Chapter 8 ASSESSMENT OF IMPACTS

8.1 GENERAL

Assessment of environmental impacts of any development activity is the key component of EIA process. Environmental impacts are assessed based on understanding of the project features/activities, environmental setting in the area and interaction of project activities with environmental components leading to prediction of likely impacts due to development of project in a particular area/region. Hydropower projects are location specific, leading to large-scale construction activities in generally pristine areas. Therefore, impact assessment is carried out by establishing site-specific environmental settings through baseline data collection and defining project components from detailed project information. Baseline environmental status in the project area is established through field studies in different seasons and also obtained from various secondary sources as discussed in previous chapters. Project related information is sourced from Detailed Project Report (DPR) of the project to carry out the impact assessment for project construction and operation phase.

The proposed Pemashelpu HEP would lead to generation of number of environmental impacts owing to the activities that would be undertaken during the construction of various project appurtenances, e.g. drilling and blasting, quarrying for construction material, dumping of muck generated from various project activities, transportation of material, material handling and storage, waste generation from labour colonies, operation of construction machinery/equipment, etc. Additionally, large-scale labour migration to the area, during the construction period, impacts the local inhabitants. Operation phase of the hydroelectric project is much cleaner as far as pollution generation is concerned; however a significant impact during operation phase is permanent change in flow regime of the river impacting aquatic life, fish fauna and downstream users.

All the likely impacts have been considered for various aspects of environment, including physico-chemical, ecological and socio-economic aspects. Invariably there are two types of impacts that occur due to construction and operation of hydroelectric projects viz. permanent which generally lead to loss of plant species, change of land-use, change in flow regime, etc. and temporary which can be minimized and mitigated by adopting environmental management plan. Environmental protection measures can be best enforced through inclusion of relevant clauses in the contract not only for the main contractors but also for sub-contractors as most of activities are undertaken through various contractors.

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Pemashelpu HE Project have been identified. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken. This Chapter deals with the anticipated positive as well as negative impacts during the construction as well as operation phase of the proposed Pemashelpu HE project.

8.2 IMPACTS DURING CONSTRUCTION

Majority of the environmental impacts attributed to construction works are temporary in nature, lasting mainly during the construction phase and often do not extend much beyond the construction period. However, as the construction phase of Hydroelectric Projects is fairly large and extend into several years, if these issues are not properly addressed, the impacts can continue even after the construction phase for longer duration. Even though the impacts due to construction are temporary in nature, they need to be reviewed closely as they could be significant due to the nature and intensity of the impacts.

Impacts can be discussed in terms of projects activities with their magnitude and potential impacts on environmental resources or alternatively resource wise in terms of impact on each environmental resource e.g. Ambient Air Quality and potential impact on this resource from various project activities. However, as some of the project activities are quite critical and it is important to understand them along with their impacts on environmental resources, therefore, they are briefly discussed below to be followed by impacts on resources.

8.2.1 Impacts due to immigration of Construction Workers

At the time of peak construction work in the project, it is estimated to engage 350 persons as labour force and 100 as technical staff. Efforts will be made to engage local labor force, as far as possible and rest will be brought from outside. Even the local population is expected to stay near the construction sites in the construction camps/colonies. It is estimated that in the first and second year 60% of the peak force will be required and in the third and fourth year 100% of the peak force will be required, however, to assess the impact of migratory work force it is assumed that entire labour force and technical staff will stay in the construction colony during the entire duration of the project.

To calculate the human pressure during the construction phase of the project the following assumptions have been considered.

i. family size is assumed as 4; and 80% of labors and technical staff are married
ii. Out of total workforce, 80% will be such that both husband and wife will work
iii. 50% of technical staff will come with their families and only husband will work
iv. 2% of total migrating population are assumed as service providers, and
v. 50% of service providers will have families.

Based on these assumptions the peak migrant population has been calculated as 850persons (**Table 8.1**). This population is expected to reside in the project area at any given time.

Table 8.1: Calculation of Total Migratory Population

A.	**Migrant Population of Laborers**	
	Total labor force	**300**
	Married laborers (80% of 300)	240
	Single laborers (20% of 300)	60
	Husband and wife both working Labour (80% of 240)	192
	Number of families where both husband and wife work (192/2)	96
	Number of families where only husband work (20% of 240)	48
	Total number of laborers families (96 + 48)	144
	Total Migrant Population of Laborers (144 x 4+ 60)	**636**
B.	**Migrant Population of Technical Staff**	
	Total technical staff	100

	Married technical staff	20
	Single technical staff	80
	Total migrant population of technical staff (20 x 4+ 80)	**160**
	Migrant Workforce (Labor plus Technical)	**796**
C.	**Service Providers**	
	Total service providers (2% of total migrant workforce)	16
	Married service providers (50 % as assumed)	8
	Single service providers	8
	Total migrant population of service providers (8 x 4+ 8)	**40**
	Total Migrant Population	**836≅850**

Separate accommodation and related facilities for workers, service providers and technical staff are to be arranged. Migration of 850 persons during the peak construction period, in otherwise scarcely populated and pristine area, is likely to create problems of sewage disposal, solid waste management, tree cutting to meet fuel requirement, etc.

8.2.2 Construction of Main Project Components

Construction work is required for the construction of following main project components:

- A 25m high Barrage across Yargyap Chhu from Average river Bed Level of EL. 2213m
- One intake structures on the right bank just upstream of the barrage axis
- One number Head Race Tunnel of 4 m diameter, horse shoe shaped concrete lined tunnel having a length of 4.172km with construction Adits at intake end and at upstream end of surge shaft.
- Restricted orifice Surge Shaft with a diameter 12.5m and a height of 39 m is provided
- One number steel lined pressure shaft of 3.5 m diameter, Circular shaped, having a length of 966.17 m (Upper horizontal limb of pressure shaft 52.49m, Vertical pressure shaft of 244 m and Lower horizontal limb of pressure shaft 669.68 m)m. trifurcating into three penstocks of 2.2 m diameter each.
- A surface power house of size 74.0 m (L) x 34.5 m (W) x 35.2 (H) m housing three units of 27MW each and a tail race channel discharging into the river.
- A switch yard of size 40 m (W) x 60 m (L) for evacuation of power.

For construction of main project components major activities are excavation and concreting. Excavation will have impact in terms of muck generation. Excavation and concreting process will require use of various construction equipment such as batching plants, aggregate processing plants, dumper trucks, excavators, dozers, concrete machines, jack hammers, generators, pumps, etc leading to generation of pollution in terms of emissions, wastewater, noise and solid waste.

8.2.3 Quarrying Operations

The Quarry area for Pemashelpu HEP is not identified exclusively; most of the material is obtained from the excavation done during project construction itself. Only small part of aggregate may be obtained from outside Quarry.

Opening of the quarries will cause visual impacts because they remove a significant part of the hills. Other impacts will be the noise generated during aggregate acquisition through explosive and crushing, which could affect wildlife in the area, air pollution is caused during the crushing

operation to get the aggregates to the appropriate size and transport of the aggregates to the site.

The quarrying operations will be semi-mechanized in nature. Normally, in a hilly terrain, quarrying is done by cutting the hill face, and this leaves a permanent scar, once the quarrying activities are over with the passage of time, rock from the exposed face of the quarry under the action of wind and other erosion forces, slowly gets weathered and they become a potential source of landslide. Thus, it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides at the quarry sites, as applicable.

8.2.4 Operation of Construction Plant and Equipment

During the construction phase, various types of equipment will be brought to the site and construction plants and repair workshops will be set up. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. List of construction equipment to be deployed major project component wise is given at **Table 8.2**. The siting of these construction equipments would require significant amount of space. In addition, land will also be temporarily acquired, i.e. for the duration of project construction; for storage of the quarried material before crushing, crushed material, cement, steel, etc.

These construction plant and repair workshops will have impact on ambient air quality due to fugitive emissions associated with operation of DG sets to meet the power requirements and other equipments; impact on water quality due to wastewater generation and impact on soil due to solid waste generation. Management of such impacts with operation control and appropriate pollution control equipment is essential to minimize their effect on surrounding environment including local population and wildlife and same is discussed in EMP. Additionally, proper siting of these facilities can also reduce the impact due to their location. Their locations have been identified during the preparation of Detailed Project Report, keeping in view the technical and economic criteria; however, same can be further refined during set up, keeping in view:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Wildlife, if any, in the nearby area
- Proximity from habitations
- Predominant wind direction
- Natural slope and drainage

Table 8.2: List of Construction Equipment at Construction Stage of Pemashelpu HEP

Sl No	Description of Equipment	Capacity	Unit	River Diversion works (Diversion Tunnel& Coffer dams)	Barrage Complex,Intake&Adit-1 works	HRT, Surge Gallery& Pressure shaft works	PH,TRC & Switch yard Works	Total
1	**Hydraulic Excavator**	**3/1 Cum**	Nos.	1+1	2	4	2	**8**
2	**Crawler Dozer**	**240 HP/200 Cum/Hr**	No.	1	1	2	1	**5**
3	**Loader**	**3/1 Cum**	Nos.	1	1	3	2	**7**
4	**Dumpers**	**8.33 Cum**	Nos.	3+2	6	0	0	**11**
5	**Tippers**	**4.5 Cum**	Nos.	0	5	8	6	**19**
6	**Air-compressor**	**600 Cfm**	Nos.	1	1	1	2	**5**
7	**Air-compressor**	**300Cfm**	Nos.	1	1	2	1	**5**
8	**Drill Jumbo**	**2Boom**	Nos.	1	0	2	0	**3**
9	**ROC/Drill Rig**		Nos .	1	1	0	1	**3**
10	**Jack Hammers & with pusher legs**		Nos.	3	3	6	6	**18**
11	**Concrete Mixer**		Nos.	1				**1**
12	**Transit Mixer**	**6 Cum**	Nos.	2	6	4	4	**16**
13	**Short Crete M/C (with Robot Arms)**		Nos.	1	0	1	0	**2**
14	**Ventilation**	**1000cfm**	Nos.	1	0	4	3	**8**
15	**DG set**	**125KVA**	Nos.	2	0	1	1	**4**
16	**DG set**	**250KVA**	Nos.	1	1	0	0	**2**
17	**DG set**	**350KVA**	Nos.	0	1	1	1	**3**
18	**Grout Pumps**		Nos.	2	2+2	4	3	**13**
19	**Rib Bending M/C**		Nos.	1	0	1	1	**3**
20	**Vibrating Compactor**	**12T**	No.	1	1	0	1	**3**
21	**Water Sprinkler**	**15000Ltrs**	No.	2	1	0	1	**4**
22	**Batching plant**	**30 Cum/Hr**	No.	0	2	1	2	**5**
23	**Concrete pump**	**30 Cum**	No.	1	1	2	2	**6**
24	**Tower Crane**	**5 Cum**		0	1	0	1	**2**

Sl No	Description of Equipment	Capacity	Unit	River Diversion works (Diversion Tunnel& Coffer dams)	Barrage Complex,Intake&Adit-1 works	HRT, Surge Gallery& Pressure shaft works	PH,TRC & Switch yard Works	Total
25	**Vibrators with Flexible needles**		No.	as required	as required	as required	as required	
26	**Mono rail Winch**	**7.5T& Bucket-1T**	No.	0	0	2		**2**
27	**Conventional Shutter**	**1.5 M Height**	No.	as required	as required	as required	as required	
28	**Mechanical Gantry**	**6.6 M Dia/6.0M/5.6M Horse Shoe**	No.	0	0	4	0	**4**
29	**D.W Pumps**		No.	as required	as required	as required	as required	
30	**Crusher plant**	**120 TPH**	No.	**1**				**1**
31	**Explosive Van**	**6T/2T**	No.	**2**				**2**
32	**Mobile Crane**	**10T**	No.	**1**				**1**
33	**Truck**	**10T**	No.	**2**				**2**
34	**407 Pick up**	**2T/6T**	No.	**2**				**2**
35	**Ambulance**		No.	**1**				**1**
36	**Flat body Trailer**	**10T**	No.	**2**				**2**
37	**Flat body Tipper**	**4.5 T**	No.	**2**				**2**
38	**JCB**	**1Cum**	No.	**2**				**2**
39	**Cement Bulkars**	**9Ton**	No.	**4**				**4**
40	**Welding Sets**		No.	**as required**				
41	**Inspection Vehicles**		No.	**as required**				
42	**Work Shop Facilities**		No.	**as required**				
43	**Store Facilities**		No.	**as required**				
44	**Common Aggregates Arrangement**		No.	**as required**				

8.2.5 Muck Disposal

Total quantity of muck generated from surface as well as underground excavations is estimated at about 7.24 lakh m^3 considering swell factor of 45%. About 46% of this will be used for the construction/ protection works, the total quantity of muck to be disposed off will be about 3.9 lakh m^3. This will be disposed off in the identified and designated muck-dumping sites, which has a total area of 9 ha. The details of total muck generated and to be disposed off are given in **Table 8.3.**

Table 8.3: Details of Excavation work in Pemashelpu Hydroelectric Project

Sites	**Total Quantity (m^3)**
Diversion Tunnel	31911
Coffer Dam	3763
Barrage & Intake	154140
HRT	88590
Pressure shaft	20410
Surge shaft	11190
Adits	11400
Power House Complex including TRC	164384
Switch Yard	13787
Total	**499575**
Total excavated material with 45% swell factor	**724386**
Quantity to be reused, about 46% of total generation (m^3)	**334657**
Total quantity to be dumped	**389729**

Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- Can be washed away into the main river which can cause negative impacts on the aquatic ecosystem of the river.
- Can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operations, trees are cut, and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates landslide like situations. Many a times, boulders/large stone pieces enter the river/water body, affecting the benthic fauna and other components of aquatic biota.
- Normally muck disposal is done at low lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some area which can provide ideal breeding habitat for mosquitoes.

A detailed Muck Disposal Plan has been prepared to minimize the impact and is given in Environmental Management Plan.

8.2.6 Road Construction

The project construction would entail significant vehicular movement for transportation of construction material and heavy construction equipment. Some of the roads in the project area might require widening; apart from that it is proposed to construct **about 3.05 km** of new road to access various areas for project construction. The details of the roads proposed to be constructed are given at **Table 8.4**.

Table 8.4: Details of Road Construction

S. No.	Description	Road length (m)
1	From existing road to river bed in Barrage Area	1112
2	From existing road to Surge Shaft, Adit-2 (near surge shaft)	2720
3	From existing road to power house complex	330
Total		**3050**

The major impacts likely to accrue as a result of construction of the roads are:

- Loss of forest and vegetation by cutting of trees
- Geological disturbance due to blasting, excavation, etc.
- Soil erosion as the slope cutting operation disturbs the natural slope and leads to land slips and landslides.
- Interruption of drainage and change in drainage pattern
- Disturbance of water resources with blasting and discriminate disposal of fuel and lubricants from road construction machinery
- Siltation of water channels/ reservoirs from excavated debris
- Effect on flora and fauna
- Air pollution due to dust from debris, road construction machinery, etc.

The indirect impact of the construction of new roads is the increase in accessibility tootherwise undisturbed areas, resulting in greater human interference and subsequent adverse impacts on the ecosystem. Appropriate management measures required to mitigate adverse environmental impacts during road construction have been recommended. The details of the same have been covered in Environmental Management Plan.

8.2.7 Impacts Summary

Impact of above activities on various components of the environment during construction phase of the project are tabulated and given at **Table 8.5**.

Table 8.5: Summary of Impacts during Construction Phase

Component of Environment	Source/Reason of Impact	Quantification, where possible
Air Environment	Fugitive Emissions from storage of construction material in open area	Fine and coarse aggregate requirement for construction has been estimated in the DPR; open storage in different construction areas will lead to generation of fugitive dust in the area
	Increase in movement of vehicles	In addition to coarse and fine aggregate; large quantity of structural steel and cement will be transported to the area requiring movement of heavy transport vehicles (trucks, dumpers, etc.) in the area; additionally transport vehicles (jeeps) will be required for movement of manpower in the area. This will substantially increase the traffic in other wise low traffic density area and hence lead to air and noise pollution.
	Operation of construction Plants, Machineries, Workshops	For construction of project components plants and workshops will be set up and construction machinery and equipment will be deployed. A list of such equipment is prepared project component wise and is enclosed as Table 8.2.Their operation will generate pollution in all manifestations viz. air, water, noise including solid and hazardous waste.
	Operation of DG sets for power Requirement	9DG sets totaling2050KVA will be used during construction phase leading to emissions due to fuel burning in the area where ambient air is free from such pollutants.
	Quarrying Operations	The Quarry area for Pemashelpu HEP is not identified exclusively; most of the material is obtained from the excavation done during project construction itself. Only small part of aggregate may be obtained from outside Quarry.
	Muck handling and transport	It is estimated that about 4.99 lakh m^3 of muck will be generated from excavation work about 46% of this will be used for the construction/ protection works and with 45% swelling factor, the total quantity of muck to be disposed off will be about 3.9 lakh m^3. This will be disposed off in the three identified and designated muck-dumping sites, which has a total area of 9.00 ha. Transportation and handling such large quantity of muck will lead to air pollution in the area.
Noise and Vibration	Increase in movement of vehicles	As discussed above
	Operation of construction Plants, Machineries, Workshops	As discussed above
	Operation of DG sets for power Requirement	As discussed above
	Blasting operations for tunneling	Potential environmental impacts of blasting include ground vibration (seismic waves), air overpressure, noise, dust and fly rock. Vibrations transmitted through the ground and pressure waves through the air are the most common impacts of blasting operations. Depending upon the location of the habitation, it can even damage the houses during the operation. At present there is no habitation along tunnel alignment, where such impacts become significant. Before the start of blasting, potential impact area will be identified depending upon blasting locations; photographs/videos of houses/structures likely to get damage due to blasting will be taken along with local authorities as a baseline to record any damage due due to blasting for the purpose of compensation.
Water Environment	Effluent from construction plant and workshops	A list of construction equipment is prepared project component wise and is given at Table 8.2. Their operation will generate pollution in all manifestations viz. air, water, noise and solid and hazardous waste. As some of the equipment will use water and discharge effluent, uncontrolled discharge will led to ground and surface water pollution.
	Muck Disposal	It is estimated that about 4.99 lakh m^3 of muck will be generated from excavation work and about 46% of total 7.24 lakh m^3 (with 45% swelling factor) will be used for the construction/

Component of Environment	Source/Reason of Impact	Quantification, where possible
		protection works and, the total quantity of muck to be disposed off will be about 389727 m^3. This will be disposed off in the three identified and designated muck-dumping sites, which has a total area of 9.00 ha. As most of the operation is along the riverbank, spillage of muck will lead to water pollution unless the operation is efficiently controlled.
	Sewage from construction camp and colonies	It is estimated that during the peak construction period, about 850persons will migrate to the area to stay in construction camps and work on project. Sewage from workers colony/construction camp can lead to serious water pollution if adequate treatment measures are not put in place.
Land Environment	Change of Land use	32.09 ha of land will be acquired for the project construction and land use of this land will change permanently. This is a permanent impact and no mitigation/management measures can be implemented for the entire land. However, land acquired for temporary construction camps, muck dumping and quarrying, etc. will be restored to bring back it to its original land use.
	Land deterioration due to muck disposal	Three dumping sites have been identified with total area of 9.00 ha. This land will be impacted due to muck dumping, however, Muck Disposal Plan will ensure that area is restored on completion of the muck dumping process so that impact remains temporary.
	Land deterioration due at construction sites, labour camps/colonies	4.36haof land has been identified as construction facilities area. This land will get impacted due to movement of vehicles, installation and use of construction equipment leading to discharge of pollutants in atmosphere. However, these impacts will be temporary as the land can be restored after completion of construction phase. Restoration of construction facility area is included in the EMP.
	Indiscriminate solid waste disposal	About 850persons are expected to migrate in the area during peak construction period. Construction and colony for workers and officers will generate solid waste - biodegradable as well as non-biodegradable. Littering of solid waste on hill slopes creates an unaesthetic scene also. Therefore, there is a need to implement a solid waste management plan to ensure that this waste will not create serious land and ground water pollution.
	Disposal of hazardous and biomedical waste on land	Hazardous waste will be generated during construction phase from machinery and equipment using fuel, lubricating oil, batteries, etc. Empty oil drums, used oil, maintenance/cleaning clothes, used batteries, etc. will constitute hazardous waste. Quantity of the hazardous waste expected to be generated cannot be estimated at this stage however, it is not expected to be large and can be managed by developing a temporary secured storage location and then transporting the waste to the nearest available TSDF. Biomedical Waste will be generated from the dispensaries set up to take care of workers medical needs, however, quantity is not expected to be very large. Therefore, biomedical waste will be securely kept in dispensary and will be transported to the nearest government/private hospital where an incinerator is installed for disposal of biomedical waste. As the quantity is not expected to be large, capacity of the host incinerator should not pose any constraint.
Flora	Loss of forest area due to project construction	The project construction would require acquisition of 32.09 ha (including area of 4.12 ha for underground structure) of forestland. All the vegetation on 32.09 ha land will be cleared for construction of project component. This is a permanent impact and can only be compensated by Compensatory Afforestation for which a plan is prepared and included in EMP.
	Tree cutting by workers for fuel wood/heating/furniture etc.	In addition to loss of forestland due to project construction, there is a potential impact of tree cutting by migratory labour force that would have fuel wood requirement and timber requirement for heating, furniture, etc. This impact can be mitigated by ensuring that labor's

Component of Environment	Source/Reason of Impact	Quantification, where possible
		fuel and timber requirement is taken care of. A plan prepared in this regard is included as part of EMP.
Fauna	Noise and vibration from construction activities including blasting, increased traffic, etc.	As discussed above, there will be higher sound levels in the area due to construction activities, operation of DG sets and other equipment's, blasting, etc. Blasting will also lead to ground vibration. Noise and vibration in the area will impact the fauna in the area especially avifauna, who may move away from the area permanently.
	Hunting and poaching	Hunting and poaching activities can be undertaken by migratory workforce and this will impact fauna of the region. As part of EMP, anti-poaching measures are suggested which needs to be implemented strictly that impact is eliminated.
	Loss of forest area	27.97 ha (excluding underground structure) of the over ground forestland will be cleared for the project construction and will directly impact fauna of the area.
Socio-economic	Social and cultural conflicts with migratory labour force	Influx of people in otherwise isolated area may lead to various social and cultural conflicts during the construction stage. Developers need to take help of local leaders, Panchayat and NGOs to ensure minimum impact on this count.
	Increase incidents of diseases due to migratory labour force	Large scale activity in the area due to the proposed project may become a cause of spread of various communicable diseases including HIV/AIDS in the project area as project requires long-term input of labour from outside the area and many of them may remain separated from their families for a long period of time.
	Direct job opportunities for locals	Locals will get direct employment opportunity in the project based on their qualifications and skill set. In addition, There will be various opportunities for local contractors to be involved in construction, fabrication, transportation, etc.
	Secondary jobs/service due to increased activity in the area	Due to construction of project there will be increased activity in the area. Migratory workforce will settle in the area and also there will be increased movement in the area due to material transport, consultants, engineers, etc. This will give job/service opportunity to the locals to meet their daily requirements of food, stay, etc.

8.3 IMPACTS DURING OPERATION PHASE

On completion of the construction of the project, the land used for construction activities, muck dumping, quarrying, etc. will be restored. Construction workers who have resided in that area will move to another project site. By ensuring all the mitigation and management measures, as planned for this project, are implemented to minimize the impact of construction phase, large part of the area will go back to its original form. However, there will be some permanent changes such as barrage across the river, reservoir formation, powerhouse and project colony. Hydropower projects are considered as clean source of renewable energy as there are no significant pollution generation sources during project operation. There is no air and water pollution from the project operation. Similarly generation of solid and hazardous waste is also insignificant.

One critical impact of operation of hydropower projects has received substantial attention from environmentalists in last two to three decades based on the observations made on operational projects in developed countries. Diversion of water from barrage to powerhouse will make the intermediate stretch of the river almost dry especially during lean season, except for the flow contribution of the intermediate catchment. However, the same will be compensated by release of minimum environment flow, for which requirement needs to be assessed in detail for different season. The aquatic ecology including fish fauna, riparian vegetation and fauna dependent on it; and downstream users requirements are to be assessed not only in lean season but also in all the months.

Pemashelpu HEP is in Siang sub-basin for which cumulative environment impact assessment study has recently been completed. The study was initiated by Central Water Commission, Government of India and the final report has been accepted by the Technical Appraisal Committee (TAC) specially constituted for the purpose. The report has dealt the subject of assessment of environment flow requirement in detail and made project specific recommendations. For Pemashelpu HEP; the recommendations made for the environment flow release are as follows:

Lean Season

Environment flow release in lean season should be based on average of four leanest months discharge in 90% dependable year i.e. average of 12 - ten daily values in four leanest months in 90% dependable year. Recommended release in lean season should be worked out as percentage of the average value and should be subtracted from the every 10 daily value of discharge available in the river in four leanest months, balance should be shown and used as discharge available for power generation. The report has recommended 25% release (1.1 cumec) in lean season as environment flow.

Monsoon Season

Environment flow release in monsoon should be based on average monsoon discharge in 90% dependable year i.e. average of 12 - ten daily values in four monsoon months in 90% dependable year. Recommended release in monsoon should be worked out as percentage of the average value and should be subtracted from the every 10 daily value of discharge available in the river in monsoon, balance should be shown and used as discharge available for power generation. The report has recommended 30% release in monsoon season as environment flow.

Non Monsoon Non Lean Period Season

Environment flow release in pre and post monsoon months (non monsoon and non lean period) should be based on average discharge in 90% dependable year in two pre-monsoon and two post-monsoon months i.e. average of 12 - ten daily values in four pre and post monsoon months in 90% dependable year. Recommended release in pre and post monsoon period should be worked out as percentage of the average value and should be subtracted from the every 10 daily value of discharge available in the river in pre and post monsoon period, balance should be shown and used as discharge available for power generation. The report has recommended 25% release in pre and post monsoon season as environment flow.

Keeping in view the recommendations made in basin study and the TOR requirement for environment flow release, provisions have been made in DPR for such releases and only balance water is used for power generation. This has resulted in revision of installed capacity from 90 MW to 81 MW, for which MoEF approval has already been taken.

Other impacts of the construction phase include formation of reservoir impacting the water quality and aquatic ecology, pollution generation from colony and plant and positive as well negative impacts on socio-economic environment mainly due to improved infrastructure in the area. These impacts are summarized at **Table 8.6**.

Table 8.6: Summary of Impacts during Operation Phase

Sl. No.	Component of Environment	Source/Reason of Impact	Quantification, where possible
1	Air Environment	No significant air pollution during operation phase	
2	Noise and Vibration	Noise and vibration from turbines	There is a provision of three vertical Francis turbines of 27 MW each to be housed in a surface powerhouse. Noise and vibration inside the powerhouse will be high especially during operation time when turbines are running at under capacity. Noise levels are expected to be in the range of 95-100 dB (A) at 1m from the source. These turbines will be housed within the powerhouse building, which will provide sufficient attenuation, therefore, impact of noise outside the powerhouse is not significant. Work instructions will be developed for workers working in the high noise area so as to limit their exposure to high noise and encourage the use of PPEs.
3	Water Environment	Reduced flow round the year in the river stretch between barrage and powerhouse	This is one of the most serious impacts of hydropower projects during their operation phase. Operation of the plant will involve diversion of water by 25m high barrage, through HRT of 4.172 km length to surface powerhouse. The intermediate river length of 5.7 km will become dry throughout the year but for the mandatory environmental flow releases. Reduced flow in the intermediate stretch will alter the aquatic ecology and change the fish habitat altogether. To minimize this impact, provisions for environment flow releases have been made in line with the TOR requirement and the recommendations made in Siang basin study.
4		Formation of reservoir	The flooding of previously forest and agricultural land in the submergence area will increase the availability of nutrients resulting from decomposition of the vegetative matter. Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. Enrichment of impounded water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. However, this phenomenon is likely to last for a short duration from the filling up of the reservoir.
5		Sewage from project colony	During the operation phase, due to absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O&M staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructural facilities, the problems of water pollution due to disposal of sewage are not anticipated. The treated sewage will be reused for gardening and green belt around the colony.
6	Land Environment		There will not be any negative impact on land during operation phase. Change of land-use is a permanent impact and has been covered under construction phase. There will be positive impact on land as part of the land used for temporary activities **(13.26 ha)** will be restored to natural conditions.
7	Flora and fauna		There will be no negative impact on flora of region during the operation phase. Impact on riparian vegetation and aquatic flora due to reduced flow in the intermediate stretch has been covered under water environment. Implementation of biodiversity conservation and management plan, catchment area treatment plan and compensatory afforestation plan will have positive impacts on flora in the area. Development of green belt in the project activity area and along the periphery of the reservoir will also have positive impact. Additionally, restoration of land used for muck dumping, construction activity, etc. will also have positive impact on the flora.

Sl. No.	Component of Environment	Source/Reason of Impact	Quantification, where possible
8	Socio-economic		Project construction will lead to large-scale infrastructure development in the area. Due to development of road network, accessibility to the area will significantly improve. Local area development activities planned as part of the project will not only benefit the project-affected families but also other people residing in the area including that of nearby villages. Setting up of school, health care facilities, skill development activity center, vocational training center, etc. will ensure higher education and skill levels of the local population. Provision of scholarships will help deserving students to go for higher studies. Overall it is expected that quality of life of the local population will improve due to setting up of the project in the area.