationship between residual impact – or the lack of it – and Project implementation. Compliance is not a goal in itself. The objective is to minimise or remove any negative impact and to optimise benefits and opportunities.

But since compliance can be a matter of a legal dispute, the compliance monitoring shall as a minimum include monitoring, i.e. recording, of all mitigation requirements as described in the environmental agreement.

Recording of compliance will include:

A. Institutional Capacity Development

Records must be kept on all organisational issues that may affect environmental or social performance. Such records will be reference points to all performance standards of the Project and will therefore be needed in any contractual dispute.

The institutional capacity development monitoring will normally be implemented as part of normal, daily administrative duties of the management and its support staff. Verification may be done as part of regular audit systems.

The institutional capacity development monitoring includes i.a.:

- Recording of all new public policies of the Company in relation to environmental management.
- Recording of all institutional changes (setting up of new functions and responsibilities).
- Recording of training of staff dealing with environmental management.
- Rerecording of procurement of equipment and facilities for environmental management.
- Recording of all executive orders relating to social or environmental issues.
- Recording of all memoranda, work instructions, rules and procedures related to environmental management.

The monitoring shall also include recording of follow-up procedures, findings and corrective actions for each of the monitored points.

B. Organisational Cooperation

The social and environmental management of this Project may involve several organisations or individuals and new cooperation fora may be set up. Normally each individual or function in a company will be filing information and correspondence related to each such contact the person is in touch with. For this Project, a central filing system, which is accessible to management, environmental executives and environmental auditors must include copies of all such recording of organisational cooperation.

The central filing system must thus hold, as a minimum:

- Records of detailed planning and work instructions.
- Summary of minutes of meetings for water catchment management.
- Summaries of meetings or correspondence with government agencies.
- List of inspections received by government agencies.
- Description of facilities made available for external parties.

C. Progress

In addition to the company's records of physical progress in relation to contracts and development schedules, records shall specifically mention when environmental mitigation measures are being installed and their working conditions.

The Project shall thus:

- Record and file information pertaining to detailed planning and work instructions.
- Record progress of all issues and activities, for which there are environmental conditions.
- Record all break-downs and corrective actions taken for mitigating measures mentioned in the environmental conditions.
- Record status for all cleaning up after finishing of partial or whole activities.

It will be advantageous for the Project if records similarly shows issues pertaining to mitigation efforts implemented even though they are not imposed by the environmental conditions.

The monitoring may be done in a cooperation between the Project's contract team and the environmental organisation. Records and field evidence shall be verified by external verifiers or auditors.

D. Soils

The soils management is the key issue for negative impacts for this Project as loss of soil control may lead to deterioration of water quality, again leading to deterioration og aquatic habitat and thus threatening human livelihoods.

The soils protection plan includes several issues, which must all be monitored. These may be summarised as:

- Description of all implemented mitigation measures requested by the environmental agreement.
- Map of all cut and fill areas.
- Record road gradients exceeding 8% on road maps.
- Map and description of all measures taken to protect slopes from failures and land slides.

Daily records of most of the soils protection activities may be made by the site engineers but such records need to be verified by external auditors. It is important that all field mitigation efforts are mapped and geo-referenced.

E. Water

As mentioned above, water quality issues are mostly the consequences of other problems such as soil instability, decomposition of biomass and spillage of hazardous wastes.

There are, however a few issues directly related to water quality, that still have to be recorded with respect to construction and operation including break downs and repairs:

- Mapping and description of all tall riparian reserves.
- Mapping and description of all bridges and culverts.
- Mapping and description of all siltation ponds or systems.
- Mapping and description of all drainage systems.
- Mapping and description of all waste water disposal systems.
- Mapping of all oil and fuel depots and their distances to water courses.
- Mapping of garbage disposal sites.
- Mapping of excess earth disposal sites.

The other water issue is the flow regime. Compliance is here focused on maintenance of the environmental flow of 16 m^3/second. Other records may show actual release of water after the main turbines or through the spillway:

- Records of environmental flow.
- Records of release through the spillway.
- Records of release through the main turbines.
- Water level records from the reservoir.

Flow records will be part of normal operational procedures but must be verified and spot checked by external verifiers. The compliance monitoring for water quality control and protection will again be part of the daily routine by the site engineers but must also be verified by external auditors in connection with regular impact monitoring.

E. Wildlife

Wildlife protection falls basically in two groups plus the activities that ate implemented in order to ensure all staffs are aware of the wildlife issues: Non-poaching/exploitation and rescue. The Project shall in this connection

- Record and describe all activities taken to inform workers and staff about wildlife protection.
- Record and describe measures taken to directly prevent poaching.
- Record and describe activities taken to rescue stranded wildlife species.

The records may be established by the Projects environmental management team for external auditors to verify before reporting to the authorities.

G. Flora

As the Project shall avoid creating further destruction of habitats anywhere due to its procurement, records of all timber procurements must be kept and for each procured lot evidence must be obtained about its legality.

H. Biomass Removal

For reservoir, right-of-way and construction site clearing details shall be filed concerning:

- Detailed planning and work instructions.
- Progress and methodologies.
- Volumes removed from the site.
- Disposal of residual biomass.
- Use of fire and chemicals.

This monitoring of biomass removal compliance will normally be part of the company's daily monitoring of contractual progress and compliance. However, this work needs to be mapped and geo-referenced beyond the work expected of sub-contractors. This may be done by the Project Proponent staff or external consultant staff.

I. Traffic Safety

Traffic safety compliance mainly concerns instructions given to drivers, the safe conditions of vehicles and erection of proper road furniture (road signs, fenders). Any activity in these fields must be recorded as part of the compliance monitoring program.

J. Workers Health and Safety

This Social and Environmental Impact Assessment has i.a. focussed on workers' health and safety and several activities and issues have been included in the environmental management plan. The compliance with each of these requirements must be recorded as and when they occur and the records kept in an accessible place. The records will i.a. include:

- Detailed planning and work instructions.
- Description of awareness and training activities.
- Description of medical facilities and regular medical activities (worker's health checks).
- Issuance of safety clothing and equipment and the activities to ensure their use.
- Schedules of health checks for staff and families.
- Records of scheduled safety inspections of machines and equipment.
- Description of handling of hazardous substances and materials.
- Description of handling of domestic waste from offices and living quarters.
- Description of cleanliness inspections in canteens and eateries.
- Description of measures taken to control immoral activities and subsequent spread of diseases.
- Description of facilities for health and education for workers' families.
- Description of systems for provision of clean, potable water.

The monitoring of workers' health and safety may be done by the internal health and safety team in the field among the work shifts to the health clinic workers to the management inspectors. The records should be verified by external auditors.

K. Sewage and Domestic Waste

These issues are mostly dealt with under water quality and workers' health and safety.

In addition, all sewage systems must be recorded with technical descriptions and records of maintenance and repairs.

L. Construction Waste

When construction waste is created and disposed of, records must be made of the disposal method and place.

M. Scheduled Wastes

When scheduled waste is created and disposed of, records must be made of the disposal method and place.

N. Fire Control

Records must be made of the fire organisation and awareness activities:

- Description of organisation and alert mechanisms.
- Description and mapping of fire related logistics such as fire fighting equipment, pumps and water sources.
- Description of training of staff in fire prevention and suppression.
- Mapping of fire danger rating signs.
- Files containing instructions related to fire control.

O. Reservoir Management

This is dealt with under water flow.

P. Security Arrangements

The security management plan requires that the local communities are well informed about the arrangements and that security personnel is properly selected and trained so as to avoid unnecessary incidents.

The Project records must therefore clearly show:

- Security instructions and records of their summarized disclosure to nearby communities.
- Training records.
- Maps of security perimeter and installations.

Q. Community Relations

Community relations is an ever ongoing activity that constantly takes new directions depending on the mutual understanding between the parties and the level at which the parties decide to interact. To avoid misunderstandings and to ensure promises are being both made and kept records should be made as and when new developments take place:

- Detailed planning and work instructions.
- Record and summary of minutes of meetings with community participation: Issues, main arguments (by whom) and final decision.
- Record of acquisitions and compensations given.
- Record of grievances, the response given and the follow-up action taken.
- Record of all cultural sites discovered and the action taken.
- Training and information records.
- List of public notices, meetings or other awareness raising activities.
- List of compensations delivered for loss of rights, livelihoods.
- List of community development activities undertaken.

While the records may be made by the Project Proponent's section for corporate social responsibility or a similar section, they should be available for public scrutiny and inspection. Verification for reporting purposes must be made by external auditors or verifiers.

8.3.2 MONITORING OF RESIDUAL IMPACTS

The residual impacts are likely to be at different levels during the construction stage and the operation and maintenance stage. Nevertheless, residual impacts must be monitored with the same zeal and accuracy.

The objective of the impact monitoring is to create immediate awareness of impacts that need corrective action. The monitoring therefore acts as a tool in the analysis of cause and effects. The compliance monitoring monitors the cause while the impact monitoring provides information about the effect. The monitoring is thus not carried out just for the sake of a required reporting to the government agencies but equally much as part of the management information system parallel to progress reporting, financial reporting and similar internal analytical information.

The monitoring shall in principle be a constant state of alert and a constant level of gathering of social and environmental data. The data gathering is not supposed only to happen in connection with periodic reporting to the Government. The reporting to the government is rather a snapshot of the monitoring information available at the time of reporting.

Monitoring is not just recording of facts and the state-of-affairs.

Monitoring must include an analysis and a conclusion of cause-effect relations, of whether the observations are as expected or whether the parameters are exceeding or threatening to exceed permissible limits.

All issues mentioned in **Section 8.1: Residual Impacts**, must be monitored. The text below is a summary of the minimum requirements.

8.3.2.1 SOILS

The soil stability is a major concern of this Project. Any instability must therefore be recorded and analysed:

- Record all cases of landslides and slope failures within the Project area and its immediate vicinity but excluding the larger catchment area, whether Project induced or otherwise.
- Survey and record gully formation along the reservoir banks.

8.3.2.2 AIR

Air quality monitoring is recommended at locations as designated in **Table 8.3-1**. Refer to the sampling locations in **Map 8.3- 1 Proposed Air and Noise Monitoring Locations**. The objective of air quality monitoring is to ensure that the air quality in the Project's vicinity is maintained below the stipulated level or not worse than the baseline that was collected earlier on for this SEIA study. The parameters to be monitored are Total Suspended Particulates (TSP), Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2). However, the SO_2 and NO_2 monitoring is only proposed at MA1-MA3, i.e. near the main power house as it is mainly expected to be generated at this area and the existing baseline levels are found to be considerably high. The compliance limit for TSP is equivalent or below 260 $\mu g/m^3$ over 24 hours while for NO_2 is up to 320 $\mu g/m^3$. As for SO_2 compliance, it should not exceed the existing baseline level of 124 $\mu g/m^3$ for MA1 and 105 $\mu g/m^3$ for MA2 and MA3.

Additional sampling locations may be added wherever and whenever necessary at different stages of the Project. Priority shall be given to representative residence sites near construction activities.

In any instances where the levels of the parameters above exceed their respective limits as stipulated in the Malaysian Ambient Air Quality Guidelines (MAAQG) or existing baseline levels, the causes should be identified and corrective actions should be taken immediately to restore the exceedances below the stipulated limits.

Table 8.3-1 Proposed Air Quality Monitoring Points

Points*	Location	Longitude (E)	Latitude (N)	Parameters	Compliance	Frequency*
MN1	Bridge near Powerhouse Site, Tomani	115^{0}51’30.5”	04^{0}51’48.5”	Total Suspended Particulate (TSP), SO_2 and NO_2	Malaysian Recommended Guidelines for Gaseoues and Pollutants (MRGGP) TSP: 260 µg/m^3 SO_2: 105 µg/m^3 NO_2: 320 µg/m^3	Quarterly
MN2	Residential area, Kg. Katambalang Baru, Tomani	115^{0}52’05.9”	04^{0}51’32.9”			
MN3	Residential area, Kg. Kaliwata Lama, Tomani	115^{0}52’40.5”	04^{0}51’04.6”			
MN4	Residential area, Kg. Marais, Tomani	115^{0}52’40.0”	04^{0}51’46.9”			
MN5	Proposed access road area, Lembaga Industri Getah Tomani	115^{0}51’19.3”	04^{0}49’56.7”			
MN6	Residential area, Kg. Kungkular	115^{0}42’38.0”	04^{0}41’00.5”			
MN7	Residential area, Kg. Sugiang Tengah	New locations established based on final alignment option chosen by the Project Proponent. These differ from some of the baseline sampling locations. Hence, exact GPS coordinates are not available at present. The exact monitoring locations shall be based on the nearest settlement of the villages concerned to the finalised transmission line.				
MN8	Residential area, Kg. Baru Jumpa					
MN9	Residential area, Kg. Paal					
MN10	Residential area, Kg. Sapong					
MN11	Residential area, Kg. Amboi					
MN12	Residential area, Kg. Pakiak					
MN13	Residential area, Kg. Marau					
MN14	Residential area, Kg. Kaban	115^{0}35’58.8”	04^{0}59’41.3”			
MN15	School area, SK Lubang Buaya	115^{0}34’49.0”	04^{0}59’38.4”			

Note: * Monitoring points might change in tandem with the progress and period of construction

8.3.2.3 NOISE

Noise monitoring shall be carried out to ensure that the noise levels at sensitive areas do not exceed levels stipulated by the Department of Environment (DOE) Malaysia under Schedule 6 of the Permissible Sound Level (see **Appendix 5-3: Schedule of Permissible Sound Levels, Department of Environment, 2004**). The noise nuisance will be mainly during construction stage of the Project.

Noise monitoring is to be carried out at the selected locations as indicated in **Table 8.3-2** and depicted in **Map 8.3- 1 Proposed Air and Noise Monitoring Locations**.

The sampling locations are subject to change whenever and wherever necessary during the construction stage of the Project. Priority would be given to representative residence near construction activities. Noise monitoring should be undertaken to cover 1 hour at the time frame of 7.00 a.m. to 7.00 p.m. (daytime) and another hour at the time frame of 7.00 to 10.00 p.m. (night time).

Table 8.3-2 Proposed Noise Level Monitoring Points

<table>
<tr><th>Points*</th><th>Description</th><th>Longitude (E)</th><th>Latitude (N)</th><th>Compliance</th><th>Frequency*</th></tr>
<tr><td>MN1</td><td>Bridge near Powerhouse Site, Tomani</td><td>115°51’30.5”</td><td>04°51’48.5”</td><td rowspan="15">Schedule 6 of DOE’s Planning Guidelines for Environmental Noise Limits and Control.

Day Time:
L_{90}=60 dBa
L_{10}=75 dBA
L_{max}=90 dBA

Night Time:
L_{90}=55 dBA
L_{10}=70 dBA
L_{max}=85 dBA</td><td rowspan="15">Quarterly</td></tr>
<tr><td>MN2</td><td>Residential area, Kg. Katambalang Baru, Tomani</td><td>115°52’05.9”</td><td>04°51’32.9”</td></tr>
<tr><td>MN3</td><td>Residential area, Kg. Kaliwata Lama, Tomani</td><td>115°52’40.5”</td><td>04°51’04.6”</td></tr>
<tr><td>MN4</td><td>Residential area, Kg. Marais, Tomani</td><td>115°52’40.0”</td><td>04°51’46.9”</td></tr>
<tr><td>MN5</td><td>Proposed access road area, Lembaga Industri Getah Tomani</td><td>115°51’19.3”</td><td>04°49’56.7”</td></tr>
<tr><td>MN6</td><td>Residential area, Kg. Kungkular</td><td>115°42’38.0”</td><td>04°41’00.5”</td></tr>
<tr><td>MN7</td><td>Residential area, Kg. Sugiang Tengah</td><td colspan="2" rowspan="7">New locations established based on final alignment option chosen by the Project Proponent. These differ from some of the baseline sampling locations. Hence, exact GPS coordinates are not available at present. The exact monitoring locations shall be based on the nearest settlement of the villages concerned to the finalised transmission line.</td></tr>
<tr><td>MN8</td><td>Residential area, Kg. Baru Jumpa</td></tr>
<tr><td>MN9</td><td>Residential area, Kg. Paal</td></tr>
<tr><td>MN10</td><td>Residential area, Kg. Sapong</td></tr>
<tr><td>MN11</td><td>Residential area, Kg. Amboi</td></tr>
<tr><td>MN12</td><td>Residential area, Kg. Pakiak</td></tr>
<tr><td>MN13</td><td>Residential area, Kg. Marau</td></tr>
<tr><td>MN14</td><td>Residential area, Kg. Kaban</td><td>115°35’58.8”</td><td>04°59’41.3”</td></tr>
<tr><td>MN15</td><td>School area, SK Lubang Buaya</td><td>115°34’49.0”</td><td>04°59’38.4”</td></tr>
<tr><td colspan="6">Note: * Monitoring points might change in tandem with the progress and period of construction</td></tr>
</table>

8.3.2.4 WATER

Water quality monitoring at the affected areas of the Upper Padas Hydroelectric Project shall also be undertaken. The proposed monitoring locations are as in **Table 8.3-3** and illustrated in **Map 8.3- 2 Proposed Water Quality Monitoring Locations**.

The water quality monitoring results shall be compared to Class IIA/IIB of the Interim National Water Quality Standards (INWQS) while for parameters such as nitrate nitrogen and total phosphorus, the levels shall be compared to the average baseline levels detected. Refer to **Table 8.3-4** for the list of water quality monitoring parameters. The table also marks the parameters, which will be recorded *in-situ*.

Table 8.3-3 Proposed Water Quality Monitoring Locations

Points*	Description	Longitude (E)	Latitude (N)	Compliance	Frequency*
Upper Dam				Class IIA/IIB (INWQS) / Baseline Levels	Quarterly
MW1	Sg. Meligan, at the cement bridge	115^{0}42’31”	04^{0}40’58”		
MW2	Sg. Padas, at the cement bridge	115^{0}45’39”	04^{0}29’05”		
MW3	Sg. Padas, upstream of the dam site	115^{0}49’52”	04^{0}46’06”		
MW4	Sg. Padas, near dam site	115^{0}49’56”	04^{0}46’36”		
MW5	Sg. Padas, upstream of the secondary power house	115^{0}49’33”	04^{0}47’09”		
Dam – Tailrace					
MW6	Tributary into Sg. Padas	115^{0}50’35”	04^{0}50’41”		
MW7	Sg. Padas, upstream of main power house	115^{0}50’46”	04^{0}51’31”		
Power House – Tomani					
MW8	Sg. Padas, upstream of main power house, before the bridge	115^{0}51’31”	04^{0}51’50”		
MW9	Sg. Padas, downstream of main power house	115^{0}52’12”	04^{0}51’34”		
MW10	Sg. Tomani	115^{0}53’19”	04^{0}50’51”		
Transmission Lines (Tomani – Tenom)					
MW11	Sg. Padas, near Kemabong	115^{0}55’12”	04^{0}54’34”		
MW12	Unnamed tributary into Sg. Padas, besides intersection to Sipitang	115^{0}55’11”	05^{0}00’30”		
MW13	Sg. Padas, near main road to Kg. Sapong	115^{0}56’56”	05^{0}03’39”		
MW14	Sg. Padas, near Kg. Cinta Mata	115^{0}56’24”	05^{0}06’38”		
Transmission Lines (Tenom – Sipitang Highway)					
MW15	Bridge crossing, tributary into Sg. Mengalong	115^{0}46’38”	04^{0}59’53”		
MW16	Sg. Mengalong, near Kg. Solob	115^{0}45’27”	04^{0}59’24”		
MW17	Sg. Mengalong, near Kg. Malaman	115^{0}39’16”	05^{0}00’19”		
MW18	Sg. Mengalong	115^{0}37’32”	05^{0}00’43”		
MW19	Bridge crossing, Sg. Mengalong, besides the Sipitang-Tenom Road	115^{0}32’55”	05^{0}00’01”		

Note: * Monitoring points might change in tandem with the different stages of the Project.

Table 8.3-4 Water Quality Parameters

List of Parameters	
Ammoniacal Nitrogen	Faecal Coliform
Biochemical Oxygen Demand	Total Coliform
Chemical Oxygen Demand	Oil and Grease
Dissolved Oxygen *	Salinity
pH*	Nitrate Nitrogen#
Conductivity*	Total Phosphorus#
Temperature*	Turbidity (NTU)
Total Suspended Solids	

Note: ** parameters to be recorded in-situ.*

 # parameters to be monitored only at upstream of the dam site (MW1-4).

8.3.2.5 WILDLIFE

The Project Proponent and his contractors shall work very close with the Wildlife Department during inundation as this is the period where wildlife is chased from their home territories and may not succeed escaping or settling in new areas, which may already be occupied.

The Project Proponent shall therefore at the advice of the Wildlife Department keep records of stranded animals, observation of deaths or uncommon behaviour of animal species chased out of their home ranges.

It is anticipated the Project will be able to control poaching and hunting. Nevertheless, the Project must keep records of:-

- All known cases of poaching and illegal collection of forest resources within the reservoir site.
- Sightings of protected and/or endangered wildlife species.

The Project shall also make bi-annual fish surveys in the reservoir and downstream and analyse changes.

8.3.2.6 FLORA

The major impact of the Project on the flora is the clearing and inundation of the reservoir.

The Project Proponent and his contractors must keep records of volumes of timber salvaged by the clearing contractor or others, areas and volumes burnt and how much is left to decompose aerobically.

When clearing and particularly during inundation, it will be possible to assess the flora in the 'former' canopy. Since the Padas valley is known to be rich in orchids and other epiphytes, the Project Proponent shall facilitate impact studies on these communities by competent parties such as the government agencies, universities or environmental consultants.

8.3.2.7 WORKERS HEALTH AND SAFETY

Even if all precautions are taken, there are bound to be cases of accidents or threats to the workers' health or safety in a large working environment like the proposed Project. The Project Proponent and his contractors must therefore:-

- Record all incidents and accidents related to work and transportation.
- Record statistics from the medical facilities on general health level of the work force.
- Record number of workers that have retired from the job citing health reasons.
- Report births and deaths among families staying within the facilities.
- Record illicit gambling, drinking and immoral establishments feeding off the Project work force.
- Monitor noise level at the Project site to ensure it does not exceed Schedule 6 of DOE's guidelines at the work sites.

8.3.2.8 COMMUNITY HEALTH AND SAFETY

The monitoring issues related to community health protection are listed in **Table 8.3-5**.

Table 8.3-5 Community Health Monitoring Parameters and Locations

Parameters	Monitoring Locations	Frequency	Standard / Guidelines
Mosquitoes			
The assessment of the population of medically significant mosquitoes	▪ Kg. Ketanun ▪ Kg. Kungkular ▪ Kg. Melutut ▪ Kg. Titiku ▪ Tomani ▪ Ulu Tomani	Baseline	Nil
		Monthly - Construction Stage Quarterly - Operational Stage	Reference to baseline levels
Statistical public health surveillance of the following diseases: ▪ Malaria ▪ Dengue ▪ Japanese Encephalitis ▪ Yellow Fever	Hospital Tenom Hospital Sipitang Local private and public clinics in the surrounding region	Monthly – All Stages	Reference to baseline levels contained in **Section 6.8.11**of this report.
Electromagnetic Fields			
The assessment of EMF exposure to communities surrounding the transmission line corridor	All communities located adjacent to the transmission line corridor, for the length of the proposed transmission lines.	Annually – Operation Stage	Reference to International Commission on Non-Ionising Radiation Protection (ICNIRP) reference levels

Parameters	Monitoring Locations	Frequency	Standard / Guidelines
Statistical public health surveillance of the following diseases: ▪ Leukaemia ▪ Cancer ▪ Neurodegenerative diseases ▪ Developmental disorders	Hospital Tenom Hospital Sipitang Local private and public clinics in the surrounding region	Annually – Operation Stage	Reference to baseline levels contained in **Section 6.8.11**of this report.
Drinking Water			
The assessment of downstream river water quality	At key locations to a suitable distance downstream, adjacent communities and population centres	Quarterly – All stages	Reference to baseline levels contained in **Section 4.8, Zone 6** of this report.
Statistical public health surveillance of the following diseases: ▪ Waterborne diseases (gastroenteritis, giardiasis, cryptosporidiosis, etc)	Hospital Tenom Hospital Sipitang Local private and public clinics in the surrounding region	Prior to Construction Stage	Baseline
		Quarterly – All stages	Reference to baseline statistics

The environmental management plan maintains a priority for community safety in the vicinity of the Project site(s). The objective is to avoid negative influences from a large workforce and to avoid any form of confrontation between the Project and the communities. Negative incidences must be analysed and precautions taken to avoid repetition if any negative events occur.

The Project's registers must therefore contain the following information, which must be fully updated at all times:

- From police records, maintain a report on fluctuations in crime level involving the Project work force or otherwise connected to the Project.
- From security reports maintain a register of all security breaches / intrusions / confrontations between security personnel and outsiders.
- Assess new appearances or disappearances of local shops, workshops or other enterprises near the construction sites.
- Record proportion of the work force originating from the vicinity of the construction site(s).
- Record if the reservoir or other Project facilities have caused influx of tourism or other recreational uses.
- Record if any major show of public dissatisfaction has occurred, whether from local communities or by external groupings. Assess the background for such show of dissatisfaction.

8.4 REPORTING

8.4.1.1 INTERNAL REPORTING

Monitoring reports shall be circulated to senior management staff and a record must be maintained of such circulation. The reports shall clearly point out when residual impacts threaten to exceed agreed threshold values and what mitigating actions have proven inadequate to maintain the environmental targets.

The management staff must, as a result of this reporting, issue a directive for corrective measures.

8.4.1.2 REPORTING TO THE GOVERNMENT

All issues mentioned in **Sections 8.3.1**, **Compliance Monitoring** and **8.3.2**, **Monitoring of Residual Impacts** must be reported to the Environment Protection Department.

Reporting to the Environment Protection Department of monitoring results plus of the directives issued for corrective actions must submitted quarterly to the Environment Protection Department. If the monitoring reports are established by internal staff, these reports must be verified by an external verifier.

The reports shall be in a format that satisfies the Environment Protection Department requirements and shall include laboratory results, maps and photographs as well as textual descriptions.

The Project Proponent shall, in addition, report to the Environment Protection Department when the Project goes from one stage to another, i.e. when planning is completed, when diversion is effectuated, when construction of major components is completed, when biomass clearance takes place in the reservoir, when inundation is initiated and when the reservoir reaches operational level and when operation starts etc.

Monitoring results shall be publicly accessible in hard copy in the Project Proponent's offices or on the Project Proponent's Internet website.

If monitoring shows drastic changes of a parameter, such changes shall immediately be reported to the Environment Protection Department and other relevant government agencies accompanied with a description of the corrective actions planned or a request for advice on how to take such corrective action.

8.4.1.3 REPORTING TO FINANCING INSTITUTIONS

The financial institutions supporting this Project may require separate, verified reports. Such reporting is outside the scope of this Special Environmental Impact Assessment to describe.

8.4.2 DISCLOSURE

The monitoring results and corrective actions must be made available to the public on the internet and as hard copies in the Project office. In cases where there may be a danger of imminent threats to the public health or welfare, appropriate action must be taken by the Project owner to alert and advise the communities that may be affected.

8.5 SUMMARY

Table 8.5-1 summarizes the residual impacts.

Table 8.5-1 Summary of the Risk Level of Residual Impacts

Residual Impact	Likelihood	Consequences	Risk Level
PREPARATION & CONSTRUCTION			
Seismic	1	4	High
Diversion Tunnels			
Landscape Impact	4	1	Moderate
Sediment/Erosion	3	2	Moderate
DAM CONSTRUCTION			
Landscape Scarring	4	1	Moderate
Sediment/ Erosion	4	3	High
Dust	4	2	High
RESERVOIR IMPOUNDMENT			
Reduced Downstream Flow			
River Morphology	3	2	Moderate
Aquatic Fauna Habitat	4	3	High
Riparian Flora	4	3	High
Reservoir Filling			
Loss of Vegetation Biodiversity	2	2	Low
Fragmentation of Wildlife Habitat	3	2	Moderate
DAM OPERATION			
Vegetation Decomposition			
Water Quality	2	2	Low
Sedimentation of Reservoir	2	4	Moderate
Reduced Storage Capacity	2	4	High
Reduced Downstream Flow			
River Morphology	3	2	Moderate
Aquatic Fauna Habitat	4	3	High
Riparian Flora	4	3	High
Public Health	3	3	High
Dam break	1	5	High

While attention needs to be paid to the all the residual impacts, those indicated as representing high risk should be given constant and specific attention.

These should have a central focus in the monitoring programme. Appropriate actions where impacts begin to affect persons or the Project significantly will depend on the particular circumstances. In some cases, it may be necessary to delay activities while an issue is being resolved.

CHAPTER 9 ECONOMIC VALUATION

9.1 INTRODUCTION

This section specifically covers the analysis of the environmental economics of the development and operation of the proposed Upper Padas Hydroelectric Project. But for completeness, a valuation of the impacts upon the environment, economy and society is also provided. The report identifies the costs and benefits associated with the impacts of the proposed Project including:

- Value of the benefits in terms of revenue from the generation of the electric power, and employment creation.
- Value of the environmental and social impacts of the proposed Project.

It also sums up these values into a total economic value (TEV) framework.

The TEV is not a formal decision-making tool like cost benefit analysis, but it can be used to illustrate the aggregated extent of environmental impacts of a project. It is an estimate of the total, rather than the incremental, value of the environmental impacts of the Project to society. TEV addresses not only market benefits, such as hydropower generation or market losses such as a decline in timber, but also the public goods and externalities that such inundations of forests would create. Various impacts of the project upon various stock and flow of environmental goods and services could be computed and summed into a single aggregated value The option value and non-use values often associated with such project impacts are given due recognition alongside the traditional use values attached to environmental goods. This would then allow the issue of irreversibility and potential disturbances and losses to be addressed in a value analysis. The option and nonuse values that are measured in monetary terms can carry similar weight in the analysis of the costs and benefits of a project where environmental goods are at stake and thus provide a platform for the consideration of the environment within the project approval decision making.

9.2 SCOPE OF THE STUDY AND IDENTIFICATION OF STAKEHOLDERS

This Project is initiated by the Sabah Electricity Sdn Bhd (SESB), following identification of the Padas River south of Tenom as one of the most promising sites for hydroelectric generation. Given that the future power and energy demand in Sabah will certainly increase. Annual energy output of the UPHEP will be about 940 GWh. There will be beneficial effect of regulation from UPHEP to Tenom Pangi, which increases its annual energy production by approximately 22 GWh. The installed capacity of UPHEP is likely to be in the range 150 to 210 MW. The overall target of the construction schedule is to minimise the total construction time and bring the power plant to full commercial operation by earliest approximately end of 2014.

9.2.1 PROJECT AREA DESCRIPTION

The Upper Padas Hydroelectric Project is located in the south-western part of Sabah. The Upper Padas HEP catchment area is located upstream of the dam. The reservoir area falls under the Sabah Forest Industries (SFI) commercial forest reserve and covers approximately 5.9 km^2 or 590 ha, involving three rivers, namely Padas River, Maligan River and Ketanun River. The eastern part of the reservoir is topographically steep, making it unsuitable for logging and forest plantation activities.

Hence, the area which covers about 911 ha has been delineated by SFI as conservation area.

There are no settlements, archaeological, historical, and cultural artefacts and structures with religious or ritual significance within the reservoir and dam site. The proposed powerhouse site is located within Tenom District, next to a small island in the Upper Padas River about 16 km downstream of the dam site and another 3 km upstream of the Kuala Tomani. The area is accessible by the existing rubber estate access from Kuala Tomani along the south side of Upper Padas River. At present, there is no access road between the powerhouse and dam site. In terms of land use, the powerhouse site itself has no settlement.

The power from the Upper Padas Hydroelectric Project will be evacuated via transmission lines to be connected to the SESB Grid at the following injection points:

- At Tenom town via a 132 kV double circuit line – This line to Tenom town would approximately follow the existing road between Kuala Tomani and Tenom, to the west of Upper Padas River. The line length would be approximately 33 km.
- At Sipitang via a 275 kV double circuit line. – There are three alignment options to Sipitang, which are yet to be finalized by SESB.

9.2.2 DIRECT PROJECT COST AND REVENUE

The components of the Project include the following:

- A reservoir with surface area of full supply level (FSL) of 5.9 km^2 and a regulation storage capacity of 221.4 mil m^3.
- A Roller Compacted Concrete (RCC) gravity dam will create the reservoir with a gated main spillway in the central part of the dam.
- A power intake located as a separate structure adjacent to the upstream face of the dam.
- A long concrete lined headrace tunnel connected to a surge shaft located at the downstream end of the tunnel, followed by a long underground steel lined tunnel to the valve house located just outside of the tunnel portal.
- A long steel penstock in open air down to a 150 – 210 MW power house, equipped with a 3 Francis turbine units (3 x 50 to 3 x 70 MW) situated above ground at the Upper Padas River and located some 3 km upstream of the Padas bridge at Tomani.
- A tailrace canal, with a length of 300 m (approximate) to return the generation flows to the Upper Sg. Padas.

- Two (2) sets of transmission lines – one from the power house to Tenom and the other to Sipitang.
- Establishment of construction camps, access roads and residential housing.

The minimum discharge and release of water at the dam site for environmental reasons has been agreed (by DID) as 16 m^3/s. This will be discharged to the Padas River channel immediately downstream of the dam on a continuous basis. To exploit the energy potential from the environmental release and the average pressure head of some 88 m created by construction of the dam, it is proposed to construct a secondary power station having an installed capacity of some 14 MW. The power station will likely be configured in 2 units and will provide an annual energy production of some 103 GWh.

Power from the secondary power station will be evacuated by 133 kV transmission line to the main substation located close to the main power station. The establishment cost for the UPHEP is MYR 1.7 bil computed by updating cost information from SWECO International (2000) on the Feasibility Study on Upper Padas River Hydropower Project for the Sabah Electricity Sendirian Berhad. A breakdown of the cost is provided in **Table 9.2-1**. The annual operational and management cost is assumed to be MYR 9.1 mil.

Table 9.2-1 Cost of Establishing the Project

Investment Cost	MYR (mil)
General Works	228.9
Civil Works	940.9
Mechanical Works	136.4
Electrical Works	149.6
Transmission Line	54.9
Engineering and Supervision	151.1
Total	1661.8

Once the Project is operational it would generate a cascade of electric power of about 1,065 GWh. To estimate the economic value of these power generation, an economic price is used which is based on the opportunity cost concept of the cost of supplying electricity from the next best source of generation. Taking the price received by renewal energy provider using biomass of MYR 0.020.4 per KWh as the basis, the annual revenue is computed as MYR 217.3 mil per year.

9.3 STAKEHOLDERS OF THE PROJECT

The first step in carrying out a TEV of the impacts of the project is to identify the stakeholders affected by the action, and to understand their concerns and interests in the project proposal. Primary stakeholders include affected communities such as hydropower power generators, rubber smallholders and farmers, tourist operators and fishermen. See **Table 9.3-1**.

Table 9.3-1 Stakeholders Affected by the Project

Stakeholders	Concerns and Interests	Comments
Project Proponent	Sabah Electricity Sdn Bhd (SESB), to generate Hydroelectric to meet future power and energy demand in Sabah. Annual energy output of the UPHEP will be about 940 GWh from an installed capacity in the range 150 to 210 MW. There will be beneficial effect of regulation from UPHEP to Tenom Pangi, which increases its annual energy production by approximately 22 GWh. In undertaking the Project, SESB would have to incur costs on reservoir establishment, dam, spillway and hydropower plant construction, and transmission-lines from powerhouse to Tenom and Sipitang.	The revenue of the UPHEP is the value of hydro electricity generated. The value of the electric power generated could be computed by using the price of electric power sold by independent power plants to SESB
Sabah Forest Industries	The reservoir area falls under the Sabah Forest Industries (SFI) commercial forest reserve and covers approximately 5.9 k m^2 or 590 ha, involving three rivers, namely Padas River, Maligan River and Ketanun River. Hence, SFI would obtain immediate net timber harvesting revenue while foregoing subsequent cycles of sustainable stumpage values	The commercial forest to be inundated would allow the clear cutting of commercial trees. The Project would indirectly provide an immediate benefit to SFI. This benefit could be estimated from the stumpage value of the commercial tree stand.
State Government of Sabah	Under the Federal Constitution land and natural resources are state matters. River water flows would fall under the authority and ownership of the State. River water is used by the hydropower plant to turn the turbines to generate electricity. The state can, if it chooses to seek a user fee for this use of the natural resource.	The maximum water discharge from the Upper Padas River to generate the maximum electric power capacity could be estimated. This information would help to assess the amount of water needed to generate 1 KW/hr of electricity. The value of water used could be estimated by using the price of raw river water transfer to treated water plants or the value of raw water used in alternative economic activities such as to irrigate agricultural farms in the country.
Local communities	The reservoir and powerhouse site itself have no settlement. Nevertheless, the site is located close to several land lots planted with rubber trees, of which belongs to several local owners. The transmission-lines would pass by several landlords and close to home owners.	The value of these inconveniences will have to be assessed based on the willingness to accept compensation by the affected parties.
Sabah population	The reservoir would cause the inundation of 5.9 km^2 of the forest resulting in a loss of biodiversity values	The potential loss in biodiversity resources would have to be estimated by assessing the conservation benefits from biodiversity resources.
People of Sabah	The inundation of the forest for the reservoir would cause a decline in Carbon Dioxide uptake from the atmosphere.	The Carbon Dioxide uptake / release would be computed using the published 2006 Inter-governmental Panel on Climate Change (IPCC) Guidelines for national Greenhouse Gas Inventories and the values of the reduction in CO_2 uptake would be based on the cost of Carbon Offset projects

The appropriate time horizon to select should coincide with the expected duration of the environmental impacts of the Project and the anticipated economic life-span of the proposed Upper Padas Hydroelectric Project. Previous TEV estimations on hydro electric project in detailed environmental impact assessments such as for the Hulu Terengganu Hydro Electric Project uses a period of analysis of 50 years (UKM Pakarunding 2008). This assessment will use a slightly shorter duration of 35 years enough to capture the impacts of the Project

Another important consideration at this initial stage is the geographical boundary and the time horizon of the study. The reason for defining the geographical unit of analysis is to determine the population for which costs and benefits are to be assessed. In this economic analysis, direct significant impacts were taken within the forest catchment up to the transmission of power to Tenom, with the indirect perceived impacts of biodiversity loss covering the whole population of Sabah and the reduction in CO_2 uptake from inundations of forests being a global impact.

The TEV analysis measures the sum of the net value of the impacts of the Project.

9.4 IMPACTS

The present project has several advantages. These include its long life spans hence moderate future reinvestments, low operation costs and maintenance requirements. The presence of storage dams have an additional advantage, to provide peaking supply to the State electricity grid. However, hydroelectric power plants is often associated with environmental impacts like loss of important habitats and biological diversity, and requiring resettlement of rural communities and indigenous people, if they are present within the dam and catchment area. Issues on a reduction in CO_2 uptake from the atmosphere and greenhouse gas emissions may come from a loss of forest cover. Carbon sink and methane emission from the inundated forest may contribute to a negative carbon balance through the life-time of the Project.

Specifically, the impacts of the Project are as described in the sections below.

9.4.1 TIMBER HARVESTING

Clearance of the forest prior to water impoundment of the reservoir would generate timber benefits. These benefits are estimated normally using the stumpage appraisal method. The stumpage value is the selling value timber net of the costs of felling, skidding and transportation, and a fair profit margin to be assigned to the logging contractors. The residual value is termed the economic rent for the owners of the forest concessions. The inundation of the 590 ha forest area for the reservoir assuming a stumpage value of MYR 35,000 per ha would provide the opportunity to salvage timber values under clear harvesting estimated to be MYR 20.65 million. This value is on the higher range of stumpage values in studies undertaken over various natural forests throughout Malaysia by Awang (2007).

This forest area would otherwise have been harvested selectively and managed under sustainable development. This would have yield a lower initial harvesting of about $50m^3$/ha per year and a lower average stumpage value of MYR 25,000 per ha and a reduced allowable cut area by 30% to take into account of slope and river buffer areas when reduced impact logging (RIL) is adopted. This yields about MYR 7 million. But because of the selective harvesting under RIL, there will be opportunities for return subsequent harvest on a 30 year cycle. However, it is forecasted the net growth in the subsequent cutting cycles to slightly decline as it takes more time for the residual stand to mature to its original virgin forest state. Vincent (1997) suggested a logistic relationship between standing volume per ha (net of defect) and age as follows:

$$q(t) = 0.65 * 132\, e^{1-60/t} \qquad (1)$$

where q(t) is the cumulative standing volume 30 years after the first cycle of logging. t being the period of the cutting cycle of 30 years. This assumes that timber yield in the subsequent cycles to be only 31.6 m^3/ha. Under sustainable timber harvesting taking into account immediate selective harvesting and subsequent cutting cycles, the discounted present value benefits would have been MYR 10.25 mil.

Hence, with the inundation of the forest for the reservoir, the net benefit from timber harvesting net of sustainable timber revenues would have been only MYR 10.4 mil.

Impacts Upon Local Communities

9.4.2 IMPACTS UPON LOCAL COMMUNITIES

Local communities are affected by the projects in terms of the opportunity loss from forest products collection. From the socio-economic survey on households from 24 villages along the 3 proposed alignment of the power-line along the Tomani-Tenom and Tenom-Sipitang road, it was known that apart from cultivating their respective lands, the community also collects forest products in their daily life either for personal consumption or extra income. An estimate of the value of the forest produces collected of MYR 73.64 per household is taken from an earlier investigation undertaken from the DEIA report for “Proposed SFI Pulp and Paper Mill Expansion at the SFI Complex, Sipitang District, Sabah” (**Table 9.4-1**). Assuming that the Project mainly affects communities living closer to the forest catchment of the Project, this suggests a loss of MYR 136,260 per year

Table 9.4-1 Forest Produce Collections By Local Communities

Forest Produces	Value (MYR /month)	%
Rattan	15.00	20.37
Firewood	15.97	21.69
Wild animal	20.83	28.29
Bamboo poles and shoot	8.71	11.83
Vegetables and fruits	10.83	14.71
Others	2.29	3.11
Total	**73.64**	**100.00**

Source: Adapted from forest produce collection value from the DEIA report for “Proposed SFI Pulp and Paper Mill Expansion at SFI Complex, Sipitang District, Sabah”.

9.4.3 BIODIVERSITY IMPACTS

Malaysia is blessed with a wealth of biological resources that lend themselves to biotechnology development. The country has embarked on the Biodiversity Project Malaysia which intends to strengthen the government’s capacity to map and account for its natural asset and subsequently safeguard these assets. Priority environmental concerns are being integrated into sectoral and state policies, plans and programmes. The government has acknowledged that biological diversity is one the country's relative advantages in the biotech business. The country has committed large investments into the local universities and research institutes all over the nation, to explore the bio science and technology of our rainforests for conversion into the bio-wealth sector.

Given the potential significance of the biotechnology business, there is a possibility that one development project does have a potential at contributing to the reduction of a nation's potentials in other sectors including the bio-wealth. The proposed Project may have an impact of this nature. Unless adequately mitigated, the Project will cause significant local loss biological diversity. No direct measurement on the extent of species richness and potential impact loss is conducted. However, to value biological diversity is very challenging since:

1. The physical benefits of biological diversity is only partly known for example for economic benefit, availability of food supply, environmental stability, national biological heritage, scientific values, education and recreation, and for biosafety against the probable risks of genetically modified organisms (GMO); and

2. Much of existing research work has relied on the value estimates on non-use or future options value for example relying on a contingent valuation by the general public on their willingness to pay WTP) bid for the establishment of an ecological corridors for the conservation of flora and fauna at Principle Linkage Temengor Forest Reserve (Main Range) – Royal Belum State Park (Main Range), Perak of MYR 9.47 per person per year and at Principle Linkage Resak Forest Reserve (Pekan) – Lesong (Endau Rompin), Pahang of MYR 7.05 per person per year (Mohd Shahwahid 2009a) and of the Lower Kinabatangan floodplain as a habitat for wildlife of MYR 2.22 per person per year (Mohd Shahwahid 2009b). These WTP bids are often used as a proxy average value of biodiversity resources.

The inundation of some 5.9 km^2 of natural forest for the Project would contribute to a loss of biodiversity resources. Using the above estimates obtained for the Lower Kinabatangan floodplain of the annual MYR 2.22 per person, it is possible to provide an estimate of the total annual loss in biodiversity values. The population of Sabah is estimated to be about 3.57 million or about 703,416 households. Multiplying the mean value of biodiversity with the adult population of Sabah (55%) gives a total WTP of MYR 4.36. This value estimate is just slightly higher than the estimated value of biodiversity resources involving 51.6 km^2 of inundated forest for the Hulu Trengganu hydropower Project of MYR 3.5 per annum (UKM Pakarunding 2008). Their estimate is based on the cost of mitigation measures needed to prevent species loss from the inundated forest area.

9.4.4 WATER DISCHARGE SERVICES TO TURN TURBINES

In generating hydro electricity, the water discharge from the Upper Padas River is needed to turn the turbines. Accordingly the maximum water discharge of 70 m^3/sec is required to generate a maximum hydro electricity of 940 GW/year. This is translated to a maximum water discharge of 2.208 mil m^3/ year.

River water resources are under the jurisdiction of the State Government who may charge for the use of the services of the natural resources. The water treatment plant in Malacca is paying

MYR 0.065 per m^3 of water abstracted from the Muar River, Johore, while the imputed value of water utilised by the Muda Irrigation Paddy Scheme was estimated at MYR 0.016 per m^3.

It can be argued that hydropower generation does not consume or use up the water resources, merely the speed of the water flow is being harnessed to turn the turbines, and water would flow back into the river channel. Nevertheless, a service from the natural resource has been utilised without which the hydropower could not be generated. Hence, if the State chooses to charge a fee, it is within its authority to do so. Assuming that a fee ranging from 10% to 100% of the value of irrigation is water is used, it is estimated that the State could at least obtain a revenue of ranging from MYR 2.1 mil to 21.0 mil per year from the Project.

9.4.5 GREENHOUSE GAS EMISSION / UPTAKE ESTIMATION

This section discusses the amount of greenhouse gas emitted into or removed from the atmosphere resulting from the proposed Upper Padas Hydroelectric Project. This estimation was based on the latest published 2006 IPCC (Inter-governmental Panel on Climate Change) Guidelines for national Greenhouse Gas Inventories. The IPCC Guidelines for National Greenhouse Gas Inventories are approved internationally and developed through an international process which has included:

- Wide dissemination of drafts and collection of comments from national experts;
- Testing of methods through development of preliminary inventories.
- Country studies which ensure that methods are tested in a wide variety of national contexts.
- Technical and regional workshops.
- Informal expert groups convened to recommend improvements on specific aspects of the methodology.

The computation of the net carbon dioxide balance resulting from activities of the Project involved the following assumption:

a. The total amount of dry matter in above ground biomass (existing biomas stock) is calculated based on the type of existing forest at the Project site, the size of the forest and default values provided by the IPCC document for the type of existing forest. In this case, the existing vegetation at the site is generally undisturbed mixed dipterocarp forest with above-ground dry matter biomass of 350 tonnes per hectare (Table 4.7, page 4.53), 2006 IPCC.

b. During harvesting, both timber and its residual are produced. According to the IPCC, the residual waste wood which is left to decay would oxidise and the end product manufactured from the timber would both decay in ten years.

The total area to be deforested of 590 hectares is expected to be cleared within a period of one year. Any timber harvested from this area and processed, and residual timber wasted would decay in a period of 10 years. Hence, carbon dioxide would also be released into the atmosphere for this time period beginning from 2011 until 2021.

This deforested area will be inundated for the Upper Padas Hydroelectric Project. There will be no regeneration of forest at the Project site, so there is no uptake of atmospheric carbon. So, the net amount of carbon dioxide released into the atmopshere during the first year and subsequent years is computed and tabulated for a period of 10 years upon completion of the dam from 2011 to 2020. After which, beginning 2021, there is no more net carbon dioxide emission from the area.

Hence, there is a loss of CO_2 uptake of 51,108 tons per year for the next ten years due to the land use change. Thus, with this Project, there is a released of a total of 511,080 tonnes of CO_2 equivalent.

Malaysia is not subjected to any carbon dioxide emission limits or ceilings, hence the Project is not obligated to financially burdened but there is still an opportunity cost being incurred by society. Carbon offset projects have been established around the world as a means to offset carbon dioxide emissions. Many of these projects plants native trees in developing countries to offset their carbon dioxide emissions and promotes the development of fuel-efficient technologies to reduce emissions in the future.

Using the average price of MYR 51/tonne CO_2, and an estimated CO_2 generation of 51,108 tonne annually for the ten years of operation, the environmental cost of this level of carbon emission is estimated as MYR 2.6 mil per year (**Table 9.4-2**).

Table 9.4-2 Amount of Carbon Dioxide Equivalent Released into Or Removed from the Atmosphere Over A Period of 11 years

Year	CO_2 Released (tonnes)	Methane Released (tonnes)	CO_2 Equiv. of Methane (tonnes)	Total CO_2 Equiv. Released (tonnes)	Economic Cost CO_2 Emission
2011	35,965	688	15,143	51,108	2606508
2012	35,965	688	15,143	51,108	2606508
2013	35,965	688	15,143	51,108	2606508
2014	35,965	688	15,143	51,108	2606508
2015	35,965	688	15,143	51,108	2606508
2016	35,965	688	15,143	51,108	2606508
2017	35,965	688	15,143	51,108	2,606,508
2018	35,965	688	15,143	51,108	2,606,508
2019	35,965	688	15,143	51,108	2,606,508
2020	35,965	688	15,143	51,108	2,606,508
2021	0	0	0	0	0
Total	359,650	6,880	151,430	511,080	26,065,080

9.5 TOTAL ECONOMIC VALUE OF THE ENVIRONMENTAL IMPACTS

Total economic value (TEV) can be used to illustrate the aggregated extent of environmental impacts of a project. It is an estimate of the total, rather than the incremental, value of the environmental impacts of the Project to society. Care must be taken to ensure that there is no double-counting when aggregating the components of TEV, as there may be trade-offs between the different impacts of the Project.

This method is important in highlighting to the decision-maker the value of the different environmental impacts of the Project and, therefore, the appropriate decisions to mitigate against them.

The TEV of the environmental impacts is given in **Table 9.5-1**. The value of the environmental impacts is dominated by the economic value of the use of the river water discharge to turn the turbines for power generation, if the full value of water use for irrigation is used. If a lower water value is imputed then the value of biodiversity loss and of carbon emission are higher.

The Project would generate some level of carbon emission. It is not very much but to cover its footprint, it is suggested that the Project could consider getting involve in a Voluntary Carbon Offset Scheme (VCOS) to offset this potential carbon dioxide emission to the environment. An example of a VCOS is the one being undertaken by the Malaysian Airline System (MAS) as an initial step to cover its carbon footprint.

Table 9.5-1 TEV of Major Environmental Impacts

Environmental Impacts	MYR (mill)	%	MYR (mill)	%
Loss of sustainable timber revenues (1)	(10.40)	(1.14)	(10.40)	(4.22)
Loss to Community (forest produce) (mil)	4.77	0.52	4.77	1.93
Loss of Biodiversity	152.56	16.79	152.56	61.87
Economic cost of Discharge Water (3)	735.84	80.96	73.58	29.84
Carbon Emission	26.07	2.87	26.07	10.57
TEV (2)	908.84	100.00	246.58	100.00

1. *Loss of potential sustainable timber net of timber yield from forest clearing for dam inundation. A negative sign implies that present value timber revenue from forest clearance exceeded the present value potential gain from sustainable timber production.*
2. *TEV is computed over a period of 35 years using a discount rate of 8%.*
3. *Economic cost of water computed based on 100% and 10% of the value of irrigated water respectively.*

In MAS's VCOP, the airline has set up a scheme that enables its customers on a voluntary basis to account for their carbon emissions arising from flying. The scheme allows for customers to go online and calculate their carbon miles and its associated monetary value. They can then make their contribution which will be used towards offsetting their carbon emission. MAS approached the Ministry of Natural Resources and Environment to form a national conservation trust fund that could be used to support activities that either sequester or reduce carbon emissions. Accordingly a stateland peat swamp forest in Pekan, Pahang will be gazetted as a permanent reserve forest and replanted with suitable tree species.

9.6 CONCLUSION

This chapter has conducted a economic evaluation of the environmental impacts of the Upper Padas Hydroelectric Project by using a total economic value (TEV) framework as recommended by the Guideline on the Economic Valuation of the Environmental Impacts for EIA Projects by the Department of Environment.

CHAPTER 10 CONCLUSION

The present Special Environmental Impact Assessment has analysed the proposal for establishing a Hydroelectric Project on the Padas River, about 15 km upstream of Tomani. The proposed Project will include a roller compacted concrete dam creating a 590-ha reservoir. A 14-MW power generation unit will be built into the dam to utilise the compensation flow, which at all times is released from the reservoir. A main power station will be built about 10 km downstream to utilise the additional topographic height difference. The water will be tunnelled from the water intakes at the dam to the main power station. The power station will likely be configured in 2 units and will provide an annual energy production of some 103 GWh.

Electricity will be transmitted to the Sabah Grid through two lines: a 132 kV line to Tenom and a 275 kV line to Sipitang. Both these lines will require a standard right-of-way of 40 m width.

The Consultant has studied the Project area in respect of the physical, the biological and the human environments for the purpose of determining if there are any particular social or environmental issues to include in planning and to provide a baseline against which monitoring results can be measured.

The consultant did not find any significant conservation values in the area directly affected by the Project. There are no land forms particularly worthy of landscape conservation and the biotopes in the Project area are dominated by human activities such as agriculture, industrial tree plantation areas, oil palm plantations and rubber plantations. The reservoir does include natural dipterocarp forest areas, which are managed as protection areas due to their steep slopes. There are similar areas in nearby protected areas and this habitat is common throughout Sabah’s forest estate.

The wildlife is poor due to the human influence in the area. There may be interesting wildlife such as roaming Tembedau (*Bos javanicus*) in the surrounding catchment area, but their presence on the steep slopes near the reservoir is unlikely and they will never come in the transmission line corridor, which is dominated by human activities.

The river water quality falls in general under the Malaysian Class IIA/IIB requirements but is presently suffering from heavy loads of suspended solids. There are, however, signs that the water condition is changing to the better as new management regimes have been introduced in the catchment area. The aquatic wildlife does not differ from most rivers in Sabah, but volume of wildlife is in general poor.

There are no human settlements directly in the areas of Project activities, wherefore no resettlement is anticipated. The reservoir lies in an unproductive part of a concession for industrial tree plantation, while the transmission lines will go through productive parts of the concession as well as through small holder and large plantations of rubber and particularly oil palm.

The major environmental impacts of this Project will be related to changed river flow regimes and water quality, while the social impact will be related to the land use limitations being imposed in the right-of-way for the transmission lines.

The river flow changes will have several aspects. There will be a minimum flow in the river the approximately 10 km between the dam and the main powerhouse at Tomani and for the river downstream of Tomani there will be a regulated flow, i.e. the seasonal fluctuations will be minimised. However, the water originating from the catchment upstream of the reservoir is only a small part of the total water masses in Padas, so the effect will not be major.

The river water quality impacts are of two kinds: The construction work will cause some soil to find its way into the river system but during operation, the dam will prevent sediments from the upper catchment area to flow downstream. Overall this will benefit the river users downstream.

The other impact will be an increased level of dissolved carbon dioxide and methane from anaerobic decomposing biomass in the reservoir. These gasses are expected to be naturally emitted into the atmosphere within the first 40 km of the river flow after the dam.

An overall positive impact will be the Project's interest in sustainable land use practices in the catchment area as the Project will suffer from excessive erosion and subsequent sedimentation of the reservoir.

The report includes proposals for mitigation measures against negative impacts, mainly soil conservation issues related to river quality and a requirement of maintaining a compensation flow similar to the 90% exceedance flow in the river between the dam and the power house.

Mitigation for land acquisition (the reservoir and power station areas) and land use restrictions (the transmission line) in the form of payments or replacement land will be necessary.

Based on the above, Chemsain Konsultant Sdn Bhd concludes that:-

- *The Project may be implemented in a social and environmentally acceptable manner provided the mitigation measures described in the environmental management plan are incorporated in Project planning and implementation.*
- *Main impacts that need mitigation measures to be incorporated into the present plans concern land tenure, water quality, water flow regimes, emission of green house gasses. These issues have further impact on particularly aquatic wildlife and consequential impact on human livelihoods.*
- *Main residual impacts concern catchment management, greenhouse gasses and the permanent risk of dam breach.*
- *Project benefits are likely to balance positively with environmental costs.*