

1.0 OVERVIEW

Biodiversity Management Plan (BMP) is a plan that has been prepared to address the project's primary biodiversity challenges during the project's construction, impoundment and dam operation phase, where the details for operation phase will be covered in a separate document. This BMP is also developed in consonance with Hydropower Sustainability Standards (HSS), specifically for the topic Biodiversity and Invasive Species Management Topic. The plan presents a comprehensive set of management strategies and mitigation measures specifically designed to address the biodiversity impacts identified in the SEIA report. Additionally, a biodiversity risk matrix is included, which enables identification and assessment on potential risks to biodiversity from various activities or threats and prioritize actions accordingly. To ensure a coordinated and effective approach to biodiversity management, this document also outlines the Biodiversity Management Structure, which establishes the roles and responsibilities of key personnel and provides a framework for monitoring and reporting on biodiversity management. By adopting these strategies and structures, long-term sustainability of the project will be secured, while also safeguarding the conservation of biodiversity in the project area. (BAP).

2.0 SCOPE OF BMP

This BMP is applicable throughout the project life cycle of Baleh HEP which includes construction, impoundment and dam operation. The plan which acts as a foundational document will support the subsequent biodiversity-focused plans, such as Biodiversity Monitoring and Evaluation Plan (BMEP) and Biodiversity Action Plan.

3.0 OBJECTIVES

The primary objective of this BMP is to provide a management framework for the measures recommended from the SEIA and other studies to manage the biodiversity impacts of the overall Baleh HEP. The BMP will provide guidance and systematic approach in formulating action plan and management plan to address risk and opportunities identified from the SEIA, to ensure:

- Proper assessment on biological feature baseline;
- Proper identification of biodiversity risk matrix for better understanding of aspect and impact relationship;
- Mitigation measure corresponding to issue or risk identified are developed; and
- Systematic documentation and reporting through proper monitoring programs which include impact mitigation and response procedures.

4.0 BIODIVERSITY IMPACTS AND MITIGATIONS

The development of mitigation measures is to manage the biodiversity impacts as described in Baleh HEP Social and Environmental Impact Assessment (SEIA). The general hierarchy of mitigating impacts involved the following steps; 1) Avoidance, 2) Minimization, 3) Mitigation and 4) Compensation. In this document/Biodiversity Management Plan, the first 3 steps are included. While the fourth step on compensation will be further conducted through Biodiversity Action Plan (BAP) upon reassessing /findings of new biodiversity risks which are species/ecosystem specific as well as to offset any residual adverse impact after the full implementation of the previous three steps to achieve no net loss, or a net gain in biodiversity values. Table 1 below consisted of developed mitigation measures based on Baleh SEIA Report, including appropriate timing of executing mitigation measures and reporting requirement.

Activity	Environmental Issue	Impacts	Mitigation Measure	Timing	Reporting Requirement
CONSTRUCTION					
Major construction activities which involved extensive earth-moving, excavation, diversion channel etc	Impact on Aquatic Flora				
	<ul style="list-style-type: none"> Sediment runoff and erosion 	<ul style="list-style-type: none"> The silt from sediment loading will smother the benthic environments including substrates (stone, sand, etc.). This will potentially reduce the amount of light and oxygen available to periphyton, which then can lead to a decrease in its biomass and diversity. 	<ul style="list-style-type: none"> Utilization of soil protection measures (such as plastic sheeting). Installation of silt traps at strategic slope of the construction site. Proper implementation and maintenance of best management practices in accordance to ESCP. 	<ul style="list-style-type: none"> Upon commencement of construction activities 	<ul style="list-style-type: none"> Quarterly EMR report ESCP Environmental Performance Indicators Internal and external ECA report Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
	<ul style="list-style-type: none"> Alteration of natural water flow 	<ul style="list-style-type: none"> Water level below the dam will be significantly reduced during the initial stage of dam completion Change the availability of nutrients that aquatic plants need to grow and thrive. Impact water temperature, which can affect the growth and survival of aquatic plants Impact sediment transport in rivers and streams 	<ul style="list-style-type: none"> Establish an environmental flow that ensures the continuity of the river downstream of the dam. 		<ul style="list-style-type: none"> Environmental Flows Management Hydrological Stations & Modelling
Impacts on Fish and Riverine Fisheries					
<ul style="list-style-type: none"> Sediment runoff and erosion 	<ul style="list-style-type: none"> The habitat of fish and other aquatic species can be disrupted and affect fish migration, spawning, and feeding. 	<ul style="list-style-type: none"> Conservation of watersheds upstream of the dam which cover an area from the upper most stretch of the river to as far 	<ul style="list-style-type: none"> Upon commencement of construction activities 	<ul style="list-style-type: none"> Quarterly EMR report Environmental Performance Indicators Internal and external ECA report 	

	<ul style="list-style-type: none"> Poor water quality can lead to fish mortality and affect the growth and reproduction of fish. 	<p>downstream as possible in order to include as many streams (tributaries) as possible. These watersheds include the Na, Singut and Jejambu Rivers in the upper Baleh River, which also happen to be important spawning sites for some fish species. In the Mengiong River, these areas include the Melatai, Upper Belanjang, and Entuloh Rivers. These rivers contain most of the fish species that will be lost in the inundated areas.</p>		<ul style="list-style-type: none"> Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
<ul style="list-style-type: none"> Alteration of natural water flow 	<ul style="list-style-type: none"> Create barriers to fish movement, which can limit access to spawning and feeding areas. This can lead to a decline in fish populations and affect the overall health of riverine ecosystems. Habitat fragmentation will lead to segregation of fish species which in turn will caused loss of genetic connectivity. For eg: <ul style="list-style-type: none"> ➤ Scenario 1: Habitat downstream vs habitat upstream ➤ Scenario 2: Upstream; Difference River systems disconnected due to existence of reservoir. 			<ul style="list-style-type: none"> Environmental Flows Management Hydrological Stations & Modelling
Impacts on Wildlife				
<ul style="list-style-type: none"> Habitat loss and fragmentation 	<ul style="list-style-type: none"> Force wildlife to move out to adjacent habitat. Direct mortality due to crushed by falling trees. 	<ul style="list-style-type: none"> Habitat Restoration Domestication of protected species Preparation and submission of a Wildlife Rescue and Monitoring (WiMoR) Plan is strongly recommended before major construction work commences 	<ul style="list-style-type: none"> Upon commencement of construction activities 	<ul style="list-style-type: none"> Quarterly EMR report Biodiversity Monitoring Report Biodiversity Interim Monitoring (BIM) Report Internal and external ECA report Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
<ul style="list-style-type: none"> Disturbance due to noise and dust pollution 	<ul style="list-style-type: none"> Disorientation as well as physiological and psychological stress to wildlife. 			
<ul style="list-style-type: none"> Wildlife poaching 	<ul style="list-style-type: none"> Loss of species within an ecosystem. 	<ul style="list-style-type: none"> Awareness training on Sarawak Wildlife Protection Ordinance 1998 and the protection status of various wildlife species to all staff and workers at all level. 		

			<ul style="list-style-type: none"> • Report all known cases of poaching and illegal collection of forest resources within the project site. 		
IMPOUNDMENT					
Impact on Aquatic Flora					
Reservoir impoundment	<ul style="list-style-type: none"> • Alteration of annual hydrological regime 	<ul style="list-style-type: none"> • Significant reduction in the volume of water as well as in the depth of the river which will lead to: <ul style="list-style-type: none"> ➢ Less spawning and recruitment occurring in this stretch of the river. ➢ Impair localized movement of fish ➢ Reduction in the availability of food resources for fish. 	<ul style="list-style-type: none"> • Maintenance of constant minimum residual flow. 	<ul style="list-style-type: none"> • Upon impoundment 	<ul style="list-style-type: none"> • Environmental Flows Management
	<ul style="list-style-type: none"> • Change in fish species composition 	<ul style="list-style-type: none"> • Some species from the family Cyprinidae such as Tor sp. that are adapted to swift flowing waters will move upstream beyond the influence of the reservoir. • Smaller sized species such as Osteochilus spp. and Rasbora spp. will move into the smaller tributaries • Paracrossochilus spp. and species from family Balitoridae will not survive due to unsuitable new habitat. 	<ul style="list-style-type: none"> • Controlled fishing activities by ensuring: <ul style="list-style-type: none"> ➢ Manpower requirements for reinforcement of fishing regulations must be available in the two major rivers. ➢ Strict enforcement by relevant agencies during the impoundment stage to prohibit commercial netting. ➢ Any catchment areas that are conserved should be designated as totally protected areas from commercial fishing 		<ul style="list-style-type: none"> • Quarterly EMR report • ESCP Report • Biodiversity Monitoring Report • Biodiversity Interim Monitoring (BIM) Report • Internal and external ECA report • Biodiversity Monitoring and Evaluation Programme (BMEP) • Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR) • Biomass Removal Plan (BRP)
	<ul style="list-style-type: none"> • Deposition of suspended solid 	<ul style="list-style-type: none"> • The transparent water will encourage the growth of phytoplankton which will lead to rapid increase in selected fish species, particularly planktivorous and herbivorous species such as Osteochilus spp. 	<ul style="list-style-type: none"> • Conservation of upstream watershed which cover an area from the upper most stretch of the river to as far downstream as possible in order to include as 		

		and <i>Barbonymus schwanefeldii</i> . These species will be preyed upon by carnivorous species particularly <i>Mystus</i> spp. and <i>Wallago</i> spp.	<p>many streams (tributaries) as possible.</p> <ul style="list-style-type: none"> • Development of hatchery for restocking of native species. • Timing in clearance of access roads and impoundment site by ensuring: <ul style="list-style-type: none"> ➢ Minimum clearance for access roads, jungle trails and for other construction purposes outside the reservoir ➢ Re-vegetation and landscaping of the slopes should be carried out in ➢ pace with the progress of the project in order to reduce soil erosion ➢ Clearing to be conducted during dry season to minimize soil erosion ➢ For areas within the 50 m from the river banks, clearing activity should be done right before the dam is impounded. 		
Impacts on Wildlife					
<ul style="list-style-type: none"> • Habitat loss 	<ul style="list-style-type: none"> • Forcing the wildlife out of their former habitats and move to higher ground. • Trapped or injured by falling trees 	<ul style="list-style-type: none"> • Ensure Wildlife Rescue and Monitoring (WiMoR) Plan is ready during impoundment while ensuring: <ul style="list-style-type: none"> ➢ Prior to wildlife rescue, to consult relevant agency and experts, these include officers from the Sarawak Forestry Corporation (the nearest regional office is in Sibul) and 	<ul style="list-style-type: none"> • Upon impoundment 	<ul style="list-style-type: none"> • Quarterly EMR report • Internal and external ECA report • Biodiversity Monitoring and Evaluation Programme (BMEP) • Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR) • Biomass Removal Plan (BRP) 	

			<p>Veterinary Section of the Department of Agriculture.</p> <ul style="list-style-type: none"> ➤ Awareness training on Sarawak Wildlife Protection Ordinance 1998 and the protection status of various wildlife species to all staff and workers at all level. <ul style="list-style-type: none"> • Undertake phase clearing <ul style="list-style-type: none"> ➤ Site clearing and disposal of vegetation to start at the lowest elevation near the river bank and proceed towards the higher ground to allow time for as many species and individuals as possible to move to higher ground. <ul style="list-style-type: none"> • Wildlife rescue <ul style="list-style-type: none"> ➤ Small mammals can be captured using live trapping methods. ➤ Medium size terrestrial mammals captured using tranquilizer dart. Only a registered veterinarian is licensed to use a tranquilizer gun and dart. ➤ If translocation cannot be carried out immediately the animal must be held in a cool and comfortable cage, adequately provisioned and protected from predators and inclement weather. ➤ Be carried out and supervised by relevant officers from the Sarawak Forestry Corporation and/or Sarawak Forestry Department. 		
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	<ul style="list-style-type: none"> Impact to Baleh National Park 	<ul style="list-style-type: none"> Baleh HEP reservoir will inundate the gazetted Baleh National Park, posing threat to the biodiversity of the area 	<ul style="list-style-type: none"> Assess impacts on the overlapping area, identify the need of an offsetting strategy and formulate effective conservation strategies towards no net loss of biodiversity. 	<ul style="list-style-type: none"> Upon impoundment 	<ul style="list-style-type: none"> Biodiversity Offset Framework Biodiversity Offset Implementation Strategy
DAM OPERATION					
Dam operation	Impact on Aquatic Flora				
	<ul style="list-style-type: none"> Riverbanks submerge 	<ul style="list-style-type: none"> Losses of riverine habitat which lead to establishment of new habitat formation for phytoplankton and periphyton, from lotic (fast flow) composition to lentic (slow to stagnant) composition. 	<ul style="list-style-type: none"> Construction of aeration weir and riffle structure in the downstream river of the dam is recommended to overcome the potentially problem of low dissolved oxygen in the water discharge from the dam reservoir. The flow should be maintained at optimum level at downstream of dam reservoir to minimize the effects on aquatic life downstream, and to avoid drastic change in water level change. Nuisance phytoplankton growth at the reservoir especially some blue green algae (e.g. Anabaena, Oscillatoria and Lyngbya) and green algae (e.g. Cosmarium) should be monitored by the plant operator. 	<ul style="list-style-type: none"> Upon operation 	<ul style="list-style-type: none"> Environmental Flows Management Hydrological Stations & Modelling Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
	<ul style="list-style-type: none"> Low water flow 	<ul style="list-style-type: none"> Increase the resident time of nutrients to phytoplankton and periphyton communities. However, no algal bloom is expected if the nutrients level remained at existing level. Enhance sedimentation rates in the upper parts of the Baleh River. However, phytoplankton and periphyton composition in the upper parts of the Baleh River (e.g. the Singut River) and their tributaries will not be affected where the water levels remained unchanged. 			
<ul style="list-style-type: none"> Significant water level rise 	<ul style="list-style-type: none"> Cause thermal stratification. Oxygen depletion at bottom water column due to decomposition of organic matter near the bottom environment. 				

	<ul style="list-style-type: none"> Unnatural variation in discharged, duration and frequency. 	<ul style="list-style-type: none"> Cause stress in the periphyton composition which will affect the aquatic fauna at higher trophic levels 			
Impacts on Macroinvertebrates					
	<ul style="list-style-type: none"> Impoundment of large areas of aquatic habitat. 	<ul style="list-style-type: none"> Localized disappearance of some species 	<ul style="list-style-type: none"> Upstream habitats (not inundated areas) should be considered for conservation. Discharge to maintain environmental flow at 250 m³/s. 	<ul style="list-style-type: none"> Upon operation 	<ul style="list-style-type: none"> Environmental Flows Management Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
Impacts on Fish and Riverine Fisheries					
	<u>Downstream Area</u> <ul style="list-style-type: none"> Reduced concentration of suspended solids and organic matter 	<ul style="list-style-type: none"> Affect food resources for fish 	<ul style="list-style-type: none"> Upstream habitats (not inundated areas) should be considered for conservation. Discharge to maintain environmental flow at 250 m³/s. 	<ul style="list-style-type: none"> Upon operation 	<ul style="list-style-type: none"> Environmental Flows Management Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)
	<u>Reservoir</u> <ul style="list-style-type: none"> Reduction in current flow and increased transparency of the water, the primary productivity of the lake will gradually increase. Reduction of food resources for fish 	<ul style="list-style-type: none"> Species composition and relative abundance of fish species will change. Most native species currently present in the Baleh River will not be found at the reservoir area. 			
	<u>Areas Upstream that are not Flooded</u> <ul style="list-style-type: none"> Habitat fragmentation 	<ul style="list-style-type: none"> Minimal impact on the fish species Areas will be act as refuge for some species that are strong swimmers and well adapted. However, as the streams will be cut off from other streams by the reservoir, populations will 			

		be isolated and recruitment will be impossible.			
Impacts on Wildlife					
	<ul style="list-style-type: none"> Hunting and fragmentation 	<ul style="list-style-type: none"> Increased stress and mortality in wildlife populations. 	<ul style="list-style-type: none"> Awareness training on Sarawak Wildlife Protection Ordinance 1998 and the protection status of various wildlife species to all staff and workers at all level. Ban on hunting by workers of the local wildlife. Wildlife rescue based on the approved Wildlife Rescue Plan to be carried out. Establishment of totally protected area at Baleh's upper catchment. 	<ul style="list-style-type: none"> Upon operation 	<ul style="list-style-type: none"> Biodiversity Monitoring and Evaluation Programme (BMEP) Biodiversity Action Plan (BAP)/ Wildlife Monitoring Report (WiMoR)