Tallo Seti (Tanahu) Hydropower Project (126 MW)
(Tanahu, Gandaki Province, Nepal)

Environmental Impact Assessment Report

Submitted to
Ministry of Forest and Environment (MoFE)
Singhadurbar, Kathmandu, Nepal

Through

Ministry of Energy, Water Resources, and Irrigation
Singhadurbar, Kathmandu, Nepal

and

Department of Electricity Development (DoED)
Sanogaucharan, Kathmandu, Nepal

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कार्यकारी सारंश

परिचय

नेपाल विद्युत प्राधिकरण (ने.वि.प्रा.)को सहायक कम्पनी तनहुँ हाइड्रोपावर लिमिटेडद्वारा प्रस्तावित तनहुँ र चितवन जिल्लाको बन्दीपुर गाउँपालिका, ऋषिङ्ग गाउँपालिका, देवघाट गाउँपालिका, आँबुखैरेनी गाउँपालिका, व्यास नगरपालिका र भरतपुर महानगरपालिकामा प्रस्तावित तल्लो सेती (तनहुँ) जलविद्युत आयोजना (१२६ मेगावाट) एक मुख्य आयोजना हो। मुलुकको वर्तमान उर्जा संकटको अवस्थालाई न्यूनीकरण गरी देशलाई उर्जामा स्व-निर्भर गराउन यो आयोजनाले निकै सहयोग गर्ने अपेक्षा गरिएको छ।

आयोजना सम्बन्धी विवरण

ने.वि.प्रा. नेपाल सरकारको पूर्ण स्वामित्व रहेको एक संस्था हो। वपकोस निप्पोन जेभी र टोटल म्यानेजमेन्ट सर्भिसेज प्रा.लि.ले आयोजना निर्माण गर्नु अघि वातावरण संरक्षण ऐन २०७७, वतावरण संरक्षण नियमावली, २०७८ र विधमान ऐन नियमको आधारमा प्रस्तावित आयोजनाको वातावारणीय प्रभाव मुल्यांकन अध्ययन कार्य गरेको छ। यस अध्ययनको मुख्य उदेश्य आयोजना स्थलको कार्यन्वयनबाट विधमान भौतिक, जैविक र सामाजिक-आर्थिक तथा संस्कृतिक वातावरणमा पर्नसक्ने नकारात्मक प्रभावहरुलाई न्यूनीकरण तथा निराकरण गरि सकारात्मक प्रभावहरुको पहिचान एवं कार्यान्वयन गर्नु रहेको छ।

तल्लो सेती जलविद्युत आयोजना पिकिङ रन अफ द रिभर (PROR) प्रकृतिको हो, जसले वार्षिक ५२०.७८ GWh ऊर्जा उत्पादन गर्नेछ। यस आयोजनाको बाँध तनहुँ जिल्लाको बन्दीपुर गाउँपालिका, सारङघाट नजिक सेती नदीमा प्रस्ताव गरिएको छ। बाँधको उचाइ ३२ मिटर हुनेछ र यसले करिब १२.७ कि.मी. लामो जलाशय बनाउनेछ। सञ्चित पानीलाई ६.७५ किमी लामो सुरुङमार्फत देवघाट गाउँपालिका, गाईघाटस्थित अर्धभूमिगत विद्युतगृहमा पठाइनेछ।

अध्ययन विधि

आयोजना प्रभाव क्षेत्रलाई प्रत्यक्ष र अप्रत्यक्ष प्रभाव क्षेत्र गरी वर्गीकरण गरिएको छ। प्रत्यक्ष प्रभाव क्षेत्र भन्नाले आयोजनाको संरचना निर्माण, निर्माण क्रियाकलाप, र सञ्चालनका कारण प्रत्यक्ष प्रभावित

हुने क्षेत्र, जसमा बाँध, विद्युतगृह, सुरुङ, डुबान क्षेत्र, र अन्य अस्थायी तथा स्थायी संरचनाहरू पर्दछन्। अप्रत्यक्ष प्रभाव क्षेत्र भन्नाले आयोजनाका संरचना वरपरको क्षेत्र, जसमा स्थानीय समुदाय, वन, वन्यजन्तु, वनस्पति, तथा सांस्कृतिक सम्पदा अप्रत्यक्ष रूपमा प्रभावित हुनेछन्।

तथ्याङ्क संकलन

- भौतिक तथा रासायनिक वातावरण: भू-उपयोग, भौगर्भिक अवस्था, जलवायु, हावापानी, र नदीको बहाव सम्बन्धि तथ्याङ्कहरू संकलन र विश्लेषण गरिएको छ।
- जैविक वातावरण: वन, वनस्पति, वन्यजन्तु, चरा, तथा माछासम्बन्धी स्थलगत अध्ययन र स्थानीय अन्तर्क्रियाबाट जानकारी संकलन गरिएको छ।
- सामाजिक-आर्थिक वातावरण: प्रभावित घरधुरी, जनसंख्या विवरण, पूर्वाधार, जीविकोपार्जन, र सांस्कृतिक सम्पदाहरूको तथ्याङ्क संकलन गरिएको छ।

सरोकारवालाको संलग्नता

अध्ययन क्रममा क्षेत्र निर्धारण, घरधुरी सर्वेक्षण, र सार्वजनिक सुनुवाईमार्फत सरोकारवालाहरूको सुझाव र प्रतिक्रियालाई समेटिएको छ।

- **क्षेत्र निर्धारण**: वडाध्यक्षहरू तथा स्थानीय निकायहरूसँग अन्तरक्रिया।
- **घरधुरी सर्वेक्षण**: प्रभावित परिवारलाई आयोजनाको जानकारी र अन्तरक्रिया।
- **सार्वजनिक सुनुवाई**: मिति २०८०-०३-१४ मा खहरे, बन्दीपुर गाउँपालिकामा १६६ जनाको सहभागितामा सुनुवाई सम्पन्न।

सिफारिस पत्र संकलन

सम्बन्धित स्थानीय तह, वडाहरू, र सामुदायिक वन उपभोक्ता समूहहरूसँग सिफारिस पत्र तथा सुझावहरू संकलन गरिएको छ।

प्रभावको मूल्याङ्कन

प्रस्तावित आयोजनाको निर्माण र सञ्चालनका कारण हुने भौतिक, जैविक, तथा सामाजिक-आर्थिक प्रभावहरूको परिमाण, सीमा, र अवधिको आधारमा मूल्याङ्कन गरिएको छ।

विद्यमावन वातावरणीय अवस्था

भौतिक वातावरण

सेती नदी गण्डकी नदी प्रणालीको प्रमुख नदी हो, जसले १४% जलाधार क्षेत्र ओगटेको छ र गण्डकी नदीको कुल बहावमा ११% योगदान पुऱ्याउँछ। प्रस्तावित आयोजना सेती र त्रिशूली नदीको संगमबाट करिब ११ कि.मी. माथि र मादी खोलाको संगमभन्दा २२ कि.मी. तल अवस्थित छ।

आयोजना निर्माणले तनहुँ जलविद्युत आयोजनाबाट पानी उपयोग गर्नेछ, जहाँ सुख्खा मौसममा ५० घनमिटर/सेकेन्ड र वर्षायाममा ६०० घनमिटर/सेकेन्ड बहाव रहनेछ।

वायुको गुणस्तरमा PM2.5 र CO2 औसत रूपमा मापन गरिएको थियो। ध्वनिको गुणस्तर निर्माण गतिविधि र सवारी साधनको कारण मध्यम देखिएको थियो। पानीको गुणस्तर मध्यम रहेको पाइयो भने कोलिफर्मको मात्रा बढी देखिएको थियो।

जैविक वातावरण

- **वनस्पतिः** आयोजना क्षेत्रमा १८४ प्रजातिका वनस्पतिहरू भेटिएका छन्। प्रमुख रुखमा सिरिस, राम रिट्ठा, साल, सिन्दुरे, र खिर्रो छन्। संरक्षित प्रजातिमा साल, सतिसाल, भ्याकुर, र सुनाखरीका दुई प्रजाति छन्।
- **वन्यजन्तुः**

  ३८ प्रजातिका हर्पेटोफौना (१० उभयचर, १२ छेपारो, २ कछुवा, १३ सर्प) पाइएका छन्। *Indotestudo elongata* (CR) र अन्य प्रजातिहरू CITES तथा IUCNको सूचीमा छन्। स्तनधारीका २९ प्रजातिहरू रिपोर्ट गरिएको थियो।
- **चराहरूः**

  अध्ययनको क्रममा ८३ प्रजातिका ५९४ चराहरू अवलोकन गरिएको थियो जसमा ४८ रैथाने र ३५ आगन्तुक प्रजातिका चराहरु थिए।
- **माछाः**

  अध्ययनको क्रममा ६८ प्रजातिका माछा रेकोर्ड गरिएएको थियो, जसमा २२ आगन्तुक प्रजाति थियो।

सामाजिक, सांस्कृतिक र आर्थिक वातावरण

आयोजना क्षेत्र तनहुँ जिल्लाका ऋषिङ्ग, देवघाट, बन्दीपुर, आँबुखैरेनी, व्यास, र चितवन जिल्लाको भरतपुर महानगरपालिकाका विभिन्न वडाहरूमा फैलिएको छ। आयोजनाका लागि २८५ घरधुरीको स्वामित्वमा रहेका ४३७ कित्ता आवश्यक पर्नेछ। प्रभावित परिवारको जनसङ्ख्या ९७९ रहेको छ, जसमा ५४.४४% पुरुष र ४५.५५% महिला रहेका छन्। क्षेत्रका बस्तीहरूमा गुरुङ र मगर जातिको बाहुल्यता रहेको छ भने बोटे, भुजेल, नेवार, बाहुन र क्षेत्री जातिहरू पनि बसोबास गर्छन्। मुख्यतः नेपाली भाषा बोलिने भए पनि गुरुङ र मगर जातिले आफ्नो मातृभाषा समेत प्रयोग गर्ने गर्छन्।

प्रभावित बस्तीहरूमा अधिकांश घरहरू माटो र ढुङ्गाले बनेका छन्। आयोजनाबाट मास्दी घाट, खहरेटार, सारङघाट, गाईघाट लगायतका बस्तीहरू प्रभावित हुनेछन्। यस क्षेत्रमा दशैं, तिहार, ल्होसार, माघे संक्रान्ति, फागु पूर्णिमा, चण्डीपूर्णिमा र बुद्ध पूर्णिमा जस्ता चाडपर्वहरू मनाइन्छन्। आयोजनाका कारण दुई सामुदायिक विद्यालय, श्री सेती गंगा प्राथमिक विद्यालय र श्री जनता प्राथमिक विद्यालय प्रभावित हुनेछन्।

सेती नदीको किनारमा रहेका मसदीघाट, खहरेघाट, नलबुङ, रुम्से लगायतका घाटहरूमा स्थानीयले दाहसंस्कार गर्ने चलन छ। यी क्षेत्रको सांस्कृतिक विविधता, धार्मिक स्थलहरू, र चाडपर्वहरूले सामाजिक, सांस्कृतिक र आर्थिक वातावरणमा महत्वपूर्ण स्थान ओगटेको देखिन्छ।

वातावरणीय प्रभाव

आयोजना निर्माणका लागि कुल २७१.४५ हेक्टर जग्गा आवश्यक पर्नेछ, जसमध्ये २१०.३० हेक्टर स्थायी र ६१.१५ हेक्टर अस्थायी रूपमा प्रयोग गरिनेछ। स्थायी रूपमा आवश्यक जग्गामा ५४.३२ हेक्टर वन क्षेत्र र २७.०३ हेक्टर निजी कृषियोग्य जमिन पर्दछन्। निर्माण चरणमा सम्भावित प्रभावहरूमा भू-बनोटको परिवर्तन र जमिन अस्थिरता, ध्वनी र वायु प्रदूषण, उत्खनन् र निर्माण सामग्री थुपार्दा हुने प्रदूषण, साथै मेसिन र औजार मर्मत गर्दा निस्किने तेल, मोबिल, र ग्रिजबाट हुने प्रदूषण समावेश छन्। संचालन चरणमा बाँधको कारण ११ कि.मी. लामो सेती नदी क्षेत्रमा पानीको बहाबमा कमी आउनेछ, जसले नदीको पारिस्थितिकीमा असर पुर्याउन सक्छ।

आयोजनाले १६१.४६ हेक्टर वन क्षेत्र प्रयोग गर्नेछ, जसमा २७ प्रजातिका १९,११५ रूखहरू कटान गरिनुपर्ने अनुमान गरिएको छ। प्रमुख प्रजातिहरूमा पड्के सिरिस, राम रिट्ठा, साल, सिन्दुरे, र खिर्रो रहेका छन्। यस वनक्षेत्रमा रूख कटानीको परिणामस्वरूप चरा र वन्यजन्तुको वासस्थानमा प्रभाव पर्नेछ। विशेष गरी, सिमलका रूख हटाउँदा गिद्धहरूको गुँड प्रभावित हुनेछ र वन्यजन्तुको आवतजावत र व्यवहारमा अवरोध सिर्जना हुनेछ।बाँध निर्माणले सेती नदीमा माछाको आवतजावतमा प्रभाव पर्नेछ र माछाका आहारा र प्रजनन क्षेत्रहरूमा कमी ल्याउनेछ। साथै, कम बहाब हुने ११ कि.मी. क्षेत्रमा जलचर, नदी किनाराको वनस्पति, र नदी वरपरका वन्यजन्तु तथा समुदायहरूमा प्रतिकूल असर पर्नेछ।

आयोजना अन्तर्गत कुल २७१.४५ हेक्टर जग्गा अधिग्रहण गरिनेछ, जसमा २१०.३० हेक्टर स्थायी र ६१.१५ हेक्टर अस्थायी हुनेछ।कुल ४३७ कित्तामा ३५५ निजी (३० रिसोर्ट, १ विद्यालय, ३२४ व्यक्तिगत), ६२ सरकारी, ८ सार्वजनिक, र १२ अज्ञात स्वामित्वका जग्गा रहेका छन्। २८५ घरधुरी प्रत्यक्ष प्रभावित हुनेछ। कुल २४८ निजी संरचनाहरू (आवासीय, व्यावसायिक, भान्सा, जनावरका गोठ, माछा पोखरी आदि) प्रभावित हुनेछ। साथै जनता प्राथमिक विद्यालय, सामुदायिक हल, र २ पसलहरू विस्थापित हुनेछन्। ३ मन्दिर र विभिन्न घाटहरू पनि प्रभावित हुनेछन्।

प्रभाव न्यूनिकरणका उपायहरू

आयोजनाबाट हुने भौतिक वातावरण सम्बन्धी प्रभावलाई कम गर्न विभिन्न विधिहरू लागू गरिनेछन्। बायो इन्जिनियरिङ प्रविधिको प्रयोग गरी जमिनको स्थिरता सुनिश्चित गरिनुका साथै निर्माण अवधिमा पहिचान गरिएका संभावित र सक्रिय पहिरोहरूको रोकथाम गरिनेछ। निर्माणका लागि प्रयोग गरिने जग्गाको माथिल्लो माटो सुरक्षित रूपमा भण्डारण गरी पुनः प्रयोग गरिनेछ। सेती नदीमा पर्यावरणीय सन्तुलन कायम गर्न मासिक बहावको १०% नदीमा छोडिनुका साथै थप विस्तृत अध्ययन गरी पर्यावरणीय बहाव निर्धारण गरिनेछ। स्थानीय जनतालाई सावधान गर्न साइरन जडान गरी समयमै सूचना प्रदान गरिनेछ। साथै, ध्वनि र धुलो प्रदूषण नियन्त्रणका लागि कम प्रदूषण उत्पन्न गर्ने मेसिनरीहरूको प्रयोग, निर्माण सामग्री ढाकेर राख्ने र फोहरको उचित व्यवस्थापन गरिनेछ।

जैविक वातावरणको प्रभावलाई न्यूनीकरण गर्न आयोजनाले विशेष ध्यान दिनेछ। प्रभावित रूखहरूको क्षतिपूर्ति स्वरूप १ रूख बराबर १० वटा बिरुवा रोपिने योजना अनुरूप १,९१,१५० नयाँ बिरुवा रोपिनेछ। वन क्षेत्रको प्रयोगबापत क्षतिपूर्ति स्वरूप वन विकासका लागि आवश्यक व्यवस्था गरिनेछ। जङ्गली जनावरहरूको अवैध सिकार रोक्न गस्ती, कानूनको कडाइ, र जनचेतना अभिवृद्धि कार्यक्रम संचालन गरिनेछ। महत्त्वपूर्ण वासस्थानको संरक्षण, जैविक विविधताको प्रवर्द्धन, र माछाको संरक्षणका लागि फिस ल्याडर र ह्याचरी जस्ता प्रविधिहरू अपनाइनेछन्। ह्याचरीमार्फत कृत्रिम प्रजनन प्रणालीको विकास गरी जलीय जैविक विविधता संरक्षणको प्रयास गरिनेछ।

अधिग्रहण गरिएका जग्गा, घरटहरा, र व्यवसायहरूलाई न्यायोचित मुआब्जा र क्षतिपूर्ति प्रदान गरिनुका साथै सार्वजनिक, धार्मिक, र सांस्कृतिक संरचनाहरूको पुनःस्थापना गरिनेछ। सामुदायिक सहयोग कार्यक्रम (CSP) मार्फत रोजगारीका अवसर, पुनर्वास सहयोग, र जीविकोपार्जनमा समर्थनका लागि ने.रु १२०,६००,०००. विनियोजन गरिएको छ। यस कार्यक्रमले विशेषगरी जोखिममा परेका परिवारहरू र आदिवासी समूहहरूको हितमा ध्यान केन्द्रित गर्नेछ। आयोजना निर्माण र सञ्चालनका क्रममा सबै विधिहरूको प्रभावकारी कार्यान्वयन सुनिश्चित गरिनेछ।

वातावरणीय व्यवस्थापन योजना

वातावरणीय व्यवस्थापन योजनाले वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा उल्लिखित प्रभाव न्यूनीकरणका उपायहरूको कार्यान्वयन सुनिश्चित गर्नेछ। यस योजनाले निर्माण र सञ्चालन चरणमा अनुगमनको रणनीति तयार पार्नेछ, जसमा अनुगमन गर्ने स्थान, समय र सूचाङ्कहरू समावेश हुनेछ। वातावरणीय व्यवस्थापनको प्रमुख जिम्मेवारी प्रस्तावकको हुनेछ र अनुकूल तथा प्रतिकूल प्रभावहरूलाई सम्बोधन गर्न विभिन्न कार्यहरू कार्यान्वयन गरिनेछन्। यसका लागि कुल ८३,१०,४८८ अमेरिकी डलर लागत अनुमान गरिएको छ, जसमा अनुगमन खर्च ४८५,००० अमेरिकी डलर र लेखा परीक्षण लागत ५७,६९२ अमेरिकी डलर हुनेछ। तसर्थ, वातावरणीय व्यवस्थापन योजनाको कुल अनुमानित लागत ८,८५३,१८० अमेरिकी डलर रहनेछ।

निष्कर्ष

प्रस्तावित १२६ मेगावाट क्षमताको पिकिङ रन अफ द रिभर (PROR) आयोजनाले वार्षिक ५२०.७८ GWh ऊर्जा उत्पादन गर्नेछ। जलाशय, बाँध, र मुख्य सुरुङ यसका प्रमुख संरचनाहरू हुन्। यसले तनहुँ जलबिधुत आयोजनासँग मिलेर नेपालको जलविद्युत क्षमता वृद्धि गर्ने र हरितगृह ग्यास उत्सर्जन घटाउने काम गर्नेछ। यस आयोजनाले २३७.८५ हेक्टर जग्गा प्रयोग गर्नेछ र २८५ घरधुरीलाई प्रभावित पार्नेछ। विभिन्न नकरात्मक प्रभावहरूको न्यूनीकरणका उपायहरू यस अध्ययनमा समावेश गरिएको छ। आयोजनाले न्यूनीकरण उपायहरू कार्यान्वयन गर्दै स्वच्छ हरित ऊर्जा उत्पादन, रोजगारीको अवसर सृजन, र पूर्वाधार सुधार गर्दै नेपाललाई ऊर्जामा आत्मनिर्भर बनाउन मद्दत गर्नेछ।

आयोजनाको वातावरणीय प्रभाव मूल्यांकन प्रतिवेदनमा समावेश गरिएका प्रभाव न्यूनीकरण उपायहरूको प्रभावकारी कार्यान्वयनको लागि वातावरणीय व्यवस्थापन योजना तयार गरिएको छ। यस योजनालाई प्रभावकारी रूपमा कार्यान्वयन गर्ने जिम्मेवारी प्रस्तावक (तनहुँ हाइड्रोपावर लिमिटेड) ले वहन गर्नेछ। आयोजना कार्यान्वयनको क्रममा थप प्रभावहरू देखा परेमा, उपयुक्त समाधानहरू अपनाइनेछन्। अन्ततः, प्रस्तावित हरित ऊर्जा उत्पादनले नेपालको ऊर्जा क्षेत्रमा महत्त्वपूर्ण योगदान पुर्याउने भएकाले, यो परियोजना वातावरणीय दृष्टिकोणबाट उपयुक्त ठहरिन्छ।

बिषय सुची

तालिकाको सुची

चित्रहरुको सुची

१. परिचय

प्रस्तावित तल्लो सेती जलविद्युत आयोजना पिकिङ रन अफ द रिभर (PROR) प्रकृतिको जडित क्षमता १२६ मेगावाटको आयोजना हो। यस आयोजनाले वार्षिक ऊर्जा ५२०.७८ गिगावाट आवर उत्पादन गर्नेछ। आयोजनाको बाँध बन्दीपुर गाउँपालिकाको सारङघाट नजिकै सेती नदीमा प्रस्ताव गरिएको छ जसको उचाइ ३२ मिटर रहेको छ। आयोजनाको बाँध निर्माणबाट सेती नदीमा करिब १२.७ किलोमिटर लामो जलाशय बन्नेछ। जलाशयमा सञ्चित पानीलाई ६.७५ किलोमिटर लामो सुरुङ मार्फत देवघाट गाउँपालिकाको गाईघाटमा अर्धभूमिगत विद्युतगृहमा पुऱ्याइ विद्युत् उत्पादन गर्ने प्रस्ताव गरिएको छ। यो आयोजना हाल निर्माणाधीन तनहुँ जलविद्युत आयोजनाको तल्लो तटीय क्षेत्रमा प्रस्ताव गरिएको छ। यस आयोजनाले तनहुँ जलविद्युत आयोजनाबाट आउने पानी र मादी नदीको थप पानी प्रयोग गर्नेछ।

यस आयोजना निर्माण भएपछि, देशमा आवश्यक रहेको ऊर्जाको उपलब्धतामा थप वृद्धि हुनुको साथै नेपालमा इन्धन आपुर्तिमा भइरहेको वन विनाशमा कमी आउनेछ। नेपालबाट उत्सर्जन हुने हरित गृह ग्यासको मात्रामा उल्लेखनिय कमी ल्याई वातावरण संरक्षणमा समेत महत्वपूर्ण योगदान गर्नेछ। आयोजनाको कार्यान्वयनबाट नेपाल ऊर्जामा आत्मनिर्भर भई देशमा भरपर्दो र विश्वसनिय ऊर्जा उपलब्ध हुनेछ।

२. प्रस्तावकको नाम, ठेगाना, इमेल र फोन नम्बर

यस आयोजनाको प्रस्तावक नेपाल सरकारको मातहतमा रहेको नेपाल विद्युत प्राधिकरणको पूर्ण स्वामित्व रहेको "तनहुँ हाइड्रोपावर लिमिटेड" रहेको छ।

प्रस्तावकको सम्पर्क विवरण

तनहुँ हाइड्रोपावर लिमिटेड
तल्लो सेती (तनहुँ) जलविद्युत आयोजना
चुनदेवी मार्ग, महाराजगंज, काठमाडौं, नेपाल
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३. परामर्शदाताको नाम, ठेगाना, इमेल र फोन नम्बर

तनहुँ हाइड्रोपावर लिमिटेडले वातावरणीय प्रभाव मूल्याङ्कन अध्ययन प्रतिवेदन तयार गर्ने जिम्मेवारी वपकोस लिमिटेड (इन्डिया) र निप्पोन कोइ (जापान) अर्थात् वपकोस निप्पोन जेभीलाई दिइएको छ। यस अध्ययन नेपालमा रहेका टोटल म्यानेजमेन्ट सर्भिसेज प्रा. लि. र जीइओस कन्सल्टेन्ट प्रा. लि.को सहकार्यमा गरिने सम्झौतामा उल्लेख छ।

वपकोस निप्पोन जेभी

कमलपोखरी, काठमाडौं, नेपाल

टेलिफोनः ९७७-०१-४४३५८२६

इमेलः lowsetihpp@gmail.com

टोटल म्यानेजमेन्ट सर्भिसेज प्रा.लि.

कमलपोखरी, काठमाडौं, नेपाल

टेलिफोनः ९७७-१-४४३९१८२, ४४३९१८७

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४. अध्ययनको औचित्यता

वातावरण संरक्षण नियमावली २०७७ को परिच्छेद २, नियम ३, उपदफा १ मा वातावरणीय अध्ययन गर्नुपर्ने प्रावधान राखिएको छ। सोही नियमावलीको अनुसूची ३ (ऊ) को जलस्रोत तथा ऊर्जा क्षेत्र (१) मा ५० मेगावाटभन्दा बढी क्षमताको जलविद्युत उत्पादन आयोजना निर्माण गर्न पूर्व वातावरणीय प्रभाव मूल्याङ्कन अध्ययन गर्नुपर्ने प्रावधान रहेको छ। साथै, उपखण्ड ५ अनुसार विद्युत प्रसारण लाइन बाहेक अन्य प्रयोजनको लागी ५ हेक्टर भन्दा बढीको वन क्षेत्र, वन संरक्षण क्षेत्र, संरक्षण क्षेत्र, मध्यवर्ती क्षेत्र तथा वातावरण संरक्षण क्षेत्रको वनको जग्गा प्रयोग गर्ने भएमा वातावरणीय प्रभाव मूल्याङ्कन अध्ययन गर्नु अनिवार्य रहेको छ। यस आयोजनाको विद्युत उत्पादन क्षमता १२६ मे.वा. रहेको र यसले करिब १६१.४६ हेक्टर वन क्षेत्र प्रयोग गर्ने हुनाले वातावरणीय प्रभाव मूल्याङ्कन गर्नु आवश्यक भएको हो ।

यसबाहेक आयोजना कार्यान्वयनका क्रममा २८५ घरधुरीहरु प्रभावित हुनेछन्। साथै, यसको कार्यान्वयनबाट आयोजना क्षेत्रमा पाइने वन्यजन्तु र आयोजना प्रस्तावित सेती नदीमा पाइने माछाका वासस्थानलाई समेत प्रभाव पार्ने छ। तसर्थ, प्रस्तावित आयोजना एसियाली विकास बैंकको सुरक्षण नीति कथन २००९ (ADB SPS 2009) अनुसार श्रेणी "क" मा परेको छ। यस आयोजनालाई एसियाली विकास वैंकले लगानी गर्ने इच्छा देखाएको कारण नेपाल सरकार र एसियाली विकास बैंकको ऐन, कानून र वातावरणीय तथा सामाजिक सुरक्षण नीतिहरुलाई सम्बोधन गर्न वातावरणीय प्रभाव मूल्याङ्कन अध्ययन गरिएको छ।

वातावरण संरक्षण नियमावली, २०७७ को नियम ७(८) अनुसार विदेशी लगानी भएका प्रस्तावहरुको हकमा तयार गरिने वातावरणीय प्रभाव मूल्याङ्कन अध्ययन प्रतिवेदन अङ्ग्रेजी भाषामा तयार गर्न सकिनेछ। यस आयोजना विकास गर्न एसियाली विकास बैंकले इच्छा देखाएको र अध्ययनको लागि पनि सोही बैंकले लगानी गरेको कारण यस आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन अध्ययन प्रतिवेदन अङ्ग्रेजी भाषामा तयार गरिएको छ र सोहि नियम अनुसार यो संक्षिप्त प्रतिवेदन नेपाली भाषामा तयार गरिएको र सोही नियम अनुसार यो संक्षिप्त प्रतिवेदन नेपाली भाषामा तयार गरिएको हो। नेपाल विद्युत प्राधिकरण र एसियाली विकास बैंक बीचको सम्झौता यस प्रतिवेदनको अनुसूची ए-२ मा संलग्न गरिएको छ।

५. अध्ययनको उद्देश्य

वातावरणीय प्रभाव मूल्याङ्कनको मुख्य उद्देश्य प्रस्तावित आयोजनाको कार्यान्वयनबाट आयोजना क्षेत्रको भौतिक, रासायनिक, जैविक, सामाजिक तथा सांस्कृतिक वातावरणमा पर्न सक्ने सकारात्मक तथा नकारात्मक प्रभावहरूको अध्ययन गरी सकारात्मक प्रभावहरुको बढोत्तरी र नकारात्मक प्रभावहरुको न्यूनीकरण गर्ने उपायहरू पहिल्याउनु हो।

६. आयोजना सम्बन्धी विवरण

आयोजनाले सेती नदीको पानी प्रयोग गरी विद्युत उत्पादन गर्नेछ। आयोजनाको बाँध तनहुँ जिल्लाको बन्दीपुर गाउँपालिका सारङघाट नजिकै सेती नदीमा प्रस्ताव गरिएको छ र यसको उचाइ ३२ मिटर रहेको छ। आयोजनाको विद्युत गृह अर्धभूमिगत प्रकृतिको हुनेछ र यो देवघाट गाउँपालिका

गाईघाटमा प्रस्ताव गरिएको छ। बाँधबाट विधुतगृहसम्म करिव ६.७५ किलोमिटर लामो सुरुङको निर्माण गरी पानी लगिने छ।

तालिका १: आयोजनाको मुलभूत विशेषता

आयोजना स्थान	
प्रदेश	गण्डकी र वागमती प्रदेश
जिल्ला	तनहुँ र चितवन
गाउँपालिका/नगरपालिका/ महानगरपालिका र वडा	**तनहुँ जिल्ला** रिसिङ गाउँपालिका - १, ३ व्यास नगरपालिका - १३, १४ बन्दीपुर गाउँपालिका - ६ देवघाट गाउँपालिका - २, ३, ४ आँबुखैरेनी गाउँपालिका - ५, ६ **चितवन जिल्ला** भरतपुर महानगरपालिका - २९
अक्षांश	२७° ४७' ३०" देखि २७° ५५' ००"
देशान्तर	८४° १७' ३०" देखि ८४° २८' ४२"
प्रकार	अर्धजलाशययुक्त (पिकिङ रन अफ द रिभर)
डिजाइन डिस्चार्ज	२०६.९ घनमिटर प्रति सेकेन्ड
बाँध	
बाँधको प्रकार	बराज
बाँधको उचाइ	३२ मिटर नदीको पिंधबाट ३१ मिटर
बाँधको लम्बाइ	२१३ मिटर बाँधको माथिल्लो सतहको लम्बाइ २०० मिटर
सुरुङ	

मुख्य सुरुङ मार्गको लम्बाइ	६७६३ मिटर
मुख्य सुरुङ मार्गको प्रकार	Modified Horseshoe, finished circular
भित्रि व्यास	८.२५ मिटर
पेनस्टक	
पेनस्टकको प्रकार	गोलाकार
भित्रि व्यास	६.७५ मिटर
लम्बाइ	१९७ मिटर
विद्युतगृह	
विद्युतगृहको प्रकृति	अर्ध-भूमिगत
टर्बाइन	फ्रान्सिस
संख्या	३
प्रति एकाइ क्षमता	४२.० मेगावाट
अन्य	
आयोजना प्रभावित परिवारको कुल संख्या	२८५
कटान गर्नुपर्ने रुख सङ्ख्या	१९,११५
आयोजनाको लागि आवश्यक जग्गा	स्थायीः २१०.३० हेक्टर अस्थायीः ६१.१५ हेक्टेर
आयोजनाको अनुमानित लागत	१८० मिलियन अमेरिकी डलर (२३ अर्ब ९४ करोड नेपाली रुपैया - विनिमय दर १३३ रुपैयाँ प्रति अमेरिकी डलर)
निर्माण अवधि	५.५ वर्ष

७. अध्ययन विधि

वातावरण संरक्षण नियमावली २०७७ नियम ७ को प्रावधान अनुसार तथा स्वीकृत क्षेत्र निर्धारण र कार्यसूचीमा उल्लेख गरिए अनुसारको विधि अवलम्बन गरि यस आयोजनाको वतावरणीय प्रभाव मुल्यांकन प्रतिवेदन तयार पारिएको हो।

७.१. आयोजना प्रभाव क्षेत्र

प्रस्तावित आयोजनाको संरचना बन्ने र आयोजनाको कृयाकलापका कारण प्रभावित हुने स्थानीय तहका वडाहरुको सिमाना क्षेत्रलाई आयोजना प्रभावित क्षेत्र अन्तर्गत राखिएको छ। यस आयोजनामा चितवन र तनहुँ जिल्लाका ६ वटा स्थानीय तहहरुका ११ वटा वडाहरु प्रभावित हुनेछन्। प्रभावित वडाहरु मध्ये १० वटा वडाहरु तनहुँ जिल्लामा पर्ने छन् भने एक वडा चितवन जिल्लामा पर्नेछ। आयोजनाबाट प्रभावित हुने वडाहरुको विवरण आयोजनाको मुलभूत विशेषतामा दिइएको छ। आयोजना प्रभावित क्षेत्रलाई अझ स्पष्ट पार्न प्रत्यक्ष प्रभाव क्षेत्र र अप्रत्यक्ष प्रभाव क्षेत्र गरी दुई भागमा वर्गिकरण गरिएको छ।

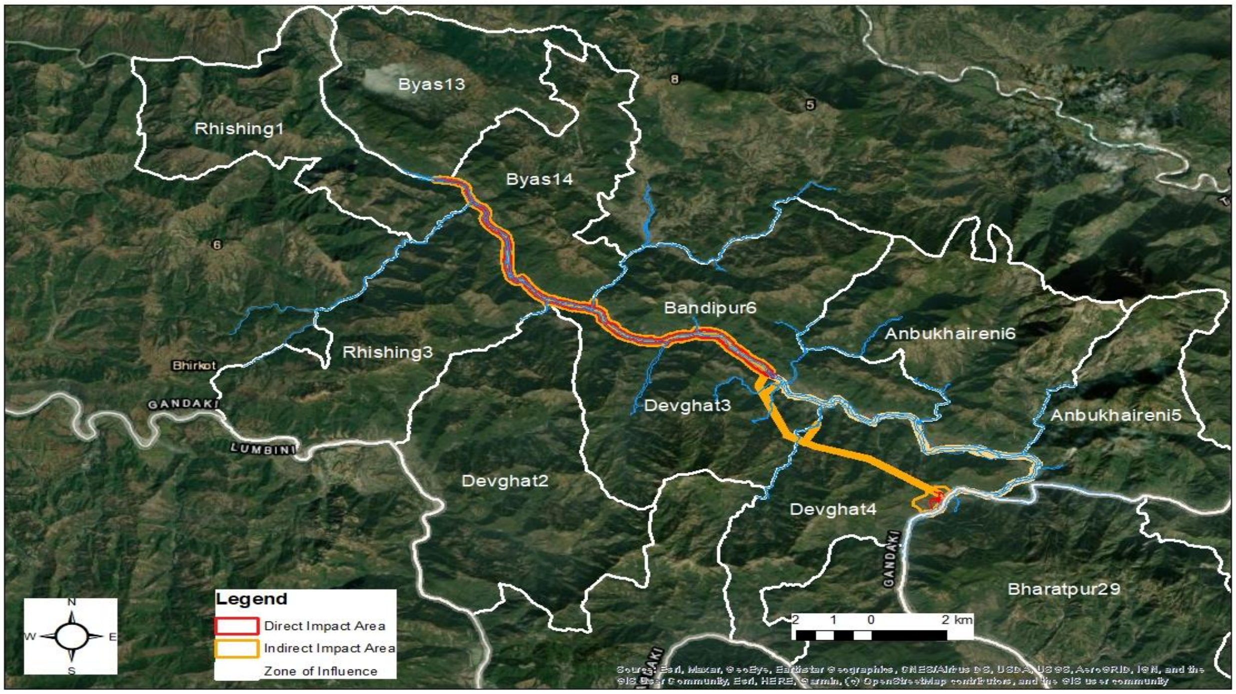
७.१.१. प्रत्यक्ष प्रभाव क्षेत्र

आयोजनाका संरचनाहरु बन्ने, आयोजना निर्माण क्रियाकलाप हुने र आयोजनाको निर्माण तथा संञ्चालनको कारण प्रभावित हुने क्षेत्रलाई प्रत्यक्ष प्रभावित क्षेत्र अन्तर्गत राखिएको छ। प्रत्यक्ष प्रभावित क्षेत्रमा बाँध क्षेत्र, विद्युतगृह, हेडरेस टनेल, कम वहाव हुने क्षेत्र, अडिटहरु, कामदार आवास क्षेत्र, डुबान क्षेत्र लगायत सबै स्थायी र अस्थायी संरचनाहरु रहेको क्षेत्र यस अन्तर्गत राखिएको छ।

७.१.२. अप्रत्यक्ष प्रभाव क्षेत्र

आयोजनाका संरचनाहरु रहेको वरिपरीको क्षेत्रलाई अप्रत्यक्ष प्रभावित क्षेत्र भनिन्छ। अप्रत्यक्ष प्रभावित क्षेत्र आयोजनाका संरचनाहरु रहेका वडा सिमाना सम्म पर्दछ। अप्रत्यक्ष प्रभावित क्षेत्रमा बस्ने समुदाय, त्यस क्षेत्रका वन, वन्यजन्तु तथा वनस्पतिहरु, धार्मिक तथा सांस्कृतिक धरोहरहरु अप्रत्यक्ष रुपमा प्रभावित हुनेछन्। प्रस्तावित आयोजनाले अन्तराष्ट्रिय मापदण्डको पालना गर्ने भएको कारण यदि कुनै समुदायहरुले प्रयोग गर्दै आएको प्राकृतिक स्रोत सम्मको पहुँच यस आयोजना

निर्माणको कारण गुमाउनु परेमा त्यस समुदायलाई अप्रत्यक्ष प्रभावित समुदायमा राखिनेछ। यी क्षेत्रहरुमा तनहुँ जिल्लाको रिसिङ गाउँपालिका वडा नं. १ र ३; व्यास नगरपालिका वडा नं. १३ र १४; बन्दीपुर गाउँपालिका वडा नं. ६; देवघाट गाउँपालिका वडा नं. २, ३ र ४ र आँबुखैरेनी गाउँपालिका वडा नं. ५ र ६ र चितवन जिल्लाको भरतपुर महानगरपालिका वडा नं. २९ पर्दछन्।



चित्र १: आयोजना प्रभाव क्षेत्र

७.२ तथ्याङ्क संकलन

अध्ययनका क्रममा भौतिक तथा रासायनिक वातावरण, जैविक वातावरण र सामाजिक-आर्थिक तथा सांस्कृतिक वातावरणसँग सम्बन्धित आवश्यक तथ्याङ्कहरु संकलन गरिएको थियो। तथ्याङ्क संकलनका क्रममा आयोजनासँग सम्बन्धित प्रकाशित तथा अप्रकाशित सन्दर्भ सामाग्रीहरुको पुनरावलोकन गरिएको थियो। आयोजनाको प्राविधिक प्रतिवेदन पुनराबलोकन गरिएको थियो। आयोजनासँग सम्बन्धित नक्सा र अन्य आवश्यक जानकारीहरु सम्बन्धित निकायहरुबाट संकलन गरिएको थियो।

७.२.१ भौतिक तथा रासायनिक वातावरण

आयोजना क्षेत्रको भौगोलिक अवस्थिति, भू-उपयोग, भौगर्भिक अवस्था, भूकम्पीय अवस्थाको बारेमा स्थलगत अवलोकन तथा प्रकाशित तथा अप्रकाशित प्रतिवेदनहरुबाट विश्लेषण गरिएको थियो। आयोजना क्षेत्रको नापी नक्सा, भौगर्भिक नक्सा, टोपोग्राफि नक्सा र गुगल नक्सा संकलन गरी तिनीहरुको अध्ययन गरिएको थियो। आयोजना बन्ने नदीको बाँध भन्दा माथिल्लो क्षेत्रको जलाधार भूउपयोग नक्साका आधारमा जिआइएस सफ्टवेर प्रयोग गरी विश्लेषण गरिएको थियो। आयोजना क्षेत्रको हावा पानी तथा मौसमको अवस्था बारे जल तथा मौसम विज्ञान विभागबाट तथ्याङ्क संकलन गरी अध्ययन गरिएको थियो। आयोजना बन्ने सेती नदीको बहाबको प्राविधिक अध्ययन गर्दा लिइएको तथ्याङ्क संकलन गरी अध्ययन गरिएको थियो। यसको साथै आयोजना क्षेत्रका बासिन्दाहरुसँग अन्तर्क्रिया गरी त्यसबाट आएका तथ्यहरुलाई समेत यस प्रतिवेदनमा संलग्न गरिएको छ। स्थलगत अध्ययनको क्रममा हावाको गुणस्तर, ध्वनीको स्तर मापन गरिएको थियो भने पानीको गुण सम्बन्धि केहि तथ्याङ्कहरु स्थलगत मापन गरिएको थियो र थप अध्ययनका लागि नमुना संकलन गरेर प्रयोगशाला परिक्षणका लागि ल्याइएको थियो।

७.२.२ जैविक वातावरण

आयोजना निर्माण क्षेत्रमा पर्ने वन र ती वनमा भएका वनस्पतिहरुको नमुना छनोट गरी तथ्याङ्क संकलन गरिएको थियो। छनोट गरिएको नमुनाको आधारमा आयोजना विकास गर्दा हुने वनस्पतिहरुको क्षति सम्बन्धि अनुमानित तथ्याङ्क निकालिएको थियो। आयोजनाका कारण क्षति हुने वनस्पतिको अनुमानि तथ्याङ्क निकाल्दा (आंकलन गर्दा) वन नियमावलीमा उल्लेख भएको प्रकृया बमोजिम गरिएको थियो। आयोजना निर्माण क्षेत्रमा भएका सामुदायिक वनहरुको बारेमा र ती सामुदायिक वन प्रतिको निर्भरता बारे तथ्याक संकलन गरी यस प्रतिवेदनमा विश्लेषण गरिएको छ। आयोजना क्षेत्रमा पाइने वन्यजन्तुहरुको बारेमा स्थलगत अध्ययन गरी तथ्याङ्क संकलन गरिएको थियो। अध्ययनको क्रममा स्थानीयसँग अन्तर्क्रिया समेत गरिएको थियो। वन्यजन्तु विज्ञ र चरा विज्ञ आयोजना क्षेत्रमा गई त्यस क्षेत्रमा पाइने वन्यजन्तु र चराहरुको विवरण लिइएको थियो। आयोजनाले सेती नदीको पानी प्रयोग गर्ने र बाँध देखि विद्युतगृह सम्मको नदीको क्षेत्रमा पानीको वहाव कम हुने भएकोले त्यहाँ पाइने माछाहरुमा प्रभाव पर्ने भएको कारण माछा विज्ञले आयोजना

क्षेत्रको सेती नदीमा माछाको स्थलगत अध्ययन गरिएको थियो। माछाहरुको नमुना संकलन गर्दा इलेक्ट्रोफिसिङ्ग विधि प्रयोग गरिएको थियो।

७.२.३ सामाजिक-आर्थिक तथा सांस्कृतिक वातावरण

प्रस्तावित आयोजना प्रभावित जिल्ला र गाउँपालिका/नगरपालिका/महानगरपालिकाको जनसंख्या सम्बन्धि विवरण राष्ट्रिय तथ्याङ्क कार्यालयबाट लिइएको थियो। आयोजनाबाट प्रभावित परिवारहरुको तथ्याङ्क घरधुरी सर्भेक्षणबाट लिइएको थियो। यस आयोजनामा जग्गा पर्ने २८५ परिवारहरु मध्ये घरधुरी सर्वेक्षणको समयमा आयोजना क्षेत्रमा उपलब्ध १७६ घरधुरीको तथ्याङ्क संकलन गरिएको थियो। आयोजना क्षेत्रमा पर्ने बस्ति, त्यस क्षेत्रका पूर्वाधारहरु, त्यस क्षेत्रका बासिन्दाहरुको जिविकोपार्जन लगायतका विषयहरुको विवरण संकलन गरिएको थियो। यसै क्रममा आयोजना क्षेत्रको अवलोकन, सामूहिक छलफल कार्यक्रम, स्थानीय प्रतिनिधिहरुसँग औपचारिक तथा अनौपचारिक अन्तर्वार्ता, स्थानीय सरोकारवालहरुबाट त्यस क्षेत्रका धार्मिक स्थल, समसान घाट, देवि देउराली, सामाजिक सम्पदाहरुको बारेमा जानकारी लिइएको थियो। यसको साथै आयोजना क्षेत्रका स्थानीय तह, वडा कार्यालयहरु, सरोकारवाला व्यक्ति तथा संस्थाहरुबाट लिखित सुझाव दिन आवह्यन समेत गरिएको थियो।

७.३ सरोकारवालाहरुको संलग्नता

आयोजना क्षेत्रमा भएका सरोकारवालाहरुसँग आयोजनाको पूर्व निर्माण चरणमा पटक पटक अन्तरक्रिया तथा छलफल गरिएको थियो। यस प्रतिवेदन तयारीको क्रममा क्षेत्रनिर्धारणको समयमा, घरधुरी सर्भेक्षणका समयमा, जैविक वातावरण सम्बन्धि स्थलगत अध्ययनको क्रममा र सार्वजनिक सुनुवाईको समयमा सरोकारवालाहरुसँग अन्तरक्रिया तथा छलफल गरिएको थियो। विभिन्न समयमा गरिएका अन्तरक्रिया तथा छलफलको कारण आयोजना क्षेत्रमा बासिन्दाहरु आयोजनाको बारेमा जानकार भएको अनुमान गर्न सकिन्छ। यस प्रतिवेदन तयारीको क्रममा गरिएका मुख्य मुख्य छलफलहरु यसमा समेटिएको छ।

७.३.१ क्षेत्रनिर्धारण

यस आयोजनाको क्षेत्रनिर्धारण प्रतिवेदन तयारीको क्रममा अध्ययन टोलीका विभिन्न विषय विज्ञहरु आयोजना क्षेत्रमा गई आयोजनाको बारेमा जानकारी गराइएको थियो। वातावरण संरक्षण ऐन, २०७६ र वातावरण संरक्षण नियमावली, २०७७ अनुसार यस समयमा क्षेत्रनिर्धारणको सूचना पनि प्रकाशित गरिएको थियो। क्षेत्र निर्धारणको समयमा आयोजना प्रभावित वडाका वडाध्यक्ष ज्यूहरुसँग समेत उहाँहरुको कार्यालयमा गई अन्तरक्रिया गरिएको थियो।

७.३.२ घरधुरी सर्भेक्षण

आयोजनामा जग्गा पर्ने जग्गा धनीहरुको घरधुरी सर्भेक्षण गर्ने क्रममा आयोजनाको प्रभावित क्षेत्रमा सूचना प्रवाह गरिएको थियो। यस समयमा आयोजनाका संरचनाहरु रहने स्थान, आयोजनाबाट हुने फाइदाहरु, आयोजना प्रभावित परिवारको लागत लिनुपर्ने औचित्य लगायतका विषयमा आयोजना प्रभावित परिवारलाई जानकारी गराइएको थियो। यस समयमा वडाका जनप्रतिनिधिहरु र स्थानीय अन्य सरोकारवालाहरुसँग समेत अन्तरक्रिया गरिएको थियो।

७.३.३ सार्वजनिक सुनुवाई

वातावरण संरक्षण ऐन, २०७६ र वातावरण संरक्षण नियमावली, २०७७ को प्रावधान अनुसार आयोजना प्रभावित क्षेत्रमा सार्वजनिक सुनुवाई कार्यक्रम आयोजना गरिएको थियो। सार्वजनिक सुनुवाईको सूचना राष्ट्रिय दैनिक, नेपाल समाचारपत्रमा मिति २०८०-०३-०३ मा प्रकाशित गरिएको थियो। सोही प्रकाशित सूचना सबै प्रभावित स्थानीय तह र वडाहरु, डिभिजन वन कार्यालय, जिल्ला समन्वय समिति, जिल्ला प्रशासन कार्यालय, सबै प्रभावित सामुदायिक वनहरु, आयोजना क्षेत्रका विद्यालयहरुमा टाँस गरिएको थियो। सार्वजनिक सुनुवाई कार्यक्रममा अधिक सहभागिता गराउनको लागि प्रकाशित सूचना दमौली एफएम र भरतपुर एफएमबाट समेत प्रकाशन (ब्रोडकास्ट) गरिएको थियो।

आयोजनाको सार्वजनिक सुनुवाई कार्यक्रम मिति २०८०-०३-१४ मा वन्दीपुर गाउँपालिका वडा नम्बर ६ मा पर्ने खहरेमा गरिएको थियो। सार्वजनिक सुनुवाई कार्यक्रममा १६६ जना (१२९ पुरुष र ३७ महिला) सहभागि भएका थिए। सार्वजनिक सुनुवाईको क्रममा आयोजनाको वारेमा

उपस्थित स्थानीयलाई जानकारी दिइएको थियो। उपस्थित सर्वसाधारणबाट भू-स्थिरता, वन स्रोत, निजी सम्पत्ति नोक्सान बापतको क्षतिपूर्ति, कृषि, रोजगारीको अवसर, आदिवासीको अधिकार, सांस्कृतिक पहिचान तथा सवाल, यथोचित सरोकारवालाहरुको संलग्नता, जग्गा धनी पूर्जा नभएको निजी भोगचलन भएको जग्गा, जिविकोपार्जन, पूर्वाधारहरुको क्षति, सेवाहरुमा पर्ने असर लगायतका सवालहरु उठेका थिए। यस कार्यक्रममा आयोजनाबाट केहि सवालहरुको जवाफ पनि दिइएको थियो।

७.४ सिफारिस पत्र संकलन

आयोजना प्रभावित स्थानीय तह र सम्बन्धित विषयगत कार्यालयबाट (प्रभावित नगरपालिका, गाउँपालिका, वडा, सामुदायिक वन उपभोक्ता समूह) बाट वातावरण संरक्षण ऐन, २०७६ र वातावरण संरक्षण नियमावली, २०७७ को प्रावधान अनुसार सिफारिस पत्र संकलन गरिएको थियो। यसै क्रममा आयोजनाबारे केहि सुझाव भए सुझावहरु दिन सात दिने सूचना समेत प्रकाशन गरिएको थियो।

७.५ प्रभावहरुको मूल्याङ्कन

प्रस्तावित आयोजनाको निर्माण तथा सञ्चालनबाट वातावरणमा पर्ने प्रभावको वारेमा यस आयोजनाको वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा मूल्याङ्कन गरिएको छ। यस क्रममा भौतिक तथा रासायनिक वातावरण, जैविक वातावरण र सामाजिक-आर्थिक तथा सांस्कृतिक वातावरण अन्तर्गत आंकलन गरिएका सबै नकारात्मक प्रभावहरुको मूल्याङ्कन गरिएको छ। मूल्याङ्कनका क्रममा प्रत्यक्ष र अप्रत्यक्ष प्रभावहरु छुट्याइएको छ भने ती प्रभावहरुको मूल्याङ्कन परिमाण, सिमा र अवधिको आधारमा गरिएको छ।

चित्र २: प्रभाव मूल्याङ्कन मापदण्ड र श्रेणीकरण (स्रोत: वातावरण संरक्षण नियमावली, २०७७)

परिमाण		**विस्तार**		**अवधि**	
विवरण	**श्रेणी**	**विवरण**	**श्रेणी**	**विवरण**	**श्रेणी**
उच्च	६०	क्षेत्रीय	६०	दीर्घकालीन	२०
मध्यम	२०	स्थानीय	२०	मध्यम अवधि	१०

कम	१०	आयोजना क्षेत्र केन्द्रित	१०	छोटो अवधि	५

८. नीति, ऐन, नियम, निर्देशिका तथा अन्तराष्ट्रिय सन्धि सम्झौताको पुनराबलोकन

यस प्रतिवेदनमा सबै आकर्षित नीति नियमहरुको पुनराबलोकन गरिएको छ। पुनराबलोकनको क्रममा नेपालको संविधान, पन्ध्रौ पञ्च वर्षिय योजना, वातावरण नीति, वन नीति, वातावरण संरक्षण ऐन, वन ऐन, वातावरण संरक्षण नियमावली, वन नियमावली लगायत हाल सम्म प्रकाशित वातावरणसँग सम्बन्धित मापदण्डहरु र यस प्रतिवेदनसँग सम्बन्धित अन्तराष्ट्रिय सन्धि सम्झौताहरु पुनराबलोकन गरिएको छ।

८.१ नेपालको संविधान

नेपालको संविधान २०७२ साल असोज ३ गते संघीय लोकतान्त्रिक गणतन्त्र नेपालको संविधानसभाले जारी गरेको थियो। यो संविधानमा ३५ भाग, ३०८ धारा र ९ अनुसूची छन्।

८.२ योजना र नीति

- आयोजनासँग प्रत्यक्ष सान्दर्भिक नेपाल सरकारका मुख्य वातावरणीय नीतिहरू तल सूचीबद्ध छन्ः
- पूर्वाधार विकास आयोजनाका लागि जग्गा प्राप्ति, पुनर्वास तथा पुर्नस्थापना सम्बन्धी नीति, २०७१
- १६औं पञ्चवर्षीय योजना (आ.व. २०८१/८२–२०८५/८६)
- जलविद्युत विकास नीति, २०५८
- राष्ट्रिय जैविक विविधता रणनीति तथा कार्ययोजना (२०१४ - २०२०)
- राष्ट्रिय जल योजना, नेपाल २०६२
- राष्ट्रिय वन नीति २०७५
- राष्ट्रिय जल रणनीति, २०५९
- नेपाल वातावरणीय नीति तथा कार्ययोजना, २०५०
- राष्ट्रिय संरक्षण रणनीति, २०४५

- राष्ट्रिय ऊर्जा सङ्कट निवारण तथा विद्युत् विकास दशक सम्बन्धी अवधारणा पत्र एवम् कार्य योजना, २०७२
- भू-उपयोग नीति, २०७२
- राष्ट्रिय भूमि नीति, २०७५
- राष्ट्रिय वातावरण नीति, २०७६
- जलवायु परिवर्तन नीति, २०७६

८.३ ऐन, नियम र नियमावलीहरू

तल सूचीबद्ध ऐन, नियम र नियमावलीहरू प्रस्तावित आयोजना विकास र सञ्चालनसँग प्रत्यक्ष सान्दर्भिक छन्।

- वातावरण संरक्षण ऐन, २०७६
- वातावरण संरक्षण नियमावली, २०७७
- विद्युत ऐन, २०४९ र विद्युत नियमावली, २०५०
- भू तथा जलाधार संरक्षण ऐन, २०३९
- वन ऐन, २०७६
- वन नियमावली, २०७९
- राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन, २०२९
- वन्यजन्तु आरक्ष नियमावली, २०३४
- जलस्रोत ऐन, २०४९
- जलस्रोत नियमावली, २०५०
- जग्गा प्राप्ति ऐन, २०३४
- प्राचीन स्मारक संरक्षण ऐन, २०१३
- स्थानीय सरकार सञ्चालन ऐन, २०७४
- श्रम ऐन, २०७४
- भूमि सम्बन्धी (आठौं संशोधन) ऐन, २०७६
- सङ्कटापन्न वन्यजन्तु तथा वनस्पततको अन्तर्राष्ट्रिय व्यापार नियन्त्रण ऐन, २०७३
- फोहरमैला व्यवस्थापन ऐन, २०६८

- फोहरमैला व्यवस्थापन नियमावली, २०७०
- योगदानमा आधाररत सामाजिक सुरक्षा ऐन, २०७४
- मुलुकी अपराध संहिता, २०७४
- मुलुकी देवानी संहिता, २०७४
- जलचर संरक्षण ऐन, २०७३
- आदिवासी/जनजाति उत्थान राष्ट्रिय प्रतिष्ठान ऐन, २०५८
- भूउपयोग ऐन, २०७६
- सूचनाको हक सम्वन्धि ऐन, २०६४

८.४ नेपाल सरकारका निर्दिशिका, कार्यनीति, कार्यविधि र मापदण्डहरू

- राष्ट्रिय वातावरणीय प्रभाव मूल्यांकन (EIA) निर्देशिका, २०४९
- सामुदायिक वन स्रोत सर्वेक्षण मार्गदर्शन, २०६२
- वन पैदावार सङ्कलन तथा विक्री वितरण निर्देशिका २०७३
- वन क्षेत्रको लागि बातावरणीय प्रभाव मूल्यांकन निर्देशिका २०५२
- सामुदायिक वन निर्देशिका, २०५८
- वातावरणीय व्यवस्थापन निर्देशिका (सडक), २०५६
- संरक्षित क्षेत्र भित्र भौतिक पूर्वाधारहरु निर्माण एवं संचालन सम्बन्धी कार्यनीति, २०६५
- सामुदायिक वन स्रोत सर्वेक्षण मार्गदर्शन, २०६१
- नेपाल सवारी प्रदूषण मापदण्ड, २०६९
- उद्योगको फोहर पानीलाई आन्तरिक सतही पानीमा निकास गर्नेसम्बन्धी सहनसीलता सीमा, २०५९ **Tolerance Limits for Industrial Effluents to be discharged into Inland Surface Waters, (2059)**
- वायुको गुणस्तर सम्बन्धी राष्ट्रिय मापदण्ड, २०६९
- नेपालको ध्वनि स्तर मापदण्ड, २०६९

८.५ अन्तर्राष्ट्रिय महासन्धिहरू

- आयोजनामा लागू हुने अन्तर्राष्ट्रिय महासन्धिहरू निम्न छन्ः
- जैविक विविधता महासन्धि १९९२ (वि.शं. २०४९)

- सङ्कटापन्न वन्यजन्तु तथा वनस्पतिका प्रजातिको अन्तर्राष्ट्रिय व्यापार. सम्बन्धी महासन्धि, १९७३ (वि.शं. २०२९)
- आदिवासी तथा जनजाति सम्बन्धी महासन्धि,(नं.१६९) १९८९ (वि.शं. २०४६)
- जलवायु परिवर्तन सम्बन्धी संयुक्त राष्ट्र सङ्घीय संरचना महासन्धि १९९२ (वि.शं.२०४९)

९. विद्यमावन वातावरणीय अवस्था

९.१ भौतिक वातावरण

सेती नदी गण्डकी नदी प्रणालीको मुख्य नदीहरू मध्य एक हो। सेती नदीले गण्डकी नदी प्रणालीको जलाधारको करिब १४% क्षेत्र ओगटेको छ र यसले गण्डकी नदीको करिब ११% बहाबमा योगदान पुऱ्याउँदछ।

प्रस्तावित आयोजना निर्माणाधीन तनहुँ जलविद्युत आयोजनाको विद्युतगृहबाट करिब २० किलोमिटर तल प्रस्ताव गरिएको छ। साथै, यस आयोजनाको प्रस्तावित बाँधस्थल सेती र त्रिशूली नदीको सङ्गम स्थलबाट करिब ११ किलोमिटर माथि पर्दछ। सेती नदीको मुख्य सहायक पानीको स्रोत भएको खोला मादी खोला हो जुन प्रस्तावित बाँध भन्दा लगभग २२ किलोमिटर माथि मिसिन्छ। यसको सङ्गमस्थल तनहुँको सदरमुकाम दमौलीको नजिकै रहेको छ। सेती नदी अन्तत त्रिसुली नदीमा मिसिन्छ।

सेती नदीको जलाधार क्षेत्रमा सामान्य भिरालो देखि धेरै भिरालो (ठाडो) पहाडहरु रहेका छन्। यी भिराला पहाडहरुमा घाम र वर्षाका कारण पहिरोले जम्मा भएका कोलुभियल डिपोजिटहरु रहेका छन्। यस्ता पहाडी भागमा भू-क्षय तथा पहिरो जाने सम्भावना अधिक हुन्छ भने यसता ठाउँमा क्षयीकरणको प्रबल सम्भावना रहेको छ। नदी तटीय क्षेत्रमा नदीले ओसारेर ल्याएको सेडिमेन्टसहरु जम्मा भएर बनेका एलुभियल टाहारहरु छन्। यस्ता टाहारहरु नदी कटानबाट सजिलै क्षति हुन सक्ने प्रकृतिका छन्।

अध्ययनको क्रममा सक्रिय तथा पुरानो पहिरो गएका क्षेत्रहरुको समेत अध्ययन तथा अवलोकन गरिएको थियो। भिरालो धरातलिय क्षेत्रलाई अस्थिर बनाउने खालका कृषिका गतिविधिहरु आयोजना क्षेत्रमा पाइएन जसले कृषि भूमिहरुको स्थिरता राम्रो रहेको पाइयो। चरीचरणको कारण वन क्षेत्र तथा घाँसे मैदानमा केही प्रभाव परेको भएतापनि, स्थानीय समुदायको संलग्नताको कारण वन संरक्षणमा क्रमिक सुधार भएको अध्ययन टोलीले अवलोकन गरेका थिए।

प्रस्तावित आयोजनाले प्रयोग गर्ने पानी तनहुँ जलविद्युत आयोजना सञ्चालनबाट निश्किएको पानी र थप मादी खोलाको पानी हो। यस बाहेक उल्लेख्य अन्य खोलाहरु बाँध भन्दा माथि रहेका छैनन्। बाँध क्षेत्रमा सुख्खा मौसममा (अक्टोबर देखि मे महिना) ५० घन मिटर प्रति सेकेण्ड बहाब हुनेछ भने वर्षाद मौसममा (जुलाई-अगस्ट) बहाब बढेर ६०० घन मिटर प्रति सेकेण्ड सम्म पुग्नेछ।

पानीको मुहानहरुः आयोजना क्षेत्रको स्थलगत भ्रमणका क्रममा स्थानीयहरूले पिउनको लागि प्रयोग गरिरहेको १८ वोटा पानीको स्रोतको पहिचान गरेको छ। पानीको मुहानहरुको स्थान निम्न तस्विरमा देखाइएको छ।

चित्र ३: आयोजना क्षेत्रको पानीको मुहानहरुको स्थान

साथै यी मुहानहरुमा पानीको बहाव (discharge) को पनि मापन गरिएको थियो र मापन गरिएको तथ्यांक तालिकामा प्रस्तुत गरिएको छ ।

तालिका २: मुहानहरुमा पानीको बहाव (discharge)को तथ्यांक

मुहानको कोड	स्थान		बहाव (discharge) (L/min)
	अक्षांश (उत्तर)	देशान्तर(पुर्व)	
S1	२७°५१'४०.८१"	८४°२३'३५.६९"	६.३४
S2	२७°५१'४४.१६"	८४°२३'३२.०५"	६.८८

मुहानको कोड	स्थान		बहाव (discharge) (L/min)
	अक्षांश (उत्तर)	देशान्तर(पुर्व)	
S3	२७°५१'५१.७८"	८४°२३'१७.२७"	७.०७
S4	२७°५२'७.३५"	८४°२३'१.१४"	७.३७
S5	२७°५२'१२.९६"	८४°२२'५५.९७"	७.९
S6	२७°५२'१४.९३"	८४°२२'४०.७४"	९.८३९
S7	२७°५२'१६.५५"	८४°२२'२७.६९"	८
S8	२७°५२'१२.९५"	८४°२२'८.८२"	६.१२
S9	२७°५२'२२.८४"	८४°२१'७.७८"	६.८७
S10	२७°५२'४८.१०"	८४°१९'५९.९६"	४.५९
S11	२७°५३'१४.४७"	८४°१९'३५.०३"	७.४३
S12	२७°५४'३.४०"	८४°१९'२२.४२"	८.१२
S13	२७°५४'२३.४०"	८४°१९'५.७०"	७.१०
S14	२७°५४'२१.७२"	८४°१९'६.२०"	७.८९
S15	२७°५४'३५.५७"	८४°१८'५६.११"	१०.६२
S16	२७°५४'५७.७०"	८४°१८'४४.२५"	७.४४
S17	२७°५५'३.०९"	८४°१८'३२.०५"	८.९१
S18	२७°५५'२१.०२"	८४°१७'३५.७४"	५.०१

वायुको गुणस्तरः आयोजना क्षेत्रमा वायुको गुणस्तर मापन गर्न Air Visual Pro सेन्सर प्रयोग गरिएको थियो। यसले PM२.५ , PM१० र CO_2 को गुणस्तर मापन गर्दछ। आयोजना क्षेत्रको नमूना स्थलहरूको वायुको गुणस्तर तलको तालिकामा प्रस्तुत गरिएको छ।

तालिका ३: आयोजना क्षेत्रका नमूना स्थलहरूको वायु गुणस्तर

नमुना संकलन स्थल	AQI			PM२.५(μg/m³)			CO_2(ppm)
	न्यूनतम	अधिकतम	औसत	न्यूनतम	अधिकतम	औसत	औसत
कोइदिम घाट	१४८	३२५	२४०	३००	४२५	३५०	४८
मस्दी घाट	१५०	२९०	२२०	२७५	४२५	३५०	४८
खहरे	१४९	२२०	१८५	२५०	४१०	३३०	४८
नाल्दी	१५०	२५०	२००	२५०	४१०	३३०	४९
साराङ घाट	१५५	२४०	२००	२५५	४१०	३३२	४८
गाई घाट	१४०	२००	१७०	३१०	४००	३५५	४५

ध्वनिको गुणस्तर: आयोजना क्षेत्रको ध्वनीको गुणस्तर मापन गर्न sound meter प्रयोग गरिएको थियो। आयोजना क्षेत्रमा मुख्य ध्वनीका स्रोतहरू सवारी साधन साथै निर्माण कार्यहरू रहेको पाईयो। आयोजना क्षेत्रका नमूना स्थलहरूको ध्वनिको तथ्यांक तलको तालिकामा प्रस्तुत गरिएको छ।

तालिका ४: आयोजना क्षेत्रका नमूना स्थलहरूको ध्वनिको गुणस्तर

क्र.सं.	नमूना संकलन स्थान	न्यूनतम [dB]	अधिकतम [dB]	औसत [dB]
१	कोइदिम घाट	३०	८०	५५
२	मस्दी घाट	३०	८०	५५
३	खहरे	३०	८१	५६
४	नाल्दी	३५	८२	५९
५	साराङ घाट	३०	८०	५५
६	गाई घाट	३०	७५	५२

पानीको गुणस्तरः अध्ययनको क्रममा सेती नदीको पानीको गुणस्तर परिक्षण गरिएको थियो। पानीको नमुना विभिन्न स्थानहरूबाट संकलन गरिएको थियो। परिक्षण गरिएको सेती नदीको पानीको गुणस्तर तलको तालिकामा प्रस्तुत गरिएको छ ।

तालिका ५: आयोजना क्षेत्रका नमूना स्थलहरूको पानीको गुणस्तर

क्र.सं.	गुण	घटी बढी सिमा		डिवाटर जोन	अपस्ट्रिम	स्प्रिङ स्रोत	मिक्सिङ जोन	ब्यारेज क्षेत्र	अडिट-४	जलाशयको सुरु बिन्दु
		विश्व स्वास्थ्य संगठन (२०१७)	NDWQS (२०७९)							
१	pH	६.५-८.५	६.५-८.५	७.२८	६.६१	७.३२	६.६३	७.१३	६.८८	७.०१
२	TDS (मि.ग्रा./लि.)	—	१०००	२८०	३२८	५४०	३९२	३३६	३१६	१२०
३	तापक्रम (°C)	—	—	२४.५	२४.४	२४.३	२४.६	२४.७	२४.८	२४.९
४	DO (मि.ग्रा./लि.)	—	—	५.५३	५.१३	६.३१	५.५३	५.१३	५.९२	५.९२
५	BOD (मि.ग्रा./लि.)	—	—	५५.४	५५.२	४७.४	४७.४	४७.४	६३.२	६३.२
६	सल्फेट (मि.ग्रा./लि.)	२५०	—	४.४६	६.५३	९.६३	५.८४	५.४९	७.०४	६.०९
७	TSS (मि.ग्रा./लि.)	—	—	२५	१३	४	७	४४	४४	११
८	कुल कोलिफर्म (MPN/१००)	०	० (९५% नमूनामा)	३६	३७	२६	३१	३५	७०	३२

क्र. सं.	गुण	घटी बढी सिमा		डिवाटर जोन	अपस्ट्रिम	स्प्रिङ स्रोत	मिक्सिङ जोन	ब्यारेज क्षेत्र	अडिट-४	जलाशयको सुरु बिन्दु
		विश्व स्वास्थ्य संगठन (२०१७)	NDWQS (२०७९)							
९	फेकल कोलिफर्म (MPN/१००)	०	०	१७	२०	९	११	२१	४५	२०
१०	चालकता (µmHOS/cm)	—	१५००	२९३	२४३	५६३	२४०	३२५	२५५	३०८
११	मटमैलेपन (NTU)	५	५	१९.६	१४.२	२.२३	१०.३	४८.४	२.१९	१७.५
१२	अमोनिया (मि.ग्रा./लि.)	—	१.५	०.२४	०.२१	०.५३	०.१९	०.२७	०.३२	०.३१
१३	नाइट्रेट (मि.ग्रा./लि.)	३	५०	०.५५	२.१९	०.८३	०.७२	०.९०	०.३९	१.८४
१४	नाइट्राइट (मि.ग्रा./लि.)	—	—	ND	ND	ND	ND	ND	ND	ND
१५	फस्फेट (मि.ग्रा./लि.)	—	—	०.०५	०.०७	०.११	०.०५	०.१६	०.१३	०.१६

क्र. सं.	गुण	घटी बढी सिमा		डिवाटर जोन	अपस्ट्रिम	स्प्रिङ स्रोत	मिक्सिङ जोन	ब्यारेज क्षेत्र	अडिट-४	जलाशयको सुरु बिन्दु
		विश्व स्वास्थ्य संगठन (२०१७)	NDWQS (२०७९)							
१६	कुल नाइट्रोजन (मि.ग्रा./लि.)	५०	—	२.४	२.८७	१.६२	२.६०	२.७	२.१	१.८
१७	तेल र चिल्लो (मि.ग्रा./लि.)	—	<१०	०.३०	ND	०.८०	०.४१	ND	२	ND
१८	COD (मि.ग्रा./लि.)	—	—	५	४	६	३	५	६	४

आयोजना क्षेत्रमा सेती नदीको पानीको गुणस्तर परिक्षण गर्दा मध्यम स्तरको रहेको पाइयो। यस क्षेत्रको पानीमा धमिलो पन केहि बढी पाइएको थियो जसको कारण माथिल्लो क्षेत्रमा भैरहेको तनहुँ जलविद्युत आयोजनाको कारण हुन सक्छ। यहाँको पानीमा गह्रौ धातुको मात्रा सामान्य पाइएको थियो भने कोलिफमको मात्रा भने गुणस्तर भन्दा बढी पाइएको थियो जसको कारण दमौलीमा मिसाइएका ढल तथा घरेलु फोहरहरु हुन सक्छ।

९.२ जैविक वातावरण

आयोजना क्षेत्र उष्ण प्रादेशिक देखि तल्लो शीतोष्ण जलवायु क्षेत्रमा पर्दछ। पोखरा उपत्यकाको निकटताले आयोजना क्षेत्रको वनस्पतिमा ओसिलो हावापानी प्रदान गरेको छ र यसले जैविक विविधता कायाम गर्न थप योगदान दिएकोछ। आयोजना क्षेत्रमा नदीको दाहिने किनार धेरै भिरालो तथा भिर भएकोले त्यहाँ कम रूखहरू पाइएको थियो त्यसैगरी बायाँ किनारमा, सडक र मानव बस्ति रहेकोले यहाँपनि पातलो वन (कम रुख भएको वन) पाइयो।

अध्ययनको क्रममा आयोजना र यसको वरपरको क्षेत्रमा कुल १८४ प्रजातिका वनस्पतिहरु पाइएको थियो। आयोजना क्षेत्रमा पाइएका मुख्य रुखहरुमा सिरिस (*Albizia lucidicor*), राम रिट्टा (*Trewia nudiflora*), साल (*Shorea robusta*), सिन्दुरे (*Mallotus philippensis*) र खिर्रो (*Falconeria insignis*) रहेका छन्। आयोजना क्षेत्रमा पाइएका संरक्षित प्रजातिहरू जस्तै साल (*Shorea robusta*), सतिसाल (*Dalbergia latifolia*), भ्याकुर (*Dioscorea deltoides*), र सुनाखरीका दुई प्रजातिहरू (*Cymbidium aloifolium and Vanda sp.*) हुन्।

आयोजना क्षेत्रमा पाइने वन्यजन्तुको वासस्थानमा वन (नदीका जङ्गलहरूसहित), कृषि भूमि, सिमसार क्षेत्र र ग्रामीण बस्तीहरू रहेकाछन्। स्थलगत अवलोकनको समयमा अत्यधिक मानवीय दोहनका कारणले धेरै जस्तो वन वासस्थानमा ह्रास आएको पाइएको थियो। तर, सेती नदीको किनारामा रहेका केही ठाडो भिरालो जमिनहरूमा रहेका वन क्षेत्रमा स्थानीयहरूको पहुँच सीमित रहेकोले यस्ता भिरालो क्षेत्रका वनहरूमा वनको अवस्था राम्रो रहेको पाइएको थियो। यस क्षेत्रमा भएको वन वासस्थान दोहनको बाबजुद यस क्षेत्रमा लोपोन्मुख र जोखिममा परेका प्रजातिहरू पाइएको थियो। जसको कारणले आयोजना क्षेत्र वन्यजन्तुहरूको लागि critical habitat (CH) रहेको निष्कर्ष यस अध्ययनले निकालेको छ।

आयोजना नजिक र वरिपरि पाइने वनस्पतिहरूको प्रारम्भिक सर्वेक्षण अनुसार, स्थानीय बासिन्दाहरू आंशिक रूपमा गैरकाष्ठ वन उत्पादन (NTFPs) र वन-आधारित स्रोतहरूमा निर्भर छन्। धेरैले दैनिक आवश्यकताहरू पूरा गर्न जडीबुटी, जंगली फलफूल, र तरकारीहरू संकलन गर्छन्, जबकि केहीले यी स्रोतहरू स्थानीय बजारमा बेचेर अतिरिक्त आम्दानी गर्छन्।

आयोजना स्थलको वरिपरिका प्रायः वन क्षेत्रहरूलाई समुदायले व्यवस्थापन गरिरहेको देखियो। आयोजनाले प्रभाव पर्ने सामुदायिक तथा कबुलियती वनको विवरण तल तालिकामा प्रस्तुत गरिएको छ।

तालिका ६: आयोजनाले प्रभाव पर्ने सामुदायिक तथा कबुलियती वनको विवरण

क्र.स.	आयोजनाको संरचना	आयोजना संरचना लागि कुल भूमिको आवश्यकता [हे]	आयोजना संरचनाक लागि आवश्यक वन क्षेत्र [हे]	स्थानिय तह	वन व्यवस्थापन (सामुदायिक वन/ राष्ट्रिय वन)	टिप्पणी
१	जलाशय	१५७.४५	३०.२९	बन्दीपुर– ६, ब्याँस १४, ब्याँस १३, देवघाट ३	सिद्धार्थ सामुदायिक वन, बाखर खोला सामुदायिक वन – साराङ घाट, रुम्सी सामुदायिक वन, हर्कपुर सामुदायिक वन, भयर सामुदायिक वन – मसदी घाट, तोडे सामुदायिक वन, बेनिकोट सामुदायिक वन – कोईडिम घाट, पोखरी छाप – खारास्दी खोला, सिर्कुली सामुदायिक वन – नाल्दीघाट	बायाँ किनारा, दायाँ किनारा

क्र.स.	आयोजनाको संरचना	आयोजना संरचना लागि कुल भूमिको आवश्यकता [हे]	आयोजना संरचनाक लागि आवश्यक वन क्षेत्र [हे]	स्थानिय तह	वन व्यवस्थापन (सामुदायिक वन/ राष्ट्रिय वन)	टिप्पणी
२	बाँध	८.६३	३.१९	बन्दीपुर - ६, देवघाट ३	सिद्धार्थ सामुदायिक वन, बाखर खोला सामुदायिक वन — साराङ घाट, सिर्कुली सामुदायिक वन	बायाँ किनारा, दायाँ किनारा
३	अडिट २	०.०९	०.०९	देवघाट ३	सिर्कुली सामुदायिक वन	
४	अडिट ३	०.०७		देवघाट ४	जनहित सामुदायिक वन	
५	अडिट ४	०.१७		देवघाट ४	घुसिटोल लिज होल्ड वन, गोठेरी उपोभोक्ता वन	
६	दम्पिङ्ग क्षेत्र	६.८८		देवघाट ४	सिरिचुली सामुदायिक वन, घुसिटोल लिज होल्ड वन, गोठेरी उपोभोक्ता वन	

आयोजना क्षेत्रमा ३८ हर्पेटोफाउनाका प्रजातिहरू रिपोर्ट गरिएको थियो, जसमा १० उभयचर, १२ छेपारो, २ कछुवा, र १३ सर्प प्रजातिहरू छन्। यी प्रजातिहरू IUCN रेड लिस्टको Least Concern (LC) देखि Critically Endangered (CR) गरी विभिन्न श्रेणीमा पर्दछन्। यसको साथै यी प्रजातिहरू CITES को अनुसूची (I र II) र नेपालको संरक्षित प्राथमिकता सूचीमा पनि सूचीबद्ध छन्। आयोजना

क्षेत्रमा Critically Endangered श्रेणीमा सूचीबद्ध भएको कछुवा (*Indotestudo elongata*) पनि रिपोर्ट गरिएको थियो। सेती नदीमा कहिलेकाहीँ गोहीहरू पनि देखिएको स्थानीयहरूले बताएका थिए। आयोजना क्षेत्रमा २९ स्तनधारी प्रजातिहरू पाइएको थियो।यी स्तनपायी प्रजातिहरू CITES को अनुसूची (I र II) र नेपालको संरक्षित प्राथमिकता सूचीमा सूचीबद्ध छन्। आयोजना क्षेत्रको देवघाट गाउँपालिका-४ आमडाँडा गाउँमा मलाएन दुम्सी (*Hystrix brachura*) रिपोर्ट गरिएको थियो। नेपालको सन्दर्भमा, आयोजना क्षेत्र यो प्रजाति रिपोर्ट गरिएको सबैभन्दा कम उचाइ भएको भागमा हो। नल्दीघाट, धाप र खहरे घाट क्षेत्रमा पनि दुम्सी पाइएको रिपोर्ट गरिएको थियो। रेकर्ड गरिएका स्तनधारी प्रजातिहरू मध्ये, ४ वटा CITES अनुसूची I मा, ६ वटा अनुसूची II मा र २ वटा नेपाल सरकारको संरक्षित सूचीमा पर्दछन्। IUCN को रेड डाटा बुक अनुसार २ प्रजातिलाई Vulnerable (V), ६ प्रजातिलाई डाटा डिफिसियन्ट (DD), र १७ प्रजातिलाई Least Concern (LC) मा वर्गीकृत गरिएको छ। नेशनल रेड डाटा बुकमा १ प्रजाति लोपोन्मुख (EN), ५ वटा जोखिमयुक्त (V), ३ लाई डाटा डिफिसिएन्ट (DD) र १२ लाई Least Concern (LC) मा सूचीकृत गरिएको छ।

आयोजना क्षेत्र पाँच महत्त्वपूर्ण पक्षी र जैविक विविधता क्षेत्रहरूसँग जोडिएको छ, तिनीहरु चितवन राष्ट्रिय निकुञ्ज, अन्नपूर्ण संरक्षण क्षेत्र, न्याम्प आईबीए, पञ्चासे आईबीए र मनासलु आईबीए हुन्। यी आईबीएले विविध चरा प्रजातिका लागि आवश्यक वासस्थान प्रदान गर्दछ र सेती नदीले तराई र पहाडी क्षेत्रहरू र्याप्टरहरू, गिद्धहरू र जलचरहरूलाई जोड्ने बसाइँसराइ मार्गको रूपमा काम गर्दछ।

स्थलगत सर्वेक्षणका क्रममा ८३ प्रजातिका ५९४ चराहरू अवलोकन गरिएको थियो। ती मध्ये ४५ प्रजाति वन चराहरू, १३ र्याप्टर प्रजातिहरू, १० रिपेरियन प्रजातिहरू, ८ सहरी प्रजातिहरू, र ७ खेतबारी प्रजातिहरू हुन्। बार्न स्वेलो, ब्लू-व्हिस्लिङ थ्रश, कमन म्याना, इन्डियन व्हाइट-आइ, र वेस्टर्न स्पोटेड डक ८२% ट्रान्जेक्ट सर्वेक्षणमा रेकर्ड गरिएको थियो भने हिमालयन बुलबुल, रेड-भेन्टेड बुलबुल, र ओरिएन्टल म्याग्पी रोबिन सबैभन्दा बढी (लगभग ८८% ट्रान्जेक्ट सर्वेक्षण) मा रेकर्ड गरिएको थियो।

अवलोकन गरिएका ८३ प्रजातिका चराहरूमध्ये ४८ रैथाने प्रजाति थिए भने ३० प्रजाति आगन्तुक थिए। यी भित्र, १८ पूर्ण आगन्तुक प्रजाति र १० प्रजातिहरू मौसम, खाना र वासस्थानको आधारमा बसाई सर्ने प्रकारका थिए। मुख्य रूपमा जाडो वा गर्मी मौसमहरूमा देखिने केही प्रजातिहरू पूर्ण आगन्तुक प्रजातिका थिए। जाडो मौसमको आगन्तुक चाराहरूमा रुड्डी शेल्डक र वालक्रिपर र गर्मी मौसमको आगन्तुक चाराहरूमा ब्यान्डेड बे कुकु, चेस्टनट-हेडेड बी-इटर, र इन्डियन गोल्डेन ओरियोल थिए।

अध्ययनको क्रममा आयोजना क्षेत्रमा (सेती नदी र त्रिशूली नदी) जम्मा ६८ प्रजातिका माछा पाइएको थियो। यी ६८ प्रजातिहरू मध्ये, २२ आगन्तुक प्रजातिका थिए, जसमध्ये १५ प्रजातिहरु नमुना संकलनमा समातिएका थिए भने ७ प्रजातिहरु स्थानीयको आधारमा रिपोर्ट गरिएका थिए। आगन्तुक प्रजातिहरू प्रस्तावित बाँध माथि र तल दुवैतिर फेला परेका थिए। यिनीहरूले डिहुल खोला र मास्दी खोला जस्ता सहायक खोलाहरू अण्डा पार्नको लागि प्रयोग गर्ने गरेको पाइयो। लामो दूरीका आगन्तुक प्रजातिहरूमा राज बाम (*Anhuilla bengalensis*), *Bagarius bagarius*, *Clupisoma sp.*, *Tor putitora*, र *Tor tor.* रहेका छन् । ६८ प्रजातिहरू मध्ये, ५ IUCN रेड लिस्ट खतरामा परेका प्रजातिहरूमा सुचीबद्ध छन्।

६.३ सामाजिक, सांस्कृतिक र आर्थिक वातावरण

आयोजनाको प्रभावित स्थानीय तहहरुमा तनहुँ जिल्लाको ऋषिङ्ग गाउँपालिका वडा नं. १ र ३; देवघाट गाउँपालिका वडा नं. २, ३ र ४; बन्दीपुर गाउँपालिका वडा नं. ६; आँबुखैरेनी गाउँपालिका वडा ५ र ६ र व्यास नगरपालिका वडा नं. १३ र १४ तथा चितवन जिल्लाको भरतपुर महानगरपालिका वडा न. २९ पर्दछन्।

प्रस्तावित आयोजनाको लागि २८५ घरधुरीको स्वामित्व रहेको कुल ४३७ कित्ता निजी जग्गा आवश्यक पर्नेछ। यसका साथै केयर एन्ड दाउनी रिसोर्ट, नेपाल विधुत प्राधिकरणको नाममा रहेको जग्गाहरु र सामुदायिक तथा सरकारी जग्गापनि आवश्यक पर्नेछ। आयोजना प्रभावित परिवारहरु (२८५ परिवार), केयर एन्ड दाउनी रिसोर्ट र श्री सेती गंगा विद्यालयलाई आयोजनाबाट प्रत्यक्ष अति प्रभावित घरधुरी अन्तर्गत राखिएको छ। यस आयोजनामा जग्गा पर्ने २८५ परिवारहरु मध्ये

घरधुरी सर्वेक्षणको समयमा आयोजना क्षेत्रमा उपलब्ध १७६ घरधुरीको तथ्याङ्क संकलन गरिएको थियो। सर्वेक्षण गरिएका घरधुरीको जनसंख्या ९७९ पाइएको थियो जस मध्ये ५४.४४% पुरुष र ४५.५५% महिला थिए।

आयोजना क्षेत्रमा गुरुङ र मगर जातिहरुको बाहुल्यता रहेकोछ भने त्यस क्षेत्रमा बोटे, भुजेल, नेवार, बाहुन र क्षेत्रीहरु पनि बसोबास गरिरहेका छन्। आयोजनाबाट प्रभावित हुने बस्तिहरुमा मास्दीघाट, खहरे, सारङघाट र गाईघाट पर्दछन्। आयोजना प्रभावित बस्तिहरुमा १६ देखि ४० परिवारहरु बसोबास गरिरहेको पाइएको थियो भने ती बस्तिहरुमा माटो, ढुङ्गाले बनेका घरहरुको बाहुल्यता रहेको छ भने बजार क्षेत्रमा केही सिमेन्टेड (पक्की) घरहरु पनि रहेका छन्। मास्दी घाट, खहरेटार र सारङघाट बस्तिहरुमा गुरुङ र मगरको बाहुल्यता रहेको छ भने गाईघाटमा गुरुङ र मगरसँगै माझी र भुजेलहरु पनि बस्छन्। आयोजना सञ्चालन समयमा कम बहाब हुने क्षेत्रमा पर्ने बस्तिहरुमा लब्दीघाट, भूत खोला, प्यूघर आदि पर्दछन्।

आयोजना क्षेत्रमा प्रमुख बोलिचालिको भाषा नेपाली रहेको छ। त्यस क्षेत्रमा मगर र गुरुङ जातिको बसोबास भएकोले ती जातिले तिनीहरुको मातृ भाषा समेत बोल्ने गरेको पाइयो। आयोजना क्षेत्रको मुख्य चाड पर्बमा दशैं, तिहार, ल्होसार, माघे संक्रान्ति, फागु पूर्णिमा, वैशाख संक्रान्ति, चण्डीपूर्णिमा, बुद्ध पूर्णिमा र साउन संक्रान्ति रहेका छन्। आयोजनाका कारण आयोजना क्षेत्रमा भएका दुई वटा सामुदायिक विद्यालयहरु श्री सेती गंगा प्राथमिक विद्यालय र श्री जनता प्राथमिक विद्यालय प्रभावित हुनेछन्।

आयोजना क्षेत्रको सेती नदीको किनारमा रहेका समसान घाटहरु मसदीघाट, मायागाउँ, खहरेघाट, नलबुङ, लुङ्ग्री, डगरा, कोइथिम, बेनीकोट, रुम्से, हर्कपुर, नाजुङ, गोभन्तल, सोलाङ र खरिभिट्टा हुन्। यी घाटहरूमा आयोजना क्षेत्रका बासिन्दाहरुले दाहसंस्कारमा प्रयोग गर्ने गरेको पाइयो।

१०. वातावरणीय प्रभाव

१०.१ सकारात्मक प्रभाव

आयोजनाको निर्माण अविध ५ वर्षको रहेको छ। निर्माण अवधिमा आयोजनाले लगभग १,२९३ व्यक्तिहरुलाई आयोजना अवधिभर रोजगारी दिने अनुमान गरिएको छ। आयोजना प्रभावित व्यक्ति तथा स्थानीय बासिन्दाहरूलाई रोजगारीको समयमा प्राथमिकता दिइनेछ। यसबाट आयोजना क्षेत्रमा रोजगारीको सिर्जना हुने र प्रभावित परिवार वा प्रभावित क्षेत्रका बासिन्दाहरुको आयआर्जन बृद्धिमा महत्त्वपूर्ण योगदान पुग्नेछ।

आयोजना निर्माणको समयमा आयोजना प्रभावित परिवारका सदस्यहरु तथा स्थानीय बासिन्दाहरुको जीविकोपार्जन सुधार्नका लागि विभिन्न प्रकारका सिपमुलक तालिम दिइनेछ। सिपमुलक तालिमले स्थानीय बासिन्दाहरूको रोजगारीमा प्रतिस्पर्धात्मक क्षमता र उत्पादनशीलता बढाउने छ। यसबाट आयोजना क्षेत्रको समृद्धि र विकासमा सहयोग पुऱ्याइ समग्र श्रम शक्तिको विशेषज्ञतालाई लाभान्वित गर्नेछ ।

आयोजना क्षेत्र हुँदै निर्माणाधीन बुद्धसिंह सडक त्रिशूली नदीमा पुल नभएका कारणले मुग्लिङ-नारायणघाट सडकसँग जोडिएको छैन। सडक सञ्चालमा नजोडिएको कारण यहाँ रहेका बजार र सारङघाट, गाईघाट लगायतका बस्तीहरू मुख्य राजमार्गसँग जोडिएका छैनन्। आयोजनाले प्रस्ताव गरेको पहुँच सडक र पुलले आयोजना क्षेत्रलाई राजमार्गसँग जोडी सवारी साधनको सञ्जालमा वृद्धि ल्याउने अपेक्षा गरिएको छ। पहुँच सडक र पुल निर्माण भएपछि आयोजना क्षेत्रको सडक राष्ट्रिय राजमार्गमा जोडिनुको साथै जीवनयापन झन् सहज हुने र स्थानीय उत्पादनले बजार पाउने छन्। सडक र पुलको निर्माणले स्थानीय व्यवसायहरूलाई पनि आर्थिक वृद्धि, विकास, र स्थायी रोजगारीको सम्भावना प्रदान गर्ने छ।

आयोजना सञ्चालन चरणमा बन्ने जलाशयले विभिन्न जलचरहरूको लागि अनुकूल वासस्थानको सृजना हुनेछ। यसले जलचरहरूको संरक्षणकासाथै स्थानीय बासिन्दाहरूले माछा पालन गर्नको लागि आवश्यक वातावरण बन्नेछ।

यसै गरी, जलाशयले आगन्तुक चराहरूको लागि महत्त्वपूर्ण विश्राम स्थलको रूपमा काम गर्नेछ। यसका अतिरिक्त, यस्ता स्थानहरूले प्राकृतिक आकर्षण, शान्ति र मनोरञ्जनका लागि पनि महत्त्वपूर्ण भूमिका खेल्नेछ। अन्ततः जलाशयले पर्यटन विकास गरी यस क्षेत्रको आर्थिक विकासमा महत्त्वपूर्ण योगदान दिनेछ।

जलविद्युत एक स्वच्छ हरित ऊर्जाको स्रोत हो। ऊर्जाको लागि काठ, दाउरामाथिको निर्भरतालाई विस्थापन गरी अप्रत्यक्ष रुपमा वन जङ्गलको संरक्षणमा सहयोग गर्ने छ। आयोजनाले कार्बन डाइअक्साइड उत्सर्जनमा उल्लेखनीय कमी ल्याउन मद्दत गर्नेछ। वातावरण प्रदूषण तथा जलवायु परिवर्तनमा कमी ल्याई वातावरणीय संरक्षणका क्षेत्रमा उत्कृष्ट योगदान प्रदान गर्ने र नेपाललाई ऊर्जामा आत्मनिर्भर बनाउने अपेक्षा गरिएको छ।

१०.२ प्रतिकूल प्रभाव

१०.२.१ भौतिक वातावरण सम्बन्धि प्रभावहरू

प्रस्तावित आयोजनाको आवश्यक संरचनाहरू निर्माणका लागि २७१.४५ हेक्टर जग्गा आवश्यक पर्नेछ, जसमध्ये २१०.३० हेक्टर स्थायी रूपमा (आयोजनाको निर्माण र सञ्चालन चरण) र बाँकी ६१.१५ हेक्टर अस्थायी रूपमा (निर्माण चरण) प्रयोग गरिनेछ। स्थायी रूपमा आवश्यक पर्ने जग्गामा ५४.३२ हेक्टर वन क्षेत्र र २७.०३ हेक्टर कृषिमा प्रयोग भएको निजी जमिन पर्दछन्। निर्माण अवधिमा आयोजना क्षेत्रको भू बनोटमा परिवर्तन, निर्माण कृयाकलापका कारण जमिनको अस्थिरता, माटोको क्षयीकरण, ध्वनी प्रदुषण, वायु प्रदुषण, ढुङ्गा खानी सञ्चालनको कारण प्रदुषण, निर्माण सामाग्री थुपार्ने र उत्खनन् कार्यबाट निस्कने माटो तथा ढुङ्गाबाट हुने प्रदुषण, आयोजनामा प्रयोग हुने मेसिन औजारहरु सञ्चालन तथा मर्मत गर्दा प्रयोग हुने तेल मोबिल, ग्रिज तथा ग्यारेजबाट निश्किएको तरल पदार्थको चुहावटबाट हुने प्रदुषणहरु देखिनेछन्।

सञ्चालन चरणमा सेती नदीमा निर्माण गरिने बाँधको कारण बाँध देखि विद्युतगृह सम्मको नदीको करिब ११ किलोमिटर भागमा पानीको बहाबमा कमी आउनेछ। यस कम बहाब हुने क्षेत्रमा ४ वटा सहायक नदीहरू आई मिसिन्छ जसले नदीको बहाबमा थप योगदान दिनेछ। सामूहिक रूपमा यी सहायक नदीहरूले सुख्खा मौसममा करिब १४ घन मिटर प्रति सेकेन्डको बहाब योगदान सेती

नदीमा पुऱ्याउने छ। बाँधबाट छोडिने बहाबलाई पनि समावेश गर्दा, सुख्खा मौसममा सेती नदीमा करिब १६ घन मिटर प्रति सेकेन्डको बहाब नियमित रहनेछ, जसले नदीको यस भागमा पर्ने वातावरणीय प्रभावलाई न्यून गर्ने अपेक्षा गरिएको छ।

१०.२.२ जैविक प्रभावहरू

आयोजनालाई १६१.४६ हेक्टर वन क्षेत्र आवश्यक पर्नेछ। आयोजनाबाट प्रभावित हुने वनमा २७ प्रजातिका कुल १९,११५ रूखहरू हटाउनुपर्ने अनुमान गरिएको छ। हटाउनुपर्ने रुखहरुमा पड्के सिरिस (*Albizia lucidicor*), राम रिट्टा (*Trewia nudiflora*), साल (*Shorea robusta*), सिन्दुरे (*Mallotus philippensis*), र खिर्रो (*Falconeria insignis*) मुख्य रहेका छन्।

आयोजनामा प्रयोग गरिने वन क्षेत्रको रुखहरु हटाउनु पर्नाले त्यस क्षेत्रमा पाइने चरा र वन्यजन्तुको वासस्थानमा ह्रास आउने छ। आयोजना क्षेत्रको चरा तथा वन्यजन्तुहरुको वासस्थान खण्डीकरण हुने, वन्यजन्तुको आवतजावत र व्यवहारमा अवरोध गर्ने, गुँड र पर्चिङ साइटहरू घट्ने छन्। विशेषगरी, सिमलका रूखहरू (*Bombax ceiba*) हटाउनाले गिद्धहरूले गुँड बनाउने र बास बस्ने ठाउँहरू गुमाउने छन्।

आयोजनाको बाँध निर्माणले सेती नदीमा माछाको आवतजावतमा बाधा पुऱ्याउनेछ, माछाको आहारा घट्नेछ भने तिनीहरुको भूरा उत्पादन गर्ने क्षेत्र कम हुनेछ। यस कारण त्यहाँ पाइने माछाहरुको प्रजातिका प्रजनन चक्रमा कमी हुनेछ र माछाको व्यवहार र वासस्थानमा समेत परिवर्तन ल्याउनेछ। आयोजनाको बाँध निर्माण भएपछि कम बहाब हुने क्षेत्र (११ किलोमिटर) मा पानीको प्रबाह कम हुन गई नदी तटीय क्षेत्रमा पाइने जलचर, नदी किनाराको वनस्पति, त्यस क्षेत्रका वन्यजन्तु लगायत नदी वरपर बसोबास गर्ने स्थानीय समुदायहरूलाई समग्रमा प्रभाव पर्नेछ।

१०.२.३ सामाजिक आर्थिक प्रभावहरू

जग्गा अधिग्रहणले ४३७ कित्ताहरूलाई प्रत्यक्ष असर गर्नेछ, जसको कुल क्षेत्रफल २७१.४५ हेक्टर हुनेछ (२१०.३० हेक्टर स्थायी र ६१.१५ हेक्टर अस्थायी रूपमा)। यी मध्ये ३५५ कित्ता निजी (३० रिसोर्ट, १ विद्यालय, ३२४ व्यक्तिगत), ६२ सरकारी, ८ सार्वजनिक, र १२

अज्ञात छन्। निजी स्वामित्वका ३५५ कित्ताहरूले १७.९५% क्षेत्र ओगट्छन्, तर सार्वजनिक कित्ताको तुलनामा तिनीहरूको अधिग्रहित क्षेत्र कम हुनेछ। यी कित्ताहरू विभिन्न व्यक्तिहरू वा संस्थाहरूको स्वामित्वमा छन्, र आयोजनाले तिनीहरूको प्रयोगलाई प्रभावित गर्नेछ। तालिकामा विभिन्न आयोजनाका संरचनाहरूको लागि आवश्यक कित्ता संख्या र क्षेत्रफल समावेश गरिएको छ।

तालिका ७: आयोजनाका संरचनाहरूको लागि आवश्यक कित्ता संख्या र क्षेत्रफल

क्र.सं.	आयोजना संरचना	स्थानिय तह	क्षेत्रफल [हेक्टर]	जमिनको प्रकार		कित्ता संख्या	प्राप्ति प्रकार
				निजी	सार्वजनिक		
१	इन्टेक क्षेत्र	डिभिघाट-३, एल.बी.: बन्दीपुर-६	८.६३		८.६३	-	स्थायी
२	जलाशय FSL २७५ मि.	एल.बी.: बन्दीपुर-६, ब्याँस-१४, ब्याँस-१३ आर.बी.: डिभिघाट-२, ३; ऋसिङ्ग-१, ३	१५७.४५	१४.२३	१४३.२२	१२८	स्थायी
३	जलाशय बफर २७८ मि.	एल.बी.: बन्दीपुर-६, ब्याँस-१४, ब्याँस-१३ आर.बी.: डिभिघाट-२, ३; ऋसिङ्ग-१, ३	२३.९५		२३.९५	१६८	स्थायी
४	स्थायी क्याम्प क्षेत्र-A	बन्दीपुर-६	०.४४	०.४४		३	स्थायी
५	Employer Camp Alternative-२	देवघाट-४	२.२८	२.२८		१३	स्थायी
६	विद्युत गृह क्षेत्र	देवघाट-४	१६.६९	६.३	१०.३९	४६	स्थायी
७	सर्ज शाफ्ट	देवघाट-४	०.८६	०.०८	०.७८	३	स्थायी
कुल क्षेत्रफल[हेक्टर]			२१०.३०	२३.३३	१८६.९७	३६१	

आयोजनाको लागि ६१.१५ हेक्टर क्षेत्रको अस्थायी जग्गा आवश्यक पर्नेछ। यो जग्गा निर्माण शिविर, सामग्री संकलन, खानी उत्खनन, फाल्न र अन्य कार्यहरूको लागि प्रयोग गरिनेछ। निर्माणपछि, जग्गालाई पुनर्स्थापना गरेर मूल अवस्थामा फर्काइनेछ। पुनर्स्थापना प्रक्रिया सावधानीपूर्वक योजना गरिएमा, जग्गाको प्रभाव कम गर्न र यसलाई पूर्वावस्थामा फर्काउन सकिन्छ।

तालिका ८: आयोजनाको लागि आवश्यक पर्ने अस्थायी जग्गाको विवरण

क्र.सं.	परियोजना घटक	नगरपालिका/वार्ड	क्षेत्रफल [हेक्टर]	जमिनको प्रकार		कित्ता संख्या	प्राप्ति प्रकार
				निजी	सार्वजनिक		
१	विस्फोटक भण्डार गृह/ब्यारक	बन्दीपुर-६	०.४१	०.४१		७	अस्थायी
२	एडीट २ का लागि पहुँच मार्ग	डिभिघाट-४	१.०६		१.०६		अस्थायी
३	ब्याचिङ्ग प्लान्ट र प्रयोगशाला A	बन्दीपुर-६	०.५२		०.५२	२	अस्थायी
४	सुरुङ B का लागि ब्याचिङ्ग प्लान्ट र प्रयोगशाला	डिभिघाट-३	१.१	०.५४	०.५६	८	अस्थायी
५	माटो क्षेत्र निजी जग्गा	ब्याँस-१४	६.८१		६.८१	१	अस्थायी
६	डम्पिङ्ग क्षेत्र-HW	बन्दीपुर-६	६.८८		६.८८	-	अस्थायी
७	थप डम्पिङ्ग क्षेत्र	देवघाट-३	२.९१		२.९१	-	अस्थायी
८	डम्पिङ्ग क्षेत्र-PH	देवघाट-४	२.५२	०.२२	२.३	४	
९	अस्थायी श्रमिक क्याम्प A	बन्दीपुर-६	१.४	०.८२	०.३३	७	अस्थायी
१०	अस्थायी श्रमिक क्याम्प B	देवघाट -४	०.५१		०.५१	-	अस्थायी
११	अस्थायी श्रमिक क्याम्प C	देवघाट -४	१.१५	१.१५		५	अस्थायी
१२	Old alluvial deposits and coarse aggregate	बन्दीपुर-६	२.७९		२.७९	-	अस्थायी
१३	अडिट-२	देवघाट -४	०.०९		०.०९	-	अस्थायी

क्र.सं.	**परियोजना घटक**	**नगरपालिका/वार्ड**	**क्षेत्रफल [हेक्टर]**	**जमिनको प्रकार**		**कित्ता संख्या**	**प्राप्ति प्रकार**
				निजी	**सार्वजनिक**		
१४	अडिट-३	देवघाट -४	०.०७	०.०३	०.०४	४	अस्थायी
१५	अडिट-४	देवघाट -४	०.१६		०.१६	५	अस्थायी
१६	सर्ज शाफ्ट एडिटको लागि पहुँच सडक	देवघाट -४	२.०५	०.९	१.१४	३२	अस्थायी
१७	RBM-१		५.५४		५.५४		अस्थायी
१८	RBM-२		७.३४		७.३४		अस्थायी
१९	RBM-३		६.२८		६.२८		अस्थायी
२०	RBM-४		३.९१		३.९१	१	अस्थायी
२१	RBM-५		२.२८		२.२८		अस्थायी
२२	Rock Quarry - B		५.३७		५.३७		अस्थायी
कुल क्षेत्रफल			**६१.१५**	४.०७	**५६.८२**	७६	

आयोजना कार्यान्वयनले कुल २८५ घरधुरीलाई स्थायी र अस्थायी रूपमा प्रभावित गर्नेछ। प्रभावित घरधुरीहरूमाः

- २८५ घरधुरीमध्ये २६९ घरपरिवारको पहिचान भएर घरधुरी सर्वेक्षण भएपनि बाँकी १६ घरधुरीको पहिचान र सर्वेक्षण हुन सकेन।
- २६१ घरधुरीबाट एक-एक कित्ता जग्गा अधिग्रहण गरिनेछ, जबकि २४ घरधुरीबाट एकभन्दा बढी कित्ता अधिग्रहण गरिनेछ।
- २६१ घरधुरीमध्ये, १२३ घरधुरीको जग्गा अस्थायी रूपमा र १३८ घरधुरीको जग्गा स्थायी रूपमा अधिग्रहण गरिनेछ।
- २४ घरधुरीमध्ये, ४९ कित्ता अस्थायी रूपमा र ४७ कित्ता स्थायी रूपमा अधिग्रहण गरिनेछन्।

स्थानिय तह	**प्रभावित घरधुरी संख्या**
बन्दीपुर-६	१३३
ब्याँस-१४	७५
देवघाट-३	१७
देवघाट-४	४४
पहिचान हुन नसकेको	१६
कुल घरधुरी	**२६९**

घरधुरीहरू बाहेक, अन्य संस्थानहरू पनि जग्गा अधिग्रहणबाट प्रभाव पर्नेछ। आयोजनाले "केयर एण्ड डाउनी" नामक निजी रिसोर्टबाट ३० कित्ता जग्गा (कुल ०.९५ हे.) स्थायी रूपमा अधिग्रहण गर्नेछ। सरकारी १३.८२ हे. (६२ कित्ता) स्थायी र ३६.३० हे. (१३ कित्ता) अस्थायी जग्गा आयोजनाको लागि प्रयोग गरिनेछ।

सार्वजनिक जग्गाको ९.९० हे. (६ कित्ता) स्थायी रूपमा भोगाधिकारको लागि लिईनेछ। प्रारम्भमा १२ कित्ताहरूको स्वामित्व अज्ञात थियो, जसमा १.२५ हे. जग्गा समावेश छ, र यो समस्या समाधान गर्न मालपोत कार्यालयसँग समन्वय गरिनेछ। अनुपस्थित स्वामीहरूको समस्या कानूनी

नोटिसमार्फत समाधान गरिनेछ, जसले सबै सम्बन्धित पक्षहरूलाई जानकारी र कानूनी प्रक्रियामा सहभागी हुने अवसर दिनेछ।

आयोजनाको प्रमुख सामाजिक प्रभावमा निजी जग्गाको अधिग्रहण रहेको छ जसको कारण आयोजना क्षेत्र बसोबास गर्ने परिवारहरूको विस्थापन हो। यो विस्थापनबाट उत्पन्न हुने सामाजिक तथा आर्थिक असरहरू नै यस आयोजनाको प्रमुख सामाजिक-आर्थिक प्रभाव हो र यसको न्यूनीकरणका लागि आयोजनाले प्रभावित परिवारहरूलाई उचित क्षतिपूर्ति उपलब्ध गराउनेछ। आयोजनाले विस्थापित परिवारका सदस्यहरुको जीविकोपार्जन सुधार्न जीविकोपार्जनका कार्यक्रमहरू लागु गर्नेछ। निजी स्वामित्वका संरचनाहरूमा आवासीय र व्यावसायिक सम्पत्ति, स्नानघर, शौचालय, सुरक्षा ट्यांका, नल, पानीका ट्यांका, भण्डारण घरहरू, भान्सा, जनावरका गोठहरू, भोजन हलहरू, कुखुरा कोठा, माछा पोखरी, र अन्य सुविधाहरू समावेश छन्। कुल २४८ निजी संरचनाहरू आयोजनाबाट प्रभावित हुनेछन्।

जनता प्राथमिक विद्यालयको विस्थापन: टेलरेस निर्माणले तनहुँ जिल्लाको गाईघाट, देवघाट-३ मा रहेको श्री जनता प्राथमिक विद्यालयलाई विस्थापित गर्नेछ। विद्यालयमा १८ विद्यार्थी र ३ शिक्षक छन्। यसले स्थानीय शिक्षा र सामुदायिक जीवनमा महत्वपूर्ण असर पार्नेछ।

गाईघाटका पसलहरूको विस्थापन: विद्युत गृह परिसरको निर्माणले गाईघाटका दुई पसलहरू विस्थापित हुनेछ।

सामुदायिक हलको विस्थापन: विद्युत गृह परिसरको निर्माणले गाईघाटमा रहेको सामुदायिक हललाई पनि विस्थापित गर्नेछ।

सांस्कृतिक र धार्मिक संरचनाहरू: आयोजना क्षेत्रमा विभिन्न घाटहरू र मन्दिरहरू पनि प्रभावित हुनेछन्। जलाशय निर्माणले ३ मन्दिरहरू (सरस्वती मन्दिर, नम देवी मन्दिर, झाक्रिथान मन्दिर, र गोरखा कालिका मन्दिर) को पहुँच र संरचनात्मक अखंडतालाई असर पार्न सक्छ।

बुद्ध सिंह मार्ग आयोजना क्षेत्रलाई दामौली बजारसँग जोड्ने महत्त्वपूर्ण सडक हो। यो सडकको लम्बाई २४ किमी रहेको छ। यो सडक त्रिशुली नदीको दायाँ किनारमा स्थित घुमाउनेसम्म पुग्छ। यस सडकमा त्रिशुली नदीमा पुल निर्माणको योजना छ, जसले पूरा भएपछि आयोजना क्षेत्र र त्रिभुवन हाइवेबीच सीधा जडान प्रदान गर्नेछ, र यात्रा समय घटाउनेछ। आयोजनाको जलासय

क्षेत्रले बुद्ध सिंह मार्गको ७.२८ किमि खण्डलाई प्रभाव पर्नेछ। प्रभाव न्यूनीकरण गर्नका लागि, यी खण्डहरू पुनः मार्गनिर्देशन गरिनेछ।

झोलुङ्गे पुलहरूको डुबानले सेती नदीको दुवै किनारामा बसोबास गरिरहेका स्थानीय समुदायहरूको दैनिक जीवनमा प्रभाव पार्नेछ। यी पुलहरूले यातायात र सञ्चारमा महत्वपूर्ण भूमिका खेल्दै, स्थानीयहरूको जीवनलाइनको रूपमा सेवा पुर्याउँदै आएको छ। त्यसैले, जलाशयको कारणले यी पुलहरू डुबानमा पर्नेछ र समुदायहरूको आवागमनमा चुनौतीहरू उत्पन्न गर्नेछ। प्रभावित पुलहरूमध्ये श्री सेती गंगा प्राथमिक विद्यालयको नजिक रहेको झोलुंगे पुल एक हो, जसले बन्दिपुर-६ र देवघाट-३ जोढछ ।

आयोजनाबाट पर्ने अन्य प्रभावहरुमा स्थानीयहरुको स्वास्थयमा पर्ने प्रभाव, बाहिरका कामदारहरु बढ्नाले स्थानीय सुरक्षामा पर्ने प्रभाव, नदीमा पानीको बहाब घट्दा स्थानीयलाई पर्ने प्रभाव, आयोजना निर्माणको समयमा कामदारहरूको आगमनको कारण जनसङ्ख्या बढ्नाले स्थानीय स्रोत र साधनमा पर्ने चाप सम्बन्धि प्रभाव, आयोजना क्षेत्रको जग्गा अधिग्रहणले स्थानीय कृषि उत्पादनमा पर्ने प्रभाव, सामुदायिक स्रोत र साधनमा प्रर्ने प्रभाव आदि रहेका छन्।

निर्माण कार्यको समापनसँगै बढेको आर्थिक क्रियाकलापहरूमा कमी आउनाले स्थानीय उत्पादन, सेवा सुविधाको प्रयोगमा पनि कमी आउनेछ र यसबाट सञ्चालन चरणमा स्थानीय आर्थिक क्रियाकलाप सुस्त हुनेछ।

११. प्रभाव न्यूनिकरणका उपायहरू

११.१ भौतिक वातावरण

आयोजनाबाट पर्ने भौतिक वातावरण सम्बन्धि प्रभाव कम गर्न तल दिइएका मुख्य विधिहरु प्रयोग गरी वातावरणमा पर्ने प्रभावहरु कम गरिनेछ।

- बायो इन्जिनियरिङ्ग प्रविधिको माध्यमबाट जमिनको स्थिरता कायम गरिने छ।
- आयोजनाको निर्माणको क्रममा संम्भावित तथा सक्रिय पहिरोहरूको पहिचान तथा रोकथाम गरिने छ।

- निर्माणको समयमा प्रयोग गरिने जग्गाको माथिल्लो सतहको माटो संकलन गरी सुरक्षित रूपमा भण्डारण गरिनेछ, जसलाई निर्माण कार्य सम्पन्न भएपछि पुनः प्रयोग गरिनेछ।
- आयोजनाले नदीको पारिस्थितिक सन्तुलन र जलीय पारिस्थितिक प्रणालीको संरक्षण गर्न सेती नदीमा सुख्खा महिनाको मासिक बहाबको १०% वातावरणीय बहाबको रूपमा बाँधबाट सेती नदीमा छोडिनेछ। यस बहाब बाहेक करिब १४ घन मिटर प्रति सेकेण्ड बराबर पानी ४ वटा सहायक नदीहरूबाट बहाब कम हुने क्षेत्रमा मिसिने हुँदा, नदीमा पर्याप्त बहाब रहिरहने अपेक्षा गरिएको छ।
- वातावरणीय बहाब निर्धारण गर्न थप विस्तृत अध्ययन गरिने छ।
- सावधानी साइरन जडान गरी स्थानीय जनतालाई आयोजना सञ्चालनको समयमा पानी छोडिने बारे सचेत गराइने छ।
- भौतिक तथा रासायनिक वातावरणमा पर्न सक्ने प्रभावहरूलाई डिजाइन अवधिदेखि नै ध्यानमा राखिएको छ, जस्तै: ध्वनी प्रदूषणमा कमी ल्याउन, ध्वनी कम उत्पन्न गर्ने मेसिनेरीहरूको प्रयोग गरिने छ।
- निर्माण कार्यहरू सकेसम्म दिनको समयमा गरिने छ।
- धुलोधुँवा न्यूनीकरण गर्न निर्माण साइट, निर्माण सामाग्री भन्डारन स्थल आदिलाई छोपेर राखिनेछ।
- आयोजनाबाट उत्पादन हुने फोहरहरूको उचित व्यवस्थापन तथा विसर्जन गरिनेछ।
- निर्माण चरणको समयमा भौतिक वातावरण सम्बन्धि प्रभाव न्यूनिकरणका उपायहरूको लागि अनुमानित बजेट तालिका ८ मा समावेश गरिएको छ।

११.२ जैविक वातावरण

आयोजनाबाट पर्ने जैविक वातावरण सम्बन्धि प्रभाव कम गर्न तल दिइएका मुख्य विधिहरु प्रयोग गरी वातावरणमा पर्ने प्रभावहरु कम गरिनेछ।

- रूख र वनस्पतिमा पर्ने प्रभावलाई कम गर्न, आयोजनाले वृक्षारोपण र वातावरणीय संरक्षण कार्यमा ध्यान केन्द्रित गर्नेछ।
- आयोजना निर्माण तथा सञ्चालनको क्रममा हटाइएका एक रूख बराबर १० वटा नयाँ बिरुवाहरु रोपिने छ। तसर्थ आयोजनाले क्षतिपूर्ति स्वरुप कुल १,९१,१५० नयाँ रूखहरू रोपिनेछ।

- यस आयोजनाले वन क्षेत्रको जम्मा १६१.४६ हेक्टर (सा.व. र राष्ट्रिय वन क्षेत्रको) जग्गा प्रयोग गरेबापत वन नियमावली २०७९ को नियम ९१ बमोजिम क्षतिपूर्ति स्वरुप वनको विकास गर्न योग्य जग्गा उपलब्ध गराईनेछ। सो बमोजिम जग्गा उपलब्ध हुन नसकेमा सोहि नियमावलीको नियम ९२ बमोजिम जग्गा प्राप्ति सहजीकरण समिति समक्ष्य जग्गा प्राप्तिको लागि अनुरोध गरिनेछ। यदि सो समितिले सेट जग्गा उपलब्ध गराउन नसकेमा नियमावलीको नियम ९३ बमोजिम अनुसूची ५१ तथा अनुसूची ५१ (क) अनुसारको रकम नियमावलीले तोकेको कोषमा दाखिला गरिनेछ।
- स्थानीय बन उपभोक्ता समूहहरूको प्राथमिकता र वन्यजन्तुहरूको लागि वासस्थान उपलब्ध गराउन क्षतिपूर्ति बापतको वृक्षारोपण गर्दा स्थानीय प्रजातिका रुखहरूलाई प्राथमिकता दिने छ।
- आयोजना निर्माणको क्रममा सडकको पहुँचमा सुधार हुँदा जङ्गली जीव-जन्तुको अवैध सिकार हुन सक्ने सम्भावना पनि बढ्ने छ। तसर्थ आयोजनाले अवैध सिकार न्यूनीकरणका उपायहरू कार्यान्वयन गर्नेछ।
- आयोजनाबाट पर्ने प्रभाव कम गर्न सरोकारवालाहरूसँगको सहकार्य, कानूनको कडा कार्यान्वयन, महत्त्वपूर्ण क्षेत्रहरूमा गस्ती गर्ने र निर्माण व्यवसायीहरूसँगको सम्झौतामा गैर कानूनी सिकार विरोधी व्यवस्था राखी कार्यान्वयन गरिने छ।
- आयोजनामा भएको महत्त्वपूर्ण वासस्थान क्षेत्र मानिएको वनको संरक्षण गर्ने, आयोजना कार्यान्वयनका समयमा अन्तराष्ट्रिय मापदण्डहरूको पालना गर्ने, लोपोन्मुख प्रजाति र तिनको वासस्थानको विकास र संरक्षण सुनिश्चित गरी जैविक विविधता संरक्षणलाई प्राथमिकता दिइनेछ।
- आयोजनाले बाहिरबाट आउने माछाहरूको बसाइसराइको महत्त्वलाई ध्यानमा राखि यसबाट पर्ने प्रभावलाई कम गर्न फिस ल्याडर र ह्याचरीहरू जस्ता उपायहरू प्रस्ताव गरिएकोछ।
- नेपालको अरु जलविद्युत आयोजनामा प्रयोग गरिएको फिस ल्याडर त्यति प्रभावकारी नदेखिएको हुँदा यस आयोजनामा ह्याचरी निर्माणलाई प्राथमिकता दिइएको छ। ह्याचरीले माछाको सङ्ख्या बढाउन कृत्रिम प्रजनन प्रविधिको प्रयोग गर्नेछ। यस अध्ययनले धाड खोलामा दुई सम्भावित ह्याचरी साइटहरू पहिचान गरेको छ।
- आयोजनाले विज्ञहरूसँग सहकार्य गरी, विस्तृत योजनाहरू कार्यान्वयन र अनुगमनको नतिजाहरू अध्ययन गरी ह्याचरी स्थापना गर्ने छ। "क्याच एन्ड हल" कार्यक्रमले माछाको स्थानान्तरणलाई सहज बनाउन र जलीय जैविक विविधता बढाउने काम गर्नेछ।

- निर्माण चरणको समयमा जैविक वातावरण सम्बन्धि प्रभाव न्यूनिकरणका उपायहरूको लागि अनुमानित बजेट तालिका ८ मा समावेश गरिएको छ।

१०.३ सामाजिक तथा आर्थिक वातावरण

आयोजनाबाट पर्ने सामाजिक-आर्थिक तथा सांस्कृतिक वातावरण सम्बन्धि प्रभाव कम गर्न तल दिइएका मुख्य विधिहरु प्रयोग गरी वातावरणमा पर्ने प्रभावहरु कम गरिनेछ।

- आयोजनाले अधिग्रहण गरिएका जग्गा, घरटहरा, व्यवसायहरूको उचित मुआब्जा तथा क्षतिपूर्ति प्रदान गर्नेछ। यस प्रक्रियालाई जग्गा प्राप्ति ऐन र नेपाल विद्युत् प्राधिकरणबाट स्थापित मापदण्डहरुको कानूनी प्रावधानहरु अनुसार दर निर्धारण गरिनेछ।
- निजी जग्गा अधिग्रहण गर्दा आयोजनाले बजार भाउमा नघटाइ क्षतिपूर्तिको निर्धारण गर्नेछ।
- आयोजनाबाट प्रभावित परिवारहरुलाई थप सहायता भत्ताको समेत व्यवस्था गरिनेछ।
- स्वामित्व नभएका जग्गा तर स्थानीयले पुस्तौ देखि प्रयोग गरिरहेको खण्डमा त्यसको समेत उचित व्यवस्थापन गर्नेछ।
- सार्वजनिक, धार्मिक तथा सांस्कृतिक संरचनाहरुको उचित पुनस्थापना गर्नेछ।
- प्रभाव न्यूनीकरणका अतिरिक्त आयोजनाको लागतको ०.५०% रकम "सामुदायिक सहयोग कार्यक्रम" को लागि प्रस्ताव गरिएको छ। यस कार्यक्रमको उद्देश्य जीविकोपार्जनमा सहयोग गर्ने, रोजगारीका अवसरहरू प्रदान गर्ने, पुनर्वासमा सहयोग गर्ने र सामुदायिक कल्याणकारी कार्यहरूलाई दिगो बनाउने रहेकोछ। यसले कृषिमा आधारित र गैर-कृषि जीविकोपार्जन समर्थनका लागि रणनीतिहरू समावेश गर्दछ, आदिवासी समूहहरूको जीविकोपार्जन पहुँचमा ध्यान केन्द्रित गर्दछ, जोखिममा परेका परिवारहरूलाई विचार गर्दछ, र स्थानान्तरण र भूमि हानिको बिचमा सामाजिक सञ्जालहरू जोगाउने लक्ष्य राख्दछ।
- सामुदायिक सहयोग कार्यक्रम (CSP) को लागि १२०,६००,०००.०० ने.रु. (९००,०००.०० अमेरिकी डलर) को बजेट विनियोजन गरिएको छ भने, निर्माण चरणको समयमा सामाजिक-आर्थिक तथा सांस्कृतिक वातावरण सम्बन्धि प्रभाव न्यूनिकरणका उपायहरूको लागि अनुमानित बजेट तालिका ८ मा समावेश गरिएको छ।

तालिका ८: निर्माण चरणको समयमा प्रभाव न्यूनिकरणका उपायहरूको लागि अनुमानित बजेट

क्र सं	विवरण	अनुमानित बजेट (अमेरिकी डलर)	रकम (नेपाली रुपैया)
१	ढलान स्थिरता र भू-क्षय नियन्त्रणका उपायहरू	२००,०००.००	२,६६,००,०००.००
२	वायु गुणस्तर न्यूनीकरणका उपायहरू	१२०,०००.००	१,५९,६०,०००.००
३	वायु गुणस्तर निगरानी	५०,०००.००	६६,५०,०००.००
४	पानीका मुलहरुको संरक्षण र मुहानहरूमा पानीको स्तर निगरानी	२०,०००.००	२६,६०,०००.००
५	तलछट नियन्त्रण उपायहरू	१००,०००.००	१,३३,००,०००.००
६	ठोस फोहोरको व्यवस्थापन	२५,०००.००	३३,२५,०००.००
७	वनको क्षतिपूर्ति	२,९४८,९५०.००	३९,२२,१०,३५०.००
८	नर्सरी स्थापना	१०,०००.००	१३,३०,०००.००
९	वन/गैर कास्ठ वन उत्पादनहरूका लागि सचेतना	१०,०००.००	१३,३०,०००.००
१०	सुनाखरीको संरक्षण	५,०००.००	६,६५,०००.००
११	वन डढेलो नियन्त्रण	२०,०००.००	२६,६०,०००.००
१२	उद्धार र पुनर्वास केन्द्र	१००,०००.००	१,३३,००,०००.००
१३	संरक्षण नियम र नियमावलीहरूको कार्यान्वयन	५०,०००.००	६६,५०,०००.००
१४	जैविक विविधता बारे सचेतना तालिम	५०,०००.००	६६,५०,०००.००
१५	चरचुरुङ्गिहरु (बासस्थान पुनर्स्थापना मापन जागरूकता कार्यक्रमहरू)	१००,०००.००	१,३३,००,०००.००
१६	माछाको स्थानान्तरण	२०,०००.००	२६,६०,०००.००
१७	माछाको जनसंख्याको अनुगमन	१०,०००.००	१३,३०,०००.००

१८	जनता प्राथमिक विद्यालयको अस्थायी स्थानान्तरण	२००,०००.००	२,६६,००,०००.००
१९	कृषि क्षतिपूर्ति	२००,०००.००	२,६६,००,०००.००
२०	सामुदायिक सहयोग कार्यक्रम (CSP)	९००,०००.००	१२०,६००,०००.००
२१	सीपमुलक तालिमहरू	५०,०००.००	६६,५०,०००.००
२२	लैङ्गिक समानता र सामाजिक समावेशीकरण बारे सचेतना तालिम	२०,०००.००	२६,६०,०००.००
	कुल लागत	५,२०८,९५०.००	६९,२७,९०,३५०.००

थप विवरणहरू वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनको वातावरणीय न्यूनीकरण मापन म्याट्रिक्समा समाबेस गरिएको छ।

१०.४ सामुदायिक सहयोग कार्यक्रम (CSP)

राष्ट्रिय ऊर्जा संकट निवारण र विद्युत विकास दशक, २०१५ को अवधारणापत्र र कार्ययोजना अनुसार आयोजनाको कुल लागतको ०.५०% सामुदायिक सहयोग कार्यक्रम (CSP) को लागि विनियोजन गर्नुपर्नेछ। जग्गा प्राप्ति प्रक्रियाका कारण स्थायी र अस्थायी दुवै आधारमा जम्मा २८५ घरधुरी मा प्रभाव पर्ने अनुमान गरिएको छ। यसले प्रभावित परिवारहरूको दुई फरक वर्गहरूमा वर्गिकरण गर्नेछः गम्भीर रुपमा आयोजना प्रभावित परिवारहरू (SPAF) र आयोजना प्रभावित परिवारहरू (PAF)। यस आयोजनाले यी परिवारहरूको आवश्यकताहरू पूरा गर्न सामुदायिक सहयोग कार्यक्रम (CSP) लागू गर्नेछ किनभने आयोजनाको करणले गर्दा उनीहरूले आफ्नो जीवनस्थरमा परिवर्तनहरू अनुभव गरिरहेका छन्।

यस आयोजनाले सामुदायिक सहयोग कार्यक्रम (CSP) को लागि कुल नेपाली रुपैया १२०,६००,०००.०० (९,००,०००.०० अमेरिकी डलर) प्रस्ताव गरिएको छ।

तालिका ९: सामुदायिक सहयोग कार्यक्रम (CSP) लागतको सारांश

क्र सं	**विवरण**	**रकम (नेपाली रुपैयाँ)**
१	शिक्षा सहयोग कार्यक्रम	१०,०००,०००.००
२	सामुदायिक वन/कबुलियती वन सहायता कार्यक्रम	१०,०००,०००.००
३	पूर्वाधार सहयोग कार्यक्रम	
	दाहसंस्कार स्थलहरू / घाट	२,२५०,०००.००
	खानेपानी तथा सुरक्षा सहयोग कार्यक्रम	१०,०००,०००.००
	साना सिंचाई सहयोग कार्यक्रम	१०,०००,०००.००
४	सीपमा आधारित र जीविकोपार्जन वृद्धि तालिम	४२,७५०,०००.००
५	स्वास्थ्य क्षेत्र सहयोग कार्यक्रम	१०,०००,०००.००
६	सांस्कृतिक सहयोग कार्यक्रम	१०,०००,०००.००
७	स्थानीय उत्पादनको प्रवद्र्धन कार्यक्रम	१५,६००,०००.००
	कुल (नेपाली रुपैया)	**१२०,६००,०००.००**

१२. वातावरणीय व्यवस्थापन योजना

वातावरणीय व्यवस्थापन योजनाले वातावरणीय प्रभाव मूल्याङ्कन प्रतिवेदनमा उल्लेख गरिएका प्रभाव न्यूनीकरणका उपायहरुको कार्यान्वयन सुनिश्चित गर्नेछ। यस आयोजनाले आयोजनाको निर्माण तथा सञ्चालन चरणमा अनुगमन कहाँ गर्ने, कहिले गर्ने, कुन कुन सुचाङ्कहरुको अनुगमन गर्ने बारे अनुगमन रणनीति तयार गर्ने छ र यस योजनामा न्यूनीकरणका उपायहरू समावेश हुनेछ। वातावरण व्यवस्थापनको मुख्य जिम्मेवारी प्रस्तावक आफैं हुनेछ। अनुकुल तथा प्रतिकूल प्रभावहरूलाई सम्बोधन गर्न विभिन्न वातावरणीय व्यवस्थापन कार्यहरू कार्यान्वयन गर्नुपर्ने हुन्छ जसको लागि कुल ८३,१०,४८८ अमेरिकी डलर लाग्ने अनुमान गरिएको छ। अनुगमन खर्च ४८५,००० अमेरिकी डलर अनुमान गरिएको छ भने लेखा परीक्षण लागत ५७,६९२ अमेरिकी डलर लाग्ने अनुमान गरिएको छ। तसर्थ, आयोजनाको वातावरणीय व्यवस्थापन योजनाको लागि कुल अनुमानित लागत ८,८५३,१८० अमेरिकी डलर लाग्ने अनुमान गरिएको छ।

१३. वातावरणीय अनुगमन

वातावरणीय प्रभाव मूल्यांकनको प्रभावकारी कार्यान्वयनका लागि वातावरणीय अनुगमन महत्त्वपूर्ण छ। यसले वातावरणीय प्रभाव मूल्यांकन प्रतिवेदनले सिफारिस गरे बमोजिम आयोजनाको प्रभावको अनुगमन र न्यूनीकरण उपायहरू कार्यान्वयन गरी आयोजना कार्यान्वयनले आयोजना क्षेत्रको वातावरणीय अवस्थालाई बिगार्ने छैन भन्ने सुनिश्चित गर्दछ। निर्माण व्यवसायीको कार्यसम्पादन र विश्लेषणात्मक नतिजाहरूमा मध्यनजर गर्दै आयोजना कार्यान्वयनको क्रममा अनुगमन गतिविधिहरू परिमार्जन गर्न सकिन्छ। यदि वातावरणमा आयोजनाको प्रभाव अपेक्षित भन्दा खराब भएको खण्डमा, समस्या समाधान गर्न कदम चालिनेछ, र एस्तो कार्य नदोहोरियोस भनेर सुनिश्चित गर्न अनुगमन परिवर्तन गरिनेछ। परिमाणात्मक अनुगमन बाहेक, त्यहाँ वातावरणीय व्यवस्थापन योजना (EMP) कार्यान्वयनको निगरानी र अनुगमन पनि हुनेछ। यस कार्यको लक्ष्य भनेको सबै वातावरणीय व्यवस्थापन योजना (EMP) उपायहरू सही समयमा पूर्ण रूपमा लागू भएको सुनिश्चित गर्नु हो।

तीन प्रकारका वातावरणीय अनुगमन गरिनेछः (क) आधारभूत अनुगमन, (ख) अनुपालन अनुगमन, (ग) प्रभाव अनुगमन

तालिका १०: वातावरणीय अनुगमन लागतको सारांश

क्र सं	विवरण	रकम (अमेरिकी डलर प्रति वर्ष)	रकम (नेपाली रुपैयाँ)
१	आधारभूत अनुगमन -	२१५,०००.००	२८५९५०००.००
२	अनुपालन अनुगमन-निर्माण चरण	१४२,०००.००	१८८८६०००.००
३	अनुपालन अनुगमन-सञ्चालन चरण	६२,०००.००	८२४६०००.००
४	प्रभाव अनुगमन-निर्माण चरण	४६,०००.००	६११८०००.००
५	प्रभाव अनुगमन-सञ्चालन चरण	२०,०००.००	२६६००००.००
	कुल अनुगमन लागत	४८५,०००.००	६४५०५०००.००

१४. वातावरणीय परीक्षण

वातावरणीय परीक्षणको लक्ष्य EIA अध्ययनमा पहिचान गरिएका वातावरणीय र सामाजिक जोखिमहरूलाई कसरी प्रभावकारी रूपमा कम गरिनेछ भन्ने कुराको मूल्याङ्कन गर्नु हो र तोकिएको वातावरणीय व्यवस्थापन योजनाको अनुपालन सुनिश्चित गर्नु हो। वातावरणीय परीक्षणले गैर-अनुपालनका कुनै पनि मुद्दाहरूलाई मात्र सम्बोधन गर्दैन तर भविष्यका परीक्षणहरू र निरन्तर अनुगमनका लागि डाटाको आधारभूत रेखा पनि बनाउँछ।

आयोजना सञ्चालनको क्रममा वातावरणीय परीक्षण गर्ने जिम्मेवारी वन तथा वातावरण मन्त्रालयको रहनेछ । यसका निर्देशिकाहरू अनुरूप, वन तथा वातावरण मन्त्रालयले २ वर्षको सञ्चालन अवधि पछि आफ्नो वातावरणीय परीक्षण गर्नेछ।

आयोजनाले वातावरणीय परीक्षण खर्चका लागि रकम छुट्याउनेछ, जसले निर्माण कार्य सम्पन्न भएको दुई वर्षपछि हुने खर्चलाई प्रतिनिधित्व गर्दछ।

तालिका ११: वातावरणीय परीक्षणका लागि बजेट।

क्र सं	विवरण	इनपुट	दर	रकम (नेपाली रुपैया)
१	नमूना र प्रयोगशाला विश्लेषण	LS		१,५००,०००.००
२	परामर्श र अन्तर्वार्ता	LS		१,५००,०००.००
३	डाटा खरिद	LS		१,०००,०००.००

क्र सं	विवरण	इनपुट	दर	रकम (नेपाली रुपैया)
४	ड्रोन सर्वेक्षण	LS		१,५००,०००.००
५	यातायात	LS		५००,०००.००
६	रिपोर्टिङ, आदि	LS		५००,०००.००
	कुल (नेपाली रुपैया)			**७,५००,०००.००**
	कुल (अमेरिकी डलर)			**५६३९०.९८**

१५. निष्कर्ष

प्रस्तावित १२६ मेगावाट क्षमताको पिकिङ रन अफ द रिभर (PROR) प्रकृतिको रहेको छ र यसले वार्षिक ५२०.७८ GWh ऊर्जा उत्पादन गर्नेछ। जलाशय, बाँध र मुख्य सुरुङ यस आयोजनाको मुख्य संरचनाहरु हुन्। यस आयोजनाले तनहुँ जलबिधुत आयोजनासँग मिलेर नेपालको जलविद्युत क्षमता बढाउने र हरितगृह ग्यास उत्सर्जन घटाउन मद्दत गर्नेछ। आयोजनाले २७१.४५ हेक्टर जग्गा प्रयोग गर्नेछ र यसबाट २८५ घरधुरीहरु प्रभावित हुनेछन्। आयोजनाको कार्यान्वयनबाट विभिन्न प्रभावहरु पर्ने छन्। नकरात्मक प्रभावहरुको न्यूनीकरणका उपायहरू यस अध्ययन प्रतिवेदनमा समावेश गरिएको छ। आयोजनाले न्यूनीकरणका उपायहरु कार्यान्वयन गर्दै तिनीहरुको नियमित अनुगमन गरी स्वच्छ हरित ऊर्जा उत्पादन गर्नेछ, रोजगारीको अवसर सृजना गर्नेछ, स्थानीय पूर्वाधारमा सुधार ल्याउनेछ र नेपाललाई ऊर्जामा आत्मनिर्भर बनाउन सहयोग गर्नेछ।

यस आयोजनाको वातावरणीय प्रभाव मूल्यांकन प्रतिवेदनमा आयोजनाबाट पर्ने नकारात्मक प्रभावहरु न्यूनीकरण गर्न प्रस्तावित वातावरणीय व्यवस्थापन योजनालाई प्रभावकारी रूपमा कार्यान्वयन गर्न जोड दिइएको छ। तसर्थ, आयोजना विकास कर्ता (प्रस्तावक/तनहुँ हाइड्रोपावर लिमिटेड) ले वातावरणीय व्यवस्थापन योजनालाई प्रभावकारी रूपमा कार्यान्वयन गरी आयोजना कार्यान्वयन गर्नेछ। आयोजना कार्यान्वयनको क्रममा यदि कुनै अतिरिक्त प्रभावहरू देखा परेमा उपयुक्त उपायहरु अपनाई तिनीहरुको समाधान प्रस्तावकले आफ्नै खर्चमा गर्नेछ। अन्तमा प्रस्तावित हरित ऊर्जा उत्पादन गरी देशको ऊर्जा क्षेत्रमा थप टेवा पुग्ने भएकोले यो आयोजना कार्यान्वयनका लागि वातावरणीय दृष्टिकोणबाट पनि उपयुक्त ठहर गरिएकोछ।

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Abbreviation/ Acronym

ADB	Asian Development Bank
AP	Affected Person
AQI	Air Quality Index
BCN	Bird Conservation Nepal
CBS	Central Bureau of Statistics
CDO	Chief District Officer
CF	Community Forest
CFUG	Community Forest User Group
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	Catch Per Unit Effort
CR	Critically Endangered
dB	Decibel
DCC	District Coordination Committee
DD	Data Deficient
DFO	Division Forest Office
DHM	Department of Hydrology and Meterology
DoED	Department of Electricity Development
DP	Displaced Person
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Nationally Endangered
EPA	Environmental Protection Act
EPR	Environmental Protection Regulations
ESMU	Environmental and Social management Unit
FGD	Focused Group Discussion
FPIC	Free Prior Informed Consent
FRTC	Forest Research and Training Center
GoN	Government of Nepal
GRC	Grievance Redress Committee
GRM	Grievance Redress Mechanism
GWh	Gigawatt hours
ha	Hectare
HH	Household
ILO	International labor Organization
INGO	International non-Governmental Organization
INPS	Integrated Nepal Power System
IR	Involuntary Resettlement
IUCN	International Union for Conservation of Nature
KIS	Key Information Surveys
KII	Key Information Interviews
Km	Kilometer
LC	Least Concerned
LFUG	Leasehold Forest User Group
TSHPP	Tallo Seti Hydropower Project
M	Meter
MBT	Main Boundary Thrust
MCT	Main Central Thrust

MT	Mahabharat Thrust
MoEWRI	Ministry of Energy, Water Resources and Irrigation
MoFE	Ministry of Forests and Environment
MW	Mega Watt
NDWQS	National Drinking Water Quality Standards
NEA	Nepal Electricity Authority
NGO	Non-Governmental Organizations
NPR	Nepali Rupee
NTFP	Non-Timber Forest Products
OHS	Occupational Health and Safety
PM	Particulate Matter
PMO	Project Management Office
PRoR	Peaking Run of River
RM	Rural Municipality
RoR	Run off River
RoR	Run of River
RP	Resettlement Plan
RRA	Rapid Rural Appraisal
SEMP	Strategic Environmental Management Plan
SPF	Safeguard Policy Framework
SPS	Safeguard Policy Standards
Sq km	Square kilometer
THL	Tanhun Hydropower Limited
THP	Tanhun Hydropower Project
ToR	Terms of Reference
UM	Urban Municipality
UN	United Nation
USD	United Nations Dollar
USHPP	Upper Seti Hydropower Project
VU	Vulnerable

Executive Summary

Introduction

The proposed TSHPP, with a capacity of 126 MW, operates as a Peaking Run of the River (PROR) scheme, yielding an annual electricity output of 520.78 GWh. The main features of this project include a 12.7 km long reservoir and 32 m tall barrage at Sarang Ghat Bandipur Municipality on the Seti River. Water from the reservoir is diverted via a 6.75 km long headrace tunnel to the semi-underground powerhouse at Gai Ghat, Dev Ghat Municipality before released into the Trishuli River through a tailrace.

The TSHPP is a downstream project to the Tanahu HEP, utilizing its tailrace water. With 126 MW, the TSHPP will supplement the Tanahu HEP's 140 MW. These combined initiatives will significantly contribute to Nepal's hydroelectric energy capacity, possibly meeting local demands and assisting neighboring nations. While exporting is possible, the TSHPP is primarily geared towards enhancing domestic supply, expanding capacity, substituting fossil fuel generation, and curbing Nepal's greenhouse gas emissions.

Project Proponent

The Proponent of Tallo Seti (Tanahun) Hydropower Project is Tanahu Hydropower Limited (THL), which is a company established under the umbrella of Nepal Electricity Authority (NEA) - an undertaking of the Government of Nepal. The contact details of the Proponent are given below:

Tanahu Hydropower Limited: Tallo Seti (Tanahun) Hydropower Project (TSHPP)
Chundevi Marg-Maharajgunj, Kathmandu, Nepal
Telephone: +977-01-5111117, 5111118
E-mail address: info@thl.com.np
Website: www.thl.com.np

Name, Address, E-mail, Phone Number of the Consultant
WAPCOS Limited (India) in Joint Venture with NIPPON KOEI (Japan) (WAPCOS NIPPON JV) in association with Total Management Services Pvt. Ltd (Nepal) and GEOCE Consultants (P). Ltd (Nepal), have been commissioned to prepare an Environmental Impact Assessment (EIA) for the project. The contact details of the consultant and sub-consultants are as follows:
Consultant:
WAPCOS NIPPON JV (Lower Seti)
Project Office, Kamalpokhari, Kathmandu, Nepal
Tel.: +977-01-4435826
E-mail: lowersetihpp@gmail.com

Sub-consultant
Total Management Services Pvt. Ltd
Kamalpokhari, Kathmandu, Nepal
Tel.: +977-1-4439182, 4439187
Email: info@tms.com.np
Website: http://www.tms.com.np

Rationale of Undertaking the EIA Study

This study was carried out to meet Nepal's Environmental Protection Act 2019 and Environmental Protection Regulations 2020 and the Asian Development Bank's Safeguard Policy Statement (SPS). According to Schedule 3 Rule 3 F-1(a) of the Environmental Protection Regulations 2077, an Environmental Impact Assessment (EIA) is mandated for hydropower projects exceeding 50 MW in installed capacity. Additionally, as per EPR 2077, projects—other than transmission lines—that necessitate the use of 5 hectares of forest land are also required to undergo an EIA study. Given that the proposed TSHPP has an installed capacity of 126MW and requires approximately 54.32 hectares of forest land, this EIA study has been conducted specifically for this project.

As per the provision of the EPR 2077 that the projects with international support, the EIA report could be prepared in English language. Given that this particular study has been supported by the Asian Development Bank, the EIA report has been prepared in the English language. The contractual agreement between ADB and NEA has been attached in Annex A-2.

Given the TSHPP's 126 MW capacity, an EIA was conducted. Additionally, this project falls under Category A of ADB SPS 2009, as it affects 285 HHs, mainly indigenous communities, and impact critical wildlife and fish habitats.

Objective of the EIA Study

The objective of the EIA study is to assess the project's environmental and social impacts and propose measures to both mitigate negative effects and enhance positive outcomes.

Methods and materials

This report encompasses essential data for EIA. It covers climatic, geological, land use, hydrological data in the physical environment; vegetation, wildlife, and fish-related data in the biological environment; and socio-economic and cultural data including population, caste, and ethnicity. The project's environmental impact was determined through desk study, field study, and matrix methods, forming the basis of this EIA report.

This involved utilizing project feasibility studies, NSO publications, district profiles of relevant wards in Municipality/Rural Municipality, and Project Layout Maps.

Various techniques were employed, including household survey 185 HHs, expert field visits, Focus Group Discussions, formal and informal interviews with local representatives, and public hearings to gather input from locals and stakeholders. Deeds, written concerns, suggestions, and recommendation letters were gathered from concerned wards, Municipality/Rural Municipality, stakeholders, and local individuals.

The evaluation process for this project assessed its effects on social, economic, cultural, biological, and physical aspects of the local environment, encompassing both positive and negative outcomes. These impacts were categorized for deeper understanding: (a) Direct impacts: Immediate effects due to project implementation. (b) Indirect impacts: Secondary effects arising from the project. For a comprehensive assessment, the process was divided into three stages: (a) Impact identification (b) Impact evaluation (c) Impact prediction.

Public engagement is a crucial procedure that establishes community trust and involvement in the EIA process. This was achieved by conducting consultations at various levels, including households, communities, community organizations, user groups, local government representatives, and government line agencies. Additionally, a public hearing was organized at the project site on 29/06/2023 at Khahare, Bandipur, Tanahu to share the outcomes of the EIA study. These public interactions aimed to empower local residents to express their opinions and enhance their confidence in the project.

Existing Environmental Condition
Physical Environmental Condition
The project is situated in the Middle Mountain Zone, marked by a succession of mountains and valleys. The reservoir's highest point reaches 275 m asl. The proposed barrage location is about 246 m asl, while the suggested powerhouse site stands at 198 m asl. The elevation gain between the Full Supply Level (FSL) and the Powerhouse is 77 m.

The Seti River is a key part of the Gandaki River Basin, joining with the Trishuli River to create the Narayani River, the main outlet of the Gandaki. Covering about 14% of the total basin area, the Seti River basin contributed 11% of Gandaki's overall runoff.

The proposed TSHPP is located around 20 km downstream from the Tanahu HEP powerhouse site, which is under construction. Additionally, the Seti-Trishuli (S/T) Confluence lies about 11 km from the proposed barrage site. The project can be considered located at the outlet point of the Seti River Basin. Madi River is one of the significant tributaries of Seti River, which is located about 22 km upstream of the project - barrage. The Seti-Madi confluence reveals a wide river valley, however, the Seti River flows through a deep valley into the Trishuli. Sediments, like bed load and suspended load, are transported, seen as channel bars, point bars, and terraces. Meandering rivers, erosional and depositional banks, and other features were also observed.

The project area witnesses watershed conditions ranging from moderate to fair. The hilly terrain exhibits varying slopes, with steeper sections having relatively thin to moderately thick colluvial soil that might become unstable during heavy monsoon precipitation. Concerns arise from old alluvial tars, particularly along terrace edges, increasing the risks of toppling and debris flow. Tributary streams connecting to the Seti River have steep longitudinal profiles, which could potentially expand sideways and upstream, posing threats to distribution line poles. Numerous both active and historical landslides were observed in the vicinity. On a positive note, agricultural lands are well-maintained and do not face erosion or instability problems. While forest and grassland contend with grazing pressures, there's a gradual improvement in forest health due to community involvement.

Water availability for TSHPP hinges on Tanahu HEP's operation. TSHPP receives natural flow only when the Tanahu HEP's powerhouse is offline and its reservoir full. Otherwise, TSHPP gets flow from the Tanahu HEP's tailrace. However, it will get an uninterrupted flow from its tributaries, notably the Madi River. The study indicates the barrage site gets 50 m^3/s discharge in the dry season (Oct-May end). Rain boosts discharge during monsoon, peaking at 600 m^3/s in July and August, gradually tapering off.

The study indicated moderate water quality in the Seti River. While many parameters are within limits, Total Coliform and Fecal Coliform values surpass recommendations, suggesting contamination from domestic effluents. Turbidity values have also exceeded standards at some points, suggesting sediment release from upstream construction activities.

Biological Environment

The project area's vegetation reflects lower tropical conditions typical of central Nepal's bioclimatic zones. Local habitat and surroundings significantly influence the flora. Proximity to the Pokhara Valley, a wet region, renders the project area's flora more representative of wet climates. High rainfall supports dense vegetation, but steep topography and rocky settings, especially on the right bank result in moderate vegetation density with fewer trees. On the left bank, road construction and settlements lead to visible forest degradation due to human interference.

The project site and its vicinity contain a variety of plant species, with a total of 184 species documented during the study. The most dominant tree species observed were Padke Siris (*Albizia lucidicor*), Ram Rittha (*Trewia nudiflora*), Sal (*Shorea robusta*), Sindure (*Mallotus philippensis*) and Khirro (*Falconeria insignis*). The project area also witnesses occurrences of protected species such as Sal (*Shorea robusta*), Satisal (*Dalbergia latifolia*), Vyaakur (*Dioscorea deltoides*), and two species of Orchids (*Cymbidium aloifolium and Vanda sp.*).

The main wildlife habitat in the project area consists of forests (including riverine forests), agricultural lands, wetlands, and rural settlements. While the forest habitat, vital for wildlife, has suffered significant degradation due to overexploitation, some steep forest areas along the Seti River remain untouched due to limited access. The existence of critically endangered, endangered, and vulnerable species emphasizes the importance of these habitats, despite degradation, as Critical Habitats (CH).

The project area harbors 38 herpetofauna species: 10 amphibians, 12 lizards, 2 turtles, and 13 snakes. These species exhibit various IUCN Red List statuses, ranging from Least Concern (LC) to Critically Endangered (CR). They are also listed in both CITES Appendices I and II and Nepal's protected priority list. The Critically Endangered Elongated Turtle (Indotestudo elongata) was identified in the project area, and occasional crocodile sightings have occurred in the Seti River. No endemic, migratory, or invasive species were observed in the project area.

A total of 29 mammal species were documented in the project area. These mammals possess global and national statuses ranging from Least Concern (LC) to Vulnerable (VU), are listed in CITES Appendices I and II, and are featured in Nepal's protected priority list. Notably, the Malayan Porcupine (*Hystrix brachura)* was spotted in Aamdanda Village, Dev Ghat Municipality – 4, marking its lowest elevation record in Nepal. This porcupine species was also observed in Naldighat, Dhap, and Khahare Ghat regions. No endemic, migratory, or invasive mammal species are found in the project area. Among the recorded mammal species, 4 are in CITES Appendix I, 6 in Appendix II, and 2 are under the protection of the GoN. Additionally, 2 were classified as Vulnerable (V), 6 as Data Deficient (DD), and 17 as Least Concern (LC) in the IUCN Red Data Book. In the National Red Data Book, 1 species was listed as Endangered (EN), 5 as Vulnerable (V), 3 as Data Deficient (DD), and 12 as Least Concern (LC).

The project is strategically positioned adjacent to five Important Bird and Biodiversity Areas (IBAs): Chitwan National Park, Annapurna Conservation Area, Ramp IBA, Panchase IBA, and Manaslu IBA. These IBAs provide essential sanctuaries for diverse bird species, and the Seti River functions as a migratory route linking raptors, vultures, and waterfowl between the Terai lowlands and mountainous regions.

A total of 594 birds from 83 species were observed during the field surveys. Forest birds dominated with 45 species, followed by 13 raptor species, 10 riparian species, 8 urban species, and 7 farmland species. The Himalayan Bulbul, Red-vented Bulbul, and Oriental Magpie Robin were the most sighted (nearly 88% of transects), along with the Barn Swallow, Blue-whistling Thrush, Common Myna, Indian White-eye, and Western Spotted Dove (82% of transects).

Among the 83 bird species observed, 48 were permanent residents, while 30 species, native to Nepal, exhibit migration patterns. Within these, 18 were full migrant residents, and 10 species display altitudinal migration based on weather, seasons, food, and habitat. Only a few species were full migrants, primarily sighted in winter or summer seasons. Notable winter visitors include Ruddy Shelduck and Wallcreeper, while summer visitors encompassed Banded Bay Cuckoo, Chestnut-headed Bee-eater, and Indian Golden Oriole. Common Kestrel and Oriental Honey-buzzard exhibited diverse migratory behaviors, with the latter being a summer visitor to Nepal.

Among the recorded bird species in the project area, forest birds make up the majority (54%), followed by raptors (16%), wetland birds (12%), urban birds (10%), and farmland birds (8%). Most of the recorded species are of Least Concern (LC) on global and national red lists of birds. However, there are several bird species of conservation significance: 16, including vultures, owls, eagles, and buzzards, are noteworthy, of which 4 have global significance. These include the critically endangered Red-headed vulture and White-rumped vulture, the globally endangered Egyptian vulture, and the globally Near Threatened Himalayan Griffon. More species are of national significance, with some being critically endangered, endangered, vulnerable, and Near Threatened. Additionally, all 13 raptor species are listed in Appendix-II of CITES. None of the recorded bird species are regulated by the National Park and Wildlife Conservation (NPWC) Act in the hydropower project area.

A total of 68 fish species were recorded from the project area within the stretch of Seti River and Trishuli River. Of these 68 fish species, 22 were migratory, comprising 15 recorded (13 sampled and 2 observed) and 7 reported species. Migratory species were found both upstream and downstream of the barrage, utilizing tributaries like Dihul Khola, Masdi Khola, and more for spawning. Long-distance migratory species include Raj Bam (*Anhuilla bengalensis*), *Bagarius bagarius*, *Clupisoma sp.*, *Tor putitora*, and *Tor tor*. Among the 68 species, 5 are IUCN Red List Threatened species: Golden Mahseer (EN), Giant Catfish or Goonch (VU), Snow Trout (VU), Giant Snakehead Fish (VU), and Sind Danio (VU). Additionally, 2 are Nepal endemics: False-Eye Catfish and Blyth's River Catfish.

Socio-economic

The TSHPP project area covers 8 wards in 4 rural municipalities (Rishing, Devghat, Bandipur, Anbukhairani) and 2 wards of Vyas Urban municipality in Tanahu district. Additionally, ward 29 of Bharatpur Metropolitan City in Chitwan District is part of the affected area due to its proximity across the Trishuli River from the proposed powerhouse site at Gai Ghat.

The cadastral survey had identified a total of 437 parcels affected by the project, owned by 285 HHs, Care & Downey Resort, Nepal Electricity Authority, Public Land, and the GoN land. Some parcels had unidentified ownership, with 12 parcels remaining unidentified.

The project area consists of varied and dispersed settlements, reflecting peaceful coexistence among different ethnicities such as Magar, Gurung, and Majhi. Notable affected settlements are Masdi Ghat, Khahare Tar, Sarang Ghat, and Gai Ghat, each with distinct characteristics. These settlements, housing 16 to 40 households, are predominantly constructed using mud, stone, and diverse roofing materials. Concrete houses are more common in market zones. Major inhabitants include Gurung and Magar in Masdi Ghat, Khahare Tar, and Sarang Ghat, while Gai Ghat accommodates Majhi and Bhujel communities alongside Gurung and Magar. Labdi Ghat, Bhoot Khola, and Pyughar are settlements situated along the Seti River downstream of the barrage in its reduced flow section.

Impact Assessment

Beneficial Impacts:

- The project aims to enhance the local economy by offering employment opportunities to about 1293 workers. Local recruitment will be a key priority for the project.
- Project workers from the local area will enhance their skills through experience and training, increasing their competitiveness in similar projects and benefiting the overall labor force's expertise.
- The planned access road and bridge over the Trishuli River will enhance vehicle connectivity, connecting the project area to the Highway and providing locals with improved transportation, market access, and economic prospects.
- The project's reservoir will establish a favorable habitat for diverse waterfowl and serve as a vital resting place for migratory birds.
- Hydropower, a cleaner energy source, significantly reduces CO2 emissions by replacing fossil-fuel, thus mitigating climate change impacts, and lowering carbon footprint.

Adverse Impacts

Physical environmental impact

The diversion of the Seti River will lead to a reduced discharge stretch of about 11 km from downstream of the barrage to the Seti-Trishuli Confluence. Though tributaries in this stretch collectively contribute around 14 m3/s, the reduction of the Seti River discharge will affect aquatic life, riparian vegetation, wildlife, and local communities. A comprehensive Eflow study is necessary to fully grasp and tackle these consequences.

Biological environmental impact

The project site covers 54.32 ha of forests. Out of this, 33.94 ha of forests will be permanently utilized for project structures, and 24.41 ha temporarily for construction. A total of 19,115 trees from 27 species will be removed, with the highest proportion being Padke Siris (Albizia lucidicor), Ram Rittha (Trewia nudiflora), Sal (Shorea robusta), Sindure (Mallotus philippensis), and Khirro (Falconeria insignis).

Vegetation clearances for the project construction will result in habitat loss of birds and wildlife, causing habitat fragmentation, disruption movement and behavior, reducing nesting and perching sites. Specifically, vultures might lose nesting and roosting sites due to the removal of Simal trees (Bombax ceiba).

The project will obstruct fish migration in the Seti River, impacting fish access to suitable feeding and spawning grounds, potentially leading to reduced reproductive success and altered fish behavior and habitats.

Socioeconomic environmental impact

The proposed land acquisition for the project will impact 437 land parcels total around 271.45 ha (210.30 ha permanently and 61.15 ha temporarily). Among these parcels 355 parcels are private (30: Resort, 1:School, 324:Individual), 62 parcels are government, 8 parcels are public lands, and 12 parcels are unidentifiable. About 17.95% of the land required is composed of privately owned parcels and the total number of HHs affected by acquisition is 285 HHs.

Mitigation Measures

Physical environment

To maintain ecological health in the reduced discharge stretch of the Seti River, an Eflow discharge will be upheld, following criteria such as simulating the natural flow regime, accounting for barrage-induced flow-changes considering various flow components, and optimizing reservoir operations, ensuring the project preserves the river's ecological balance and aquatic ecosystem.

Biological environment

To mitigate the impact of tree and vegetation removal, the project will focus on compensatory plantation and conservation efforts. Compensatory measures, adhering to regulations, will include planting 10 saplings for every felled tree, resulting in the planting of 1,91,150 new trees. The project will also restore 54.32 hectares of forest area through reforestation, adhering to a rate of 1600 saplings per hectare and considering local conditions and recommendations. Locally native species will be selected, with preferences from user groups and attention to providing habitat for wildlife.

During project construction, the potential for increased illegal hunting due to higher demand for mammalian meat and trophies, facilitated by improved road accessibility to wildlife habitats, requires preventive actions. Effective strategies involve collaboration with relevant agencies, strict enforcement of legislation, patrolling critical areas, and adding anti-illegal hunting clauses in contracts. The project, deemed Critical Habitat, must prioritize biodiversity conservation by implementing mitigation measures and adhering to international standards, ensuring responsible development and protection of endangered species and habitats.

The project emphasizes the importance of fish migration in hydropower projects and proposes measures such as fish ladders and hatcheries to address the challenges. Since the barrage is 32 meters high, proposed fish ladder will be a suitable option to mitigate the impacts assocaited with fish migratin. Additionally, a "Catch and Haul" program will work alongside the hatchery to facilitate fish migration and enhance aquatic biodiversity.

Socio-economic environment

The compensation process aligns with legal provisions from the Land Acquisition Act and NEA's established norms, ensuring equitable compensation based on market rates. This process encompasses various steps: (a) Establishment of the compensation fixation committee. (b) Procurement of land, estimated at NPR 38,272,650. (c) Temporary acquisition of construction land, with an estimated compensation of NPR 56,50,644.62. (d)

Compensation for private structures on acquired land. (e) Assistance allowances for displaced households during relocation and resettlement. (f) Compensation for non-title holders. (g) Compensation for displaced businesses. (h) Provision of legal assistance to affected households, including non-title holders. (i) Compensation for loss of agricultural productivity. (j) Social assistance for impacted households. (k) Relocation of schools and community halls. (l) Rehabilitation of religious and cultural structures, such as ghats and temples.

The project will affect 285 households due to land acquisition, categorizing them into Severely Project Affected Families (SPAF) and Project Affected Families (PAF). A "***Community Support Program"*** has been developed to aid SPAF, like those near construction sites, and assist PAF in adapting to changes without direct displacement. The program aims to support livelihoods, offer employment opportunities, aid in resettlement, and sustain community well-being. It includes strategies for agriculture-based and non-agriculture livelihood support, focuses on indigenous groups' livelihood access, considers vulnerable households, and aims to preserve social networks amid relocations and land loss. The cost allocated under CSP is NRs/120,600,000.00.

Environmental Management Plan

The environmental management plan includes a comprehensive environmental monitoring strategy and mitigation measures to ensure the proper implementation of mitigation actions outlined in the environmental documents. The project itself will hold the main responsibility for environmental management. The anticipated costs for various environmental management actions to address adverse and beneficial impacts are USD 83,10,488.00. The monitoring expenses are estimated at USD 485,000.00 while the auditing costs are USD 57,692.00. Consequently, the total projected cost for environmental management measures in the project is USD 8,853,180.00.

Conclusion

The proposed TSHPP, with a capacity of 126 MW, will operate as a Peaking Run of the River (PROR) scheme, generating 520.78 GWh of electricity annually. It involves a reservoir, barrage, headrace tunnel and a semi-underground powerhouse. The project complements the Tanahu HEP, aiding Nepal's hydroelectric capacity and reducing greenhouse gas emissions. 271.45 ha of land will be required for the project affecting 285 households. Various impacts include habitat loss and disruption, with suggested mitigation measures such as fish ladder, fish hatcheries and awareness campaigns. The project will produce clean energy, provide employment, and improve infrastructure while implementing comprehensive monitoring and mitigation measures.

By effectively executing the environmental management plan, the project can adequately mitigate its impact. Any additional impacts encountered during implementation will be addressed at the project's expense.

1 Project Description

1.1 Project Proponent

The Proponent of Tallo Seti (Tanahun) Hydropower Project is Tanahun Hydropower Limited (THL), which is a company established under the umbrella of Nepal Electricity Authority (NEA) - an undertaking of the Government of Nepal. The contact details of the Proponent are given below:

Tanahun Hydropower Limited: Tallo Seti (Tanahun) Hydropower Project (TSHPP)
Chundevi Marg-Maharajgunj, Kathmandu, Nepal
Telephone: +977-01-5111117, 5111118
E-mail address: info@thl.com.np
Website: www.thl.com.np

1.2 Consultant

Name, Address, E-mail, Phone Number of the Consultant
WAPCOS Limited (India) in Joint Venture with NIPPON KOEI (Japan) (WAPCOS NIPPON JV) in association with Total Management Services Pvt. Ltd (Nepal) and GEOCE Consultants (P). Ltd (Nepal), have been commissioned to prepare an Environmental Impact Assessment (EIA) for the project. The contact details of the consultant and sub-consultants are as follows:

Main Consultant:
WAPCOS NIPPON JV (Lower Seti)
Project Office, Kamalpokhari, Kathmandu, Nepal
Tel.: +977-01-4435826
E-mail: lowersetihpp@gmail.com

Sub-consultant:
Total Management Services Pvt. Ltd
Kamalpokhari, Kathmandu, Nepal
Tel.: +977-1-4439182, 4439187
Email: info@tms.com.np
Website: http://www.tms.com.np

2 Introduction

2.1 Description

The Tallo Seti (Tanahun) Hydropower project is a Peaking Run of the River (PRoR) initiative, boasting an impressive installed capacity of 126 MW. It is anticipated that the annual generation of 520.78 GWh will be achieved by the project. Located in Tanahu district in Gandaki Pradesh, the project spans a geographical area between 84°17'30''E and 84°28'42''E longitude and 27°47'30''N to 27°55'00''N latitude along the Seti River. This area falls within the diverse Mid Hill Region, characterized by an intricate landscape of hills and valleys.

The project's headwork resides close to Sarang Ghat, specifically in ward no. 6 of the Bandipur Rural Municipality, approximately 24 km to the south of Damauli, the administrative center of Tanahu District. Meanwhile, the proposed powerhouse is slated for Gai Ghat, found in ward no. 4 of the Devghat Rural Municipality, situated about 1.5 km downstream from the merging point of the Seti River and Trishuli River.

For context, the total catchment area at the proposed dam site amounts to 2,859 square kilometers, whereas the powerhouse's catchment area extends over 19,800 square kilometers.

The proposed project entails the construction of a barrage spanning 213 meters over the Seti River, with a height of 43 meters above the deepest foundation level of EL 234 meters. The project proposes the Highest Regulated Water Level (HRWL) to be at EL 275 meters. The water level at the proposed barrage will fluctuate between EL 275 meters and EL 272 meters, with the system withdrawing 206.9 cubic meters per second of water through the power intake. The impounded water is expected to reach a site called Sundhe, about 12 kilometers upstream from the barrage at ward no 13 of Byas Urban Municipality. The water will be conveyed through a 6.763-kilometer-long Head Race Tunnel passing through ward no 3 and 4 of Devghat Municipality to a 55-meter-deep surge shaft open to the sky, followed by an inclined pressure shaft with a horizontal steel-lined penstock of 6.75 meters diameter, trifurcating to a semi-underground powerhouse located at the right bank of Trishuli River in Devghat Rural Municipality, with a small Tail Race Channel. The proposed project will have a 220 kV single-circuit transmission line in the LILO scheme, about 2 kilometers in length, to transmit electricity.

The Department of Electricity Developmet (DoED), under the Ministy of Energy, Water Resources and Irrigation (MOWERI) has issued the survey license of Tallo Seti (Tanahun) Hydropower to Tanahun Hydropower Limited on 2074/07/13 BS for carrying out the feasibility and environmental study of 126 MW capacity project (Survey License No. Bi.Bi.Bi.74/75.Bi.U.Sa.930). The application for approval of generation license is under process. The license is attached in ANNEX A-1.

2.2 Objectives of the document

In line with the principles of the Environment Protection Act (EPA) 1997, the EIA study aims to craft a comprehensive report for the sustainable development of TSHPP, aiding concerned agencies and stakeholders in decision-making.

The specific objectives include:

- identifying project impact areas and zones, documenting baseline conditions in physical, biological, socio-economic, and cultural aspects, pinpointing project components that may alter these conditions.
- involving public opinion in decision-making,
- evaluating positive and adverse impacts of proposed alternatives, analyzing critical adverse impacts for the best environmentally/economically sound alternative,
- prescribing effective mitigation measures and crafting an Environmental Management Plan (EMP).
- include plans for Land Acquisition, Resettlement, Rehabilitation, Indigenous/Vulnerable People Development, Gender Development, Social Development, among others,
- providing recommendations for the project's feasibility from an environmental and social standpoint for further actions by decision-makers.

2.3 Relevance of the project

The proposed TSHPP is expected to generate 520.78 GWh of energy, which will be in addition to 607 GWh energy to be generated by the under construction Tanahu Hydropower Project (previously called Upper Seti Hydropower Project). Two of these projects will generate a significant amount of hydroelectric energy, which will supplement Nepal's need for power. Furthermore, energy could also be exported to neighboring countries. However, the proposed TSHPP will be developed mainly to supply to domestic purposes. It will increase the country’s existing generation capacity and will substitute for fossil fuel generation and reduce the greenhouse gas emissions of the Nepali electric matrix.

2.4 Legal Justification of the project

Environmental Protection Act (EPA) 2076 and Environment Protection Regulation (EPR) 2077, have been recently enforced by the Nepal Government. As per Sub-section (1) of Section 3 of the Act, any development project before implementation, requires either Brief Environmental Examination or Initial Environmental Examination or Environmental Impact Assessment depending upon the location, type, and size of the project.

According to Schedule 3 Rule 3 F-1(a) of the Environmental Protection Regulations 2077, an Environmental Impact Assessment (EIA) is mandated for hydropower projects exceeding 50 MW in installed capacity. Additionally, as per EPR 2077, projects—other than transmission lines—that necessitate the use of 5 hectares of forest land are also required to undergo an EIA study. Given that the proposed TSHPP boasts an installed capacity of 126MW and requires approximately 116.72 hectares of forest land, this EIA study has been conducted specifically for this project.

As per the provision of the EPR 2077, rule 7(8), the Environmental Impact Assessment reports for projects with international financing could be prepared in English language. Given that this study has been supported by the Asian Development Bank, the EIA report has been prepared in the English language. The contractual agreement between ADB and NEA has been attached in Annex A-2.

2.5 Project Description

The development of Tallo Seti (Tanahu) Hydropower Project is envisaged in an integrated manner with u/s Upper Seti Hydropower Project utilizing the releases from it with about six hours of peaking capability during dry season.

Tallo Seti Hydro-electric project is a Peaking Run of the River (PRoR) project which will have an installed capacity of 126 MW. The project is expected to generate 520.78 GWh of energy annually. A diversion structure - 32 m high and 213 m wide barrage will be constructed in the Seti River. The barrage is going to create a reservoir which is about 12.7 km long and covers an area of about 177 ha. About 207 m^3/sec water will be diverted by the barrage into the headrace tunnel. The water will convey through a 6.763 km long head race tunnel to the surge tank, and then through steel penstock and powerhouse site in the right bank of Trishuli River. A semi-underground powerhouse has been proposed, with 3 Francis turbines, each with 42 MW capacity. The water will be finally disposed of back to the Trishuli River through a tailrace tunnel. About 2 km long 220kV single circuit transmission line in the LILO scheme is proposed to transmit the electricity.

2.6 Project Location and Accessibility

The project is situated in Tanahu District, with the headworks located on the Seti River adjacent to Bandipur 6 on the left bank and Devghat 3 on the right bank. Downstream of the barrage, there is a settlement called Sarang Ghat. The reservoir formed will cover approximately 12.7 km. On the left bank of the reservoir, wards 6 of Bandipur, 13 and 14 of Vyas Municipality, and wards 3 and 2 of Devghat are located, while on the right bank, wards 3 and 1 of Rishing Municipality are located. The tunnel, which is roughly 6.763 km long, will pass through wards 3 and 4 of Devghat Municipality, and the surge tank, powerhouse, and tailrace will be in Gai Ghat settlement, in ward no 4 of Devghat Municipality. The diversion of water will create a reduced water zone of approximately 11 km on the Seti River until it converges with the Trishuli River. The tailrace site is located on the right bank of the Trishuli River, about 2 km downstream from the confluence.

The proposed project site is situated to the west of Kathmandu, in proximity to Damauli. To reach the headwork site, one must travel along the Seti River corridor, which is an earthen road of about 25 km from Damauli, which is about 150 km from Kathmandu on the Prithvi Highway. Meanwhile, the powerhouse is accessible via the Mugling-Narayan Ghat Highway, located approximately 20 km away from Mugling, which is located about 105 km from Kathmandu on the Prithvi Highway. If traveling by air, the nearest airports are in Pokhara and Bharatpur, with access to the project site via highways from both airports.

The town closest to the barrage site is Damauli, which is approximately 24 km away. The powerhouse is located about 33 km from Narayan Ghat.

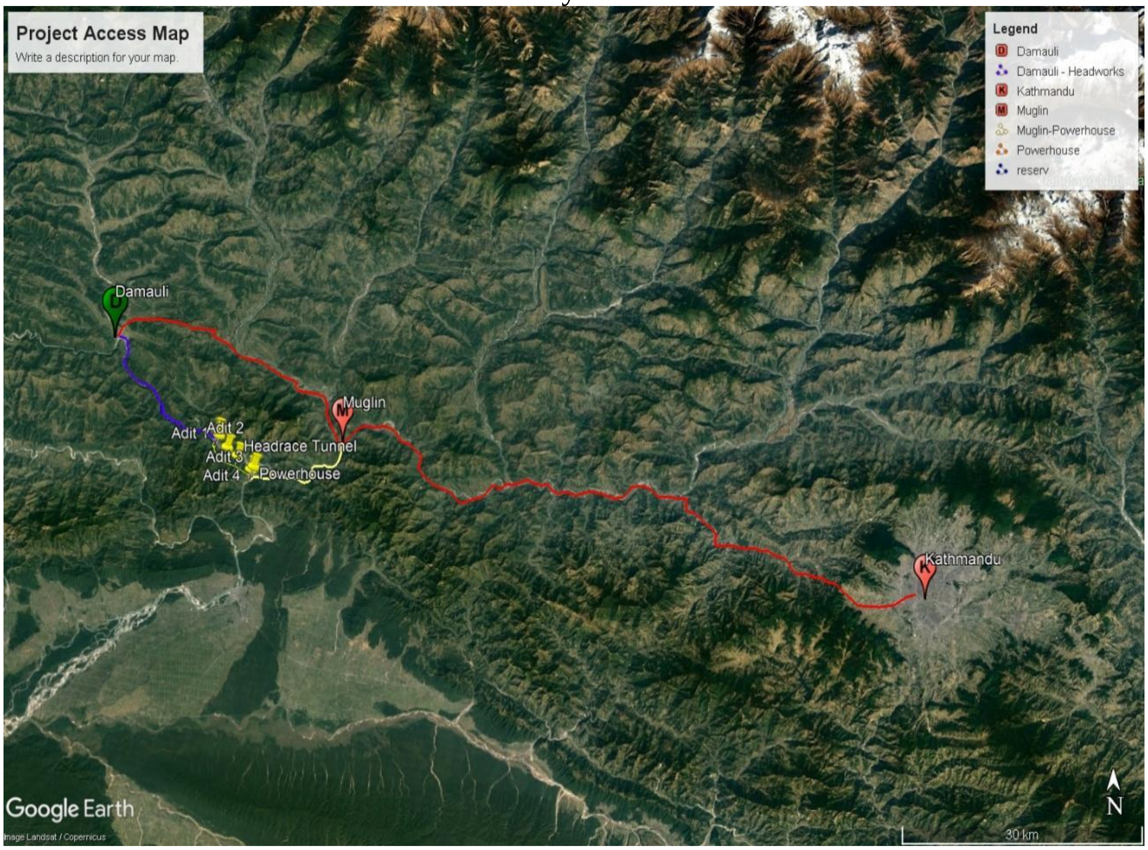


Figure 1: Project Accessibility Map (Source: Google Earth Image)

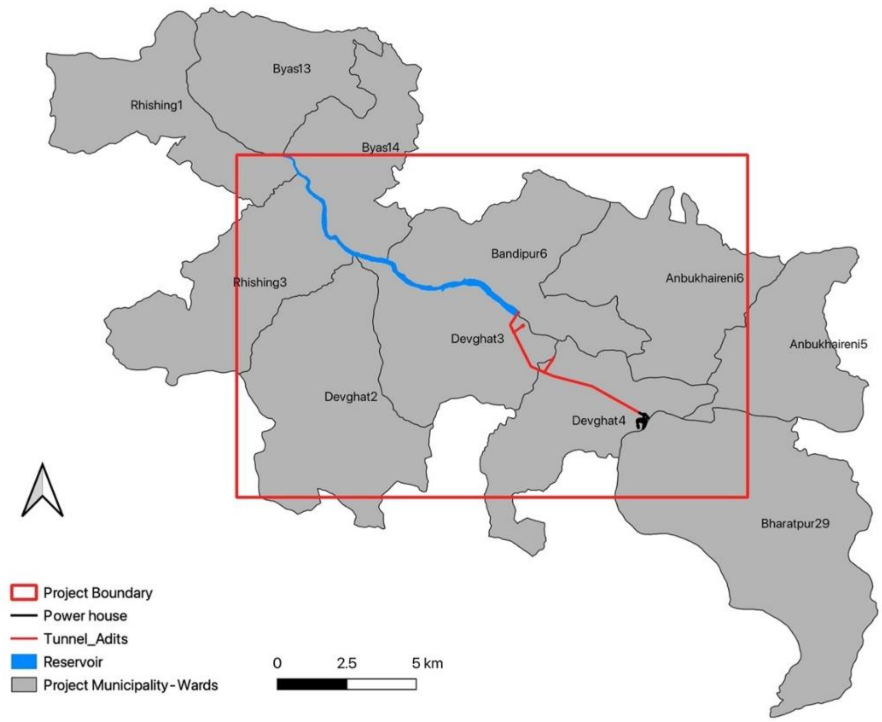


Figure 2: Project boundary map (Source: Department of Survey, 2021)

2.7 Nature/ Type

Tallo Seti (Tanahu) Hydropower Project is envisaged to be developed in the lower reaches of the Seti River. The objective of the development is to design Tallo Seti (Tanahu) Hydropower Project in an integrated manner with Upper Seti Hydropower Project using regulated flow from the tailrace of Tanahu Hydropower project (USHPP) located upstream of this project in such a manner to derive maximum generation from Lower Seti. In addition, the proposed project will also utilize the flows of Madi River and flow from intermediate area between USHPP and TSHPP.

Tallo Seti HPP is a Peaking Run of the River type development (PRoR). The project envisages construction of a barrage across the river Seti downstream of Upper Seti HEP. The waters from the barrage would be diverted to a surface powerhouse at Gai Ghat on the right bank of Seti river through about 6.76 km. long underground water conductor system comprising of power intake, head race tunnel, surge shaft, inclined shaft penstock, semi underground powerhouse, and tailrace tunnel etc. The figure below depicts the general layout of the Project.

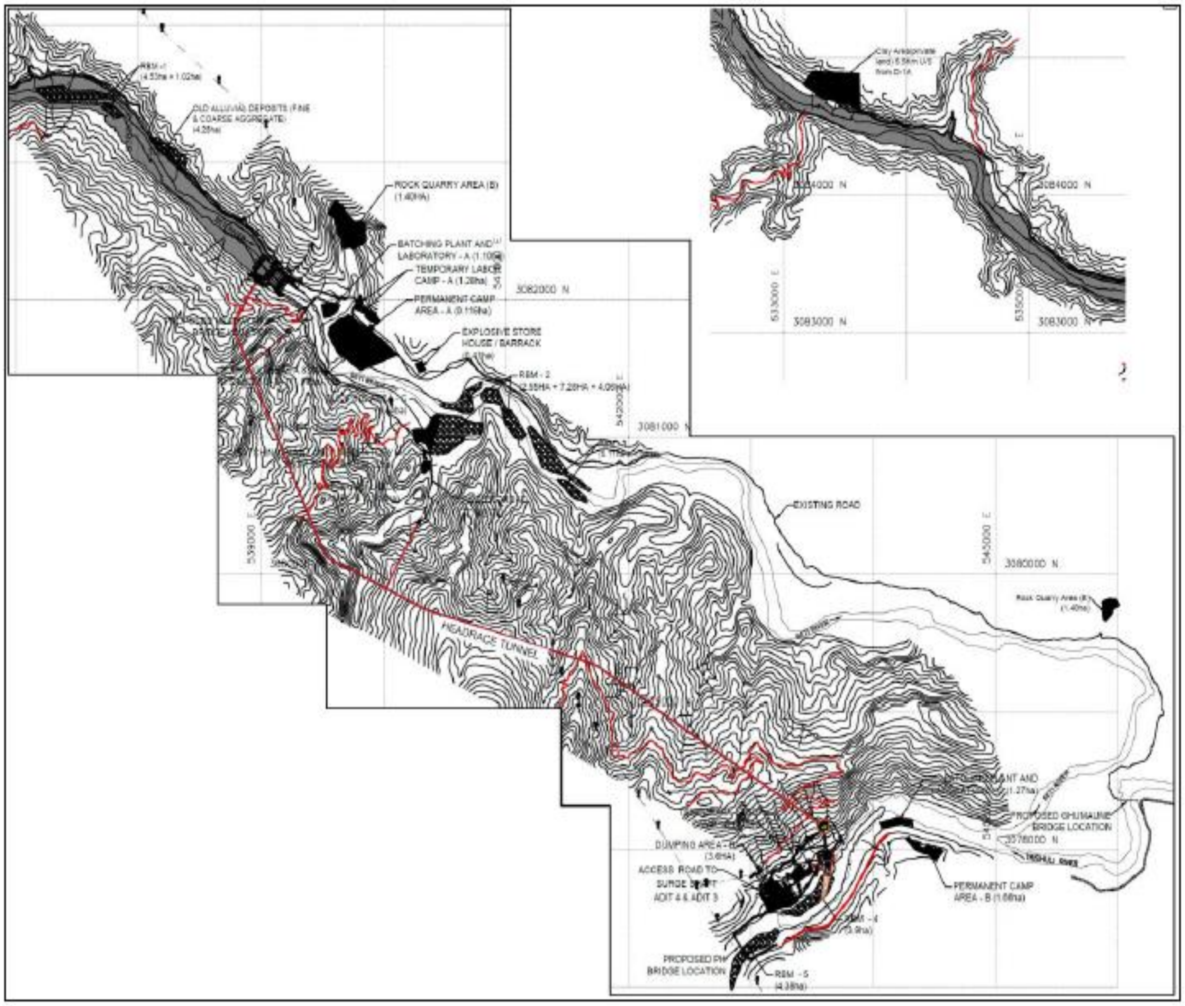


Figure 3:General Layout of the Project (Source: Detail Design Report, 2021)

2.8 Main Project Components

The main components of the project are:

- Barrage
- Power Intake
- Headrace Tunnel
- Surge Shaft
- Inclined Shaft (Steel Lined)
- Horizontal Pressure Tunnel (Steel Lined)
- Powerhouse
- Tailrace Channel
- Adit tunnels (four)

2.8.1 Barrage

A barrage is a diversion structure with EL 275 m as FRL and El. 272m as MDDL is envisaged for diverting the discharge required for power generation. It is located near Saranghat, Bandipur 6, at 84.39478 E and 27.85800N. The bed level of the river is EL. 246.0m with the top of the barrage at El. 277.0m. The total length of the barrage at top is 200.0m including the non-overflow section with the max height of 43.0 m from the deepest foundation level (El.234.0). A deck at the top of the barrage of 13.0 m width is provided including a carriageway of 6.7 m as an access for the operation and the maintenance of the gates and stoplogs of the barrage.

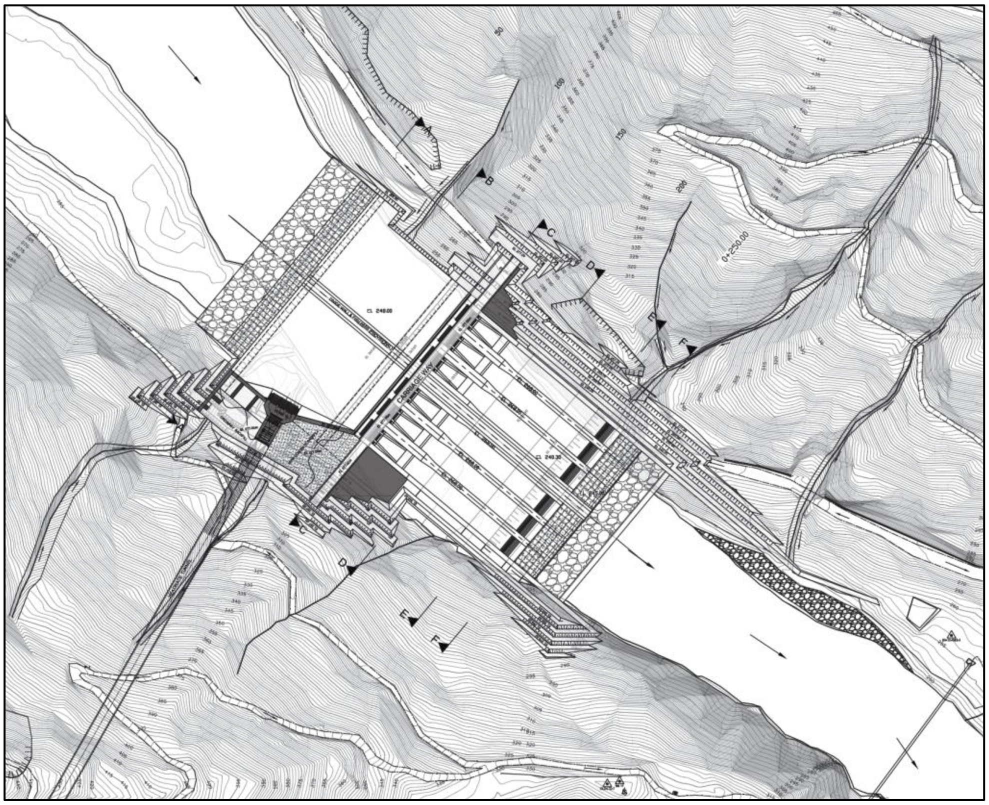


Figure 4: Layout of the barrage (Source: Detail Design Report, 2021)

2.8.2 Power Intake

A side intake is designed at the right bank of Seti River around 50m upstream of the barrage at 84.39380 E and 27.85800 N to draw the design discharge of 206.9 m3/s. To prevent the intrusion of bed load into the intake, the invert level is kept 4.5m above the skill level of the barrage at EL. 252.5m. The center line of the HRT is kept at an elevation of EL 260.5m. Three intake openings each of equal dimensions are designed for a gross velocity of less than 1 m/s through the gross area of trash racks. Each bay of the intake is separated from the other bay by a pier of 1.62m thickness, Each bay has an opening of size of 4.2 m width and a height of 22.5 m up to FSL. The deck level of the intake is foxed 2.0m above the FSL.

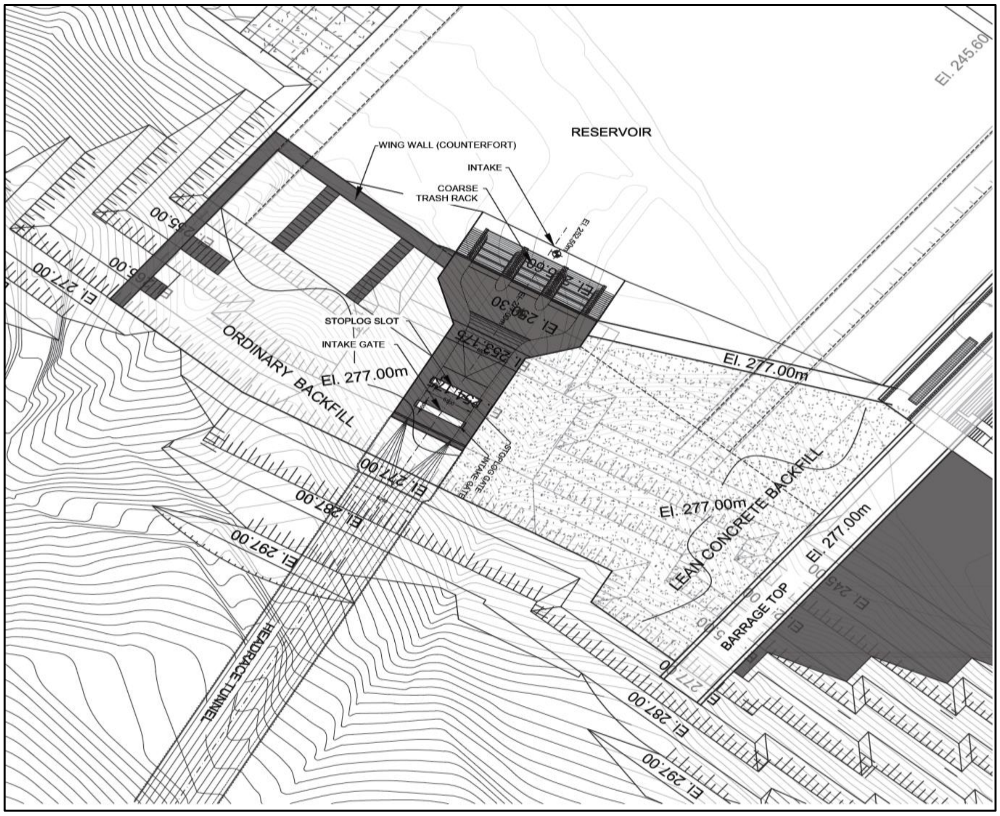


Figure 5: Layout of the Power intake (Source: Detail Design Report, 2021)

2.8.3 Headrace Tunnel

A low-pressure headrace tunnel with a design discharge of 206.9 m^3/s from the tunnel inlet to the powerhouse. The total length of the tunnel is 6763 m. The excavation section of the HRT is proposed as a modified horseshoe shape with a circular inner section of diameter 8.25m. There are 3 Adits along the HRT, thus there are five faces for taking up work viz, from Adit-1 near intake, two faces from Adit- and the fifth face from surge shaft Adit-3. The starting point of the tunnel is at the intake site 84.39478 E and 27.85793 N, and ends at Gai Ghat, Dev ghat 4 at 84.44018 E and 27.82174 N.

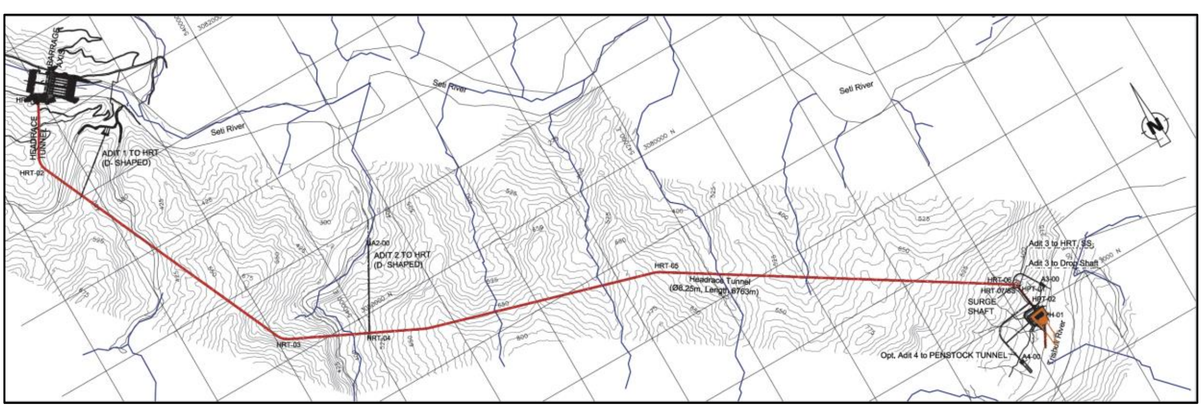


Figure 6: Layout of Tunnel (Source: Detail Design Report, 2021)

2.8.4 Adit

There are plans for 4 adits, and Adits 1, 2, and 3 will contribute to constructing the head race tunnel, which comprises 5 faces. Adit 1 contributes 2 faces, Adit 2 contributes 2 faces, and the 5th face comes from Adit 3 on the Surge Shaft side. The distances between the Intake and Adit 1, Adit 1 and 2, and Adit 2 and 3 are 718 m, 2047 m, and 3997 m respectively. The headrace tunnel section between Adit 2 and 3 holds critical importance due to its length, specifically the single face spanning 1999 m.

Adit-1 is planned to be situated along the Khahare Khola, where phyllite rocks (Q:1.10 – 1.32, RMR: 44 – 45) are visible on the riverbed. There is a possibility that water ingress may occur at the Adit portal. To address this issue, it is necessary to divert the river's flow, ensuring that water does not enter the Adit. A proper drainage system must be installed to effectively remove any water that accumulates near the tunnel face. Additionally, during the excavation process, it is crucial to install suitable rock bolts to reinforce and stabilize all vulnerable wedges in the rock.

The proposed Adit 2 spans a length of 600 m with a diameter of 7.5 m. The geological surveys along its intended path revealed an expectation of substantial colluvim cover over the rock at the portal site. A broad Khola lies to the north, increasing the likelihood of water ingress on the right-side wall (northern wall). To address this, implementing a robust drainage system is advised to manage potential water ingress.

At RD 500 m, Adit – 2 will intersect the regional synform axis at a 73^{o} angle. The rock mass is initially categorized as poor (Q:1.67 – 2.20, RMR: 47.58 – 46, Class IV category). However, due to the presence of carbonaceous phyllite and fracture zones, it might deteriorate to a very poor category. This deterioration could lead to free flowing, squeezing, or slabbing conditions, especially where bands or patches of carbonaceous phyllite occur along the tunnel route and while traversing the hinge zone of the regional synclinal fold.

Adit-3 and Adit-4 are proposed to be located on the right bank of the Trishuli River at the Powerhouse site. The tunnelling media in this area will primarily consist of fair to poor categories of phyllite (Q:4-10, RMR: 45-52, Class III-IV), with certain sections possibly degrading to Class-V due to weak rock mass, such as weathered, carbonaceous phyllite, or minor shear zones if encountered. To address this, appropriate protective measures like rock bolts and shotcrete are recommended to stabilize and reinforce potential wedges in the rock.
Moreover, there is a likelihood of water from the Trishuli River through the southern wall (left wall) at Adit-4. To manage this situation effectively, a suitable drainage system is necessary to expel seepage water from the tunnel and maintain its integrity.

Following the counsel provided by the International Panel of Expert (PoE), the project is planning to commence the early excavation of Adit 2. This adit holds a strategic position along the route, situated nearer to the midpoint of the headrace tunnel. Its preliminary excavation aims to serve as an exploratory step preceding the primary construction activities. This method anticipates multiple benefits, such as identifying potential rock types at deeper levels, and enhancing the contractor's strategies for blasting patterns, construction methods, and streamlining related procedures. This approach is poised to optimize the project's timeline, contributing to a more efficient completion process.

2.8.5 Surge Shaft

A surge tank is provided to protect the pressure tunnel and penstock from the direct effect of water hammer caused by a sudden change in flow conditions. It also assures normal supply to the turbine in response to the change of load in the generation system.

An orifice type surge shaft of 25.0 m internal diameter and a height of 5.4 m is proposed for Tallo Seti HPP is located at 84.44042 E and 27.82164 N. The surge shaft is located towards the end of the headrace tunnel before the inclined shaft takes into consideration the dynamic pressure exerted by the sudden load acceptance or closure. The maximum upsurge anticipated for sudden closure is EL 293.96m and the minimum down surge level is El. 249.02 m. A vertical gate is provided at the downstream end of the tunnel at the intake to the steel line tunnel.

2.8.6 Penstock Tunnel and Inclined Shaft

A Penstock tunnel of internal diameter 6.75 m internal dia. and 197.0 m length which includes a horizontal section at El. 234.75 m with an upper elbow bend of 17.45 m, an inclined section with lower elbow bend of 454.0 m and a horizontal section at El.192.5 m of 54 m length up to the trifurcation leading to the powerhouse. The work is similar in nature to the HRT works and the surge shaft. The shaft drops at an inclination of 50 degrees from EL. 234.75 m to EL. 192.5 m with an upper elbow and lower elbow each with a radius of 20.25 m. The horizontal penstock tunnel of internal 6.75m dia. trifurcates into 3.9 m dia., 35 m long penstock manifold leading to three turbines. For approach to bottom horizontal tunnel at EL.192.5m, one construction Adit has been proposed.

2.8.7 Powerhouse

Hydropower plant has been proposed at Right Bank of Trishuli River for installation of three units each of 42 MW (Total 126 MW). The centre point of the powerhouse is located at 84.44063 E and 27.8294 N. The powerhouse is 92 m (L at erection bay level) x 33.5m (W) x 45.6 m (H) size with steel roof truss as shown in Figure 5. The erection bay is located at the Right end and the Control Block is located downstream of Machine Hall. The centerline of the machine is set at El.192.5 m. The bottom level of Powerhouse is proposed at El 183.5 m. The construction of the powerhouse includes the construction of powerhouse, tailrace, and take-off yard. The units are located at the spacing of 17.0 m spacing.

The layout of the powerhouse is shown below.

The floor levels of the powerhouse are as follows:

MIV Floor	El. 189.50 m
Turbine Floor	El. 198.0 m
Generator Floor	El. 203.0 m
Machine Hall Floor	El.207.5 m
Auxiliary Floor	El 213.0 m

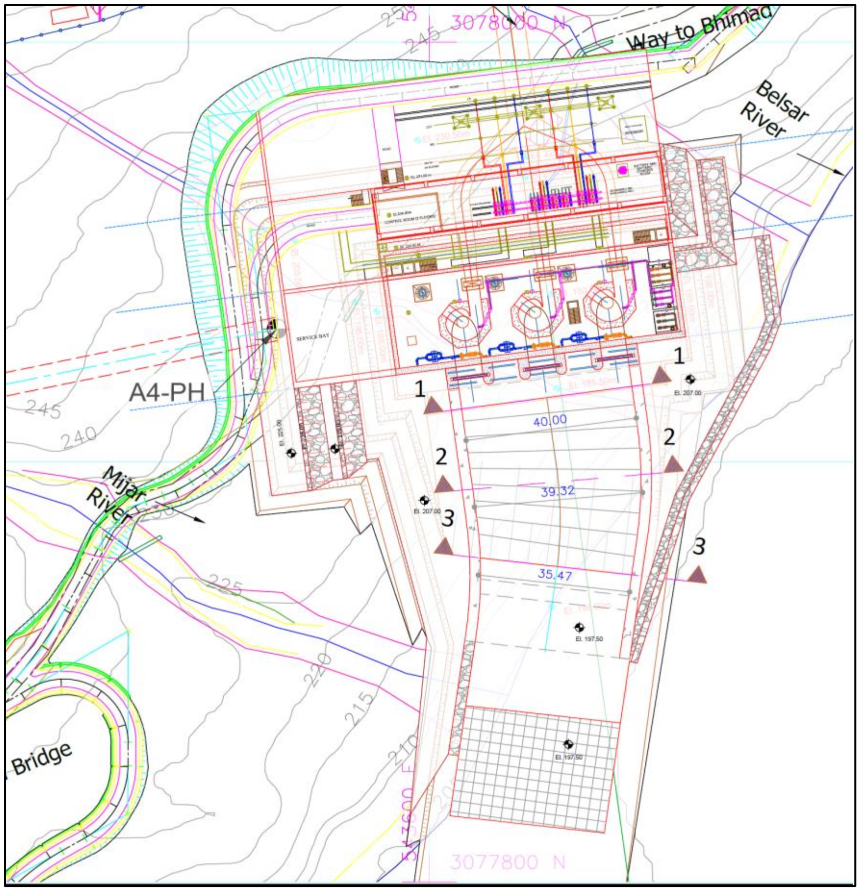


Figure 7: Layout of Powerhouse (Source: Detail Design Report, 2021)

2.8.8 Tailrace

A tailrace channel of an approximate length of 82 m conveys the discharge to Trishuli River. It is located at 84.43849 E and 27.81692 N. The channel width ranges from 40 m at the draft tube outlet to 34m at the outfall with slight bend to guide the water downstream of the powerhouse.

2.9 Salient Features of the Main Project Components

Project Location		
Province	:	Gandaki Province and Bagmati Province
District	:	Tanahu and Chitwan
Municipality/ Wards	:	Rhishing, 1, 3 Byas 13, 14 Bandipur 6 Devghat 2, 3, 4 Anbukhaireni 5, 6 Bharatpur 29

Headwork Site	:	About 24 km from Damauli
Powerhouse Site	:	at Gai Ghat (about 17 km from Mugling Bazar)
Geographical Co-ordinates		
Latitude	:	27° 47′ 30" to 27° 55' 00"
Longitude	:	84° 17' 30" to 84° 28' 42"
General		
Name of River	:	Seti River
Nearest Town	:	Damauli
Type of Scheme	:	PROR
Full Reservoir Level	:	El. 275.0 m
Minimum Draw Down Level	:	El. 272.0 m
Normal Tail Water Level	:	El. 200.0 m
Minimum Tail Water Level	:	El. 198.0 m
Max. Gross Head	:	77.0 m
Min. Gross Head	:	72.0 m
Gross Operating Head	:	75.33 m
Net Head	:	67.05 m
Installed Capacity	:	126.0 MW
Average Annual Energy after Outage	:	Total Energy = 520.78 GWh Wet Energy = 360.98 GWh Dry Energy = 159.80 GWh (Peak = 122.04 GWh & Off Peak= 37.76 GWh)
Hydrology		
Catchment Area	:	2859 sq. km at Intake
Catchment Area	:	19,800 sq. km at Powerhouse
Design Discharge	:	206.9 m^3/sec
Riparian Release	:	5.08 m^3/sec
Design Flood Discharge	:	9071 m^3/sec (1 in 500 yrs. return period, n-1 gates)
Design Flood Discharge	:	10,096 m^3/sec (1 in 1000 yrs. return period, n gates)
Diversion Structure (Barrage)		
Total Width of Barrage	:	200m at top (including non-overflow structures)
Total width between abutments	:	110.5 m
Total Length of Barrage	:	213 m
Length of Cistern	:	85 m
Nos. of gates	:	6
Width of a spillway bay	:	11m
Nos. of piers	:	5
Width of a pier	:	6m
Width of fish pass	:	5m
Width of a fish pass wall	:	1.75m
Average Riverbed Elevation	:	EL. 246.0 m
Under sluice Sill Elevation	:	EL. 248.0 m
Under sluice Opening (W X H)	:	11m x 14m
Barrage Crest Elevation	:	EL. 277.0 m

Cistern Elevation	:	EL. 240.3 m
Power Intake		
Type of Intake	:	Side Intake
Nos of Opening	:	3
Size of an Intake (W x H)	:	20.85 m x 24.5m
Intake Sill Elevation	:	EL.252.5 m
Nos. of piers	:	2
Width of a pier	:	1.62m
No. of Coarse Trash rack	:	3
Size of the trash rack (W x H)	:	5.2 m x 24.5m
Headrace Tunnel		
Type	:	Modified Horseshoe, finished circular
Diameter of tunnel	:	8.25 m (finished)
Length	:	6763 m
No. of Adits along HRT	:	3
Rock Type encountered	:	Class 3 (20%), Class 4 (60%) & Class (5 &6) (20%)
Size of Adits (WxH)	:	5.5 m x 7.5 m
Surge Shaft		
Type	:	Circular- Restricted Orifice (open to sky)
Effective Depth	:	55 m
Diameter (Or size)	:	25 m
Max. Up Surge Level	:	293.5 masl
Max. Down Surge Level	:	249.5 masl
Normal Operation Level	:	275 masl
Invert of Surge Shaft	:	231.37 masl
Dia. Of Restricted Orifice	:	3.5 m
Steel Penstock Pipe		
Type	:	Circular
Internal Diameter	:	6.75 m
Length	:	197 m
Steel Thickness	:	30 mm (varies)
Length of horizontal pressure tunnels	:	124.0 m
Length of inclined pressure tunnel	:	36.0 m
Length of bending pressure tunnel	:	35.0 m
Length of manifold	:	35.0 m one mid short part, 44 m two long side parts
Diameters of manifold	:	3.9m and 3.0m
Powerhouse		
Type	:	Semi-Underground

Size (L x W)	:	92.0 m x 32.0 m at erection bay
Height	:	47.0 m with steel roof
Turbine Axis Level	:	192.5 masl
Tailrace		
Type	:	Free Flow
Tailrace Length	:	82.0 m draft tube end
Width at EL 185.5 masl	:	40.0 m (varies towards riverbank)
Tailrace Water Level (normal)	:	200.0 masl
Tailrace Water Level (min.)	:	198.0 masl
Turbine		
Type	:	Francis
Number	:	3
Capacity per unit	:	42.0 MW
Turbine Axis Level	:	192.5 masl
Net Head	:	67.05 m
Turbine Efficiency	:	94.0%
Generator Efficiency	:	98.5%
Governor		
Type	:	(PID) Electronic-hydraulic type
Adjustment for Speed Drop	:	Speed sensor
Generator		
Type	:	Salient Pole, Semi Umbrella
Rated Output Capacity per Unit	:	52 MVA
Power Factor	:	0.9
Generation Voltage	:	11 kV+-5%
Frequency	:	50 Hz
No of Units	:	3
Transformer		
Type	:	3 phase, Outdoor, Oil Immersed
Rated Capacity	:	52 MVA, 11kV/220 kV
No of Units	:	3
Vector Group	:	YNd11
Frequency	:	50Hz
Transmission Line		
Voltage Level	:	220 kV single circuit
Length	:	About 2 km
Conductor Type	:	ACSR Bison
From	:	LSHP Pothead Yard
To	:	USHP-New Bharatpur Substation line in LILO Scheme

No. of Trees to be removed	:	19,115
Land Required (Ha)	:	Permanent: 210.30 ha Temporary: 61.15 ha
SPAF	:	285 HHs
Project Cost Estimate		
Total Cost of the Project	:	$ 180 Mil. (Base Cost)
CSP Cost	:	USD 9,00,000.00 (NRs 120,600,000.00)
Construction Period	:	5.5yrs

2.10 Ancillary Components of the Project

2.10.1 Project roads

A comprehensive road network plan has been put forth to access various project sites, including dam site, Adit, surge shaft, powerhouse, construction sites, disposal sites, and quarry sites. The proposed plan involves the construction of approximately 12.913 km of new roads to facilitate the development of different project components.

Additionally, the project includes the enhancement and reinforcement of existing roads. This upgrade will cover a total stretch of 16.72 km from Damauli to the headworks and another 9 km road from the barrage to Ghumaune. The goal is to ensure these roads can withstand heavy equipment and machinery traffic under all-weather conditions throughout the year.

For the major roads, a loading class of 40 R has been designated in adherence to IRC (Indian Road Congress) standards, aiming to provide the necessary strength and durability for efficient transportation within the project area.

The planned road width is specifically designed to accommodate smooth traffic flow, primarily consisting of rear end dumpers, tippers, transit mixers, loaders, excavators, backhoes, and other loading equipment. Considering necessary clearance on the sides, proper drainage provisions, and parapets, the required formation width for the roads has been estimated to be 7.5 m.

Road Width

- Average vehicle width = 3.00 m
- Clear distance from side drain = 1.50 m
- Clear distance from parapet = 2.00 m
- Drain width (average) = 0.50 m
- Parapet thickness = 0.50 m
- Total width = 7.50 m

A drainage system consisting of an open drain will be built along the hillside, during the water flow towards culverts placed at suitable locations. Breast walls will be strategically constructed to retain the hillside slopes as needed. On the other hand, for safety purposes, parapets will be installed at appropriate intervals along the valley side of the road. Additionally, retaining walls will be erected wherever necessary to ensure stability and support.

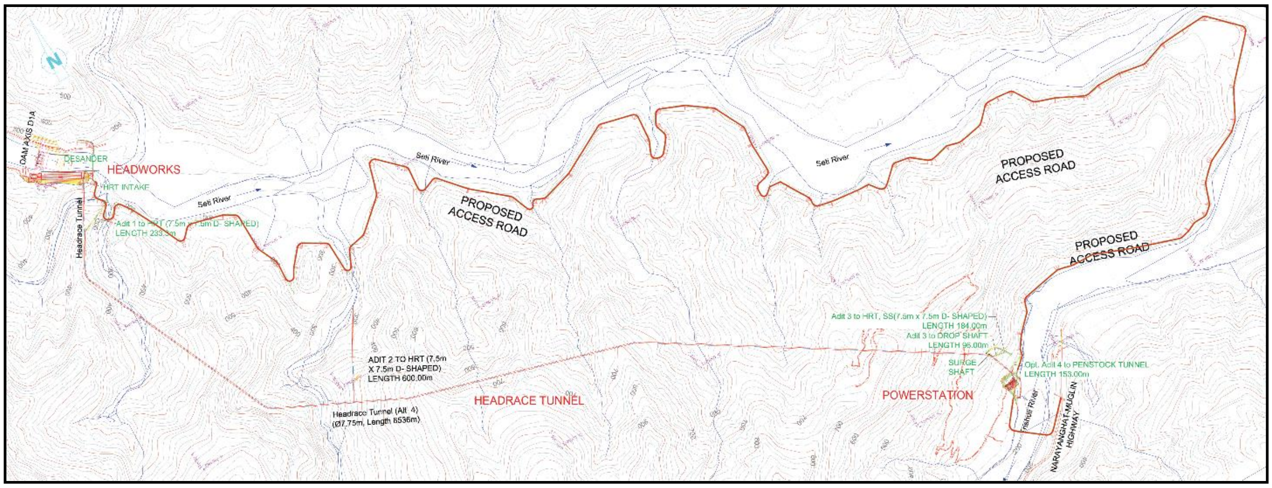


Figure 8: Project Access Roads (Source: Detail Design Report, 2021)

Table 2. 1: Proposed project roads construction and upgradations

SN	Roads	Length of road [km]	Remarks
1	Inundation Re-aligned Road	7.28	Temporary, Gravel Road
2	Access road to Adit-2	2.627	Temporary, Gravel Road
3	Highway to Surge shaft	2.517	Temporary, Gravel Road
4	Access Road to Adit 3	0.419	Temporary, Gravel Road
5	Access Road to Transformer Bay	0.07	Temporary, Gravel Road
	Subtotal	12.913	
6	Up gradation and Maintenance Works	26	
	Total	38.913	

Damauli – Headworks section

The initial segment commences from Damauli Bazar and stretches all the way to the headworks. The total length of this road is approximately 24 km. Within this segment, a total of 7280 m will be realigned because of possibility of inundation after formation of the reservoir. The remaining 16,879 m of the road will undergo upgrading.

Figure 9: Access Road from Damauli to Barrage Axis (Source: Google Earth Image)

Barrage – Adit 2 section

This segment of the access road is planned to connect the Barrage with the Adit-2. The total length of this section is 2670 m. Along this route, there is a 118 m long bridge, located between chainage 0+331 m and 0+450 m.

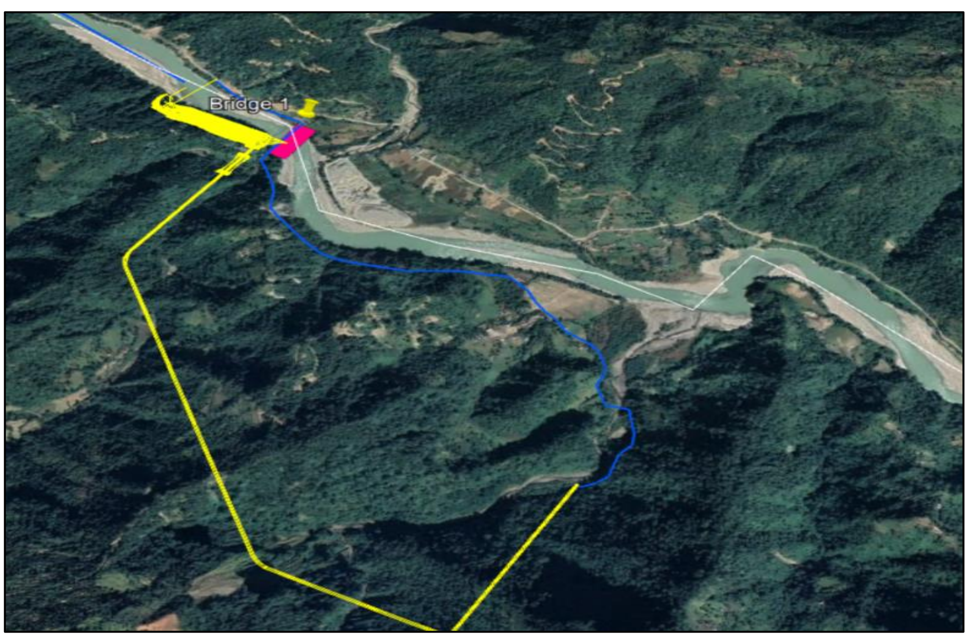


Figure 10: Access road to Adit-2 (Source: Google Earth Image)

Access to the Surge Shaft

This section of the access road links the Mugling-Narayan Ghat Highway with the Surge Shaft right uphill of the powerhouse complex. This access road commences from the Highway at 0+000 m and stretches all the way to the Surge Shaft at chainage 2+517m.

Notably, this access road incorporates a 222 m long bridge, known as Bridge-3, spanning over the Trishuli River. This bridge plays a crucial role in connecting the road and facilitating smooth transportation along the route.

Figure 11: Access Road to surge shaft (Source: Google Earth Image)

Surge Shaft – Adit 3 Section

This section of the access road establishes a connection between the previous access road of the Surge Shaft and Adit-3. This access road has a length of 419 m, serving a vital link to the Adit-3.

Figure 12: Access Road to Adit 3

Adit 3 – Transformer Bay Section

This section provides access road, extending 69.93 m in length, provides a direct connection between the access road of Adit-3 and the Transformer Bay.

Figure 13: Access Road to Transformer Bay

2.10.2 Project Bridges

Considering accessibility requirements to the project components, building of 2 bridges have been proposed. The first bridge will be located downstream of the Barrage, spanning across the Seti River. The second bridge will be positioned downstream of the powerhouse, crossing the Trishuli River.

These bridges are scheduled to be constructed before the main project components are undertaken and will be developed simultaneously with the construction of the project roads. To ensure sufficient strength and durability, the proposed bridges will adhere to a loading class of 40R, following the guidelines set forth by IRC standards.

Two bridges one downstream to the dam axis across Set River and the other downstream of the powerhouse site across Trishuli River, as shown in the figures below, will be required to facilitate the construction of various components of the project. The construction of the bridges would be done prior to the construction of the main project components and parallel to the construction of the project roads. The bridges have been proposed of 40R loading class as per IRC standards.

Figure 14: Proposed location of bridge at headworks site (Source: Detail Design Report, 2021)

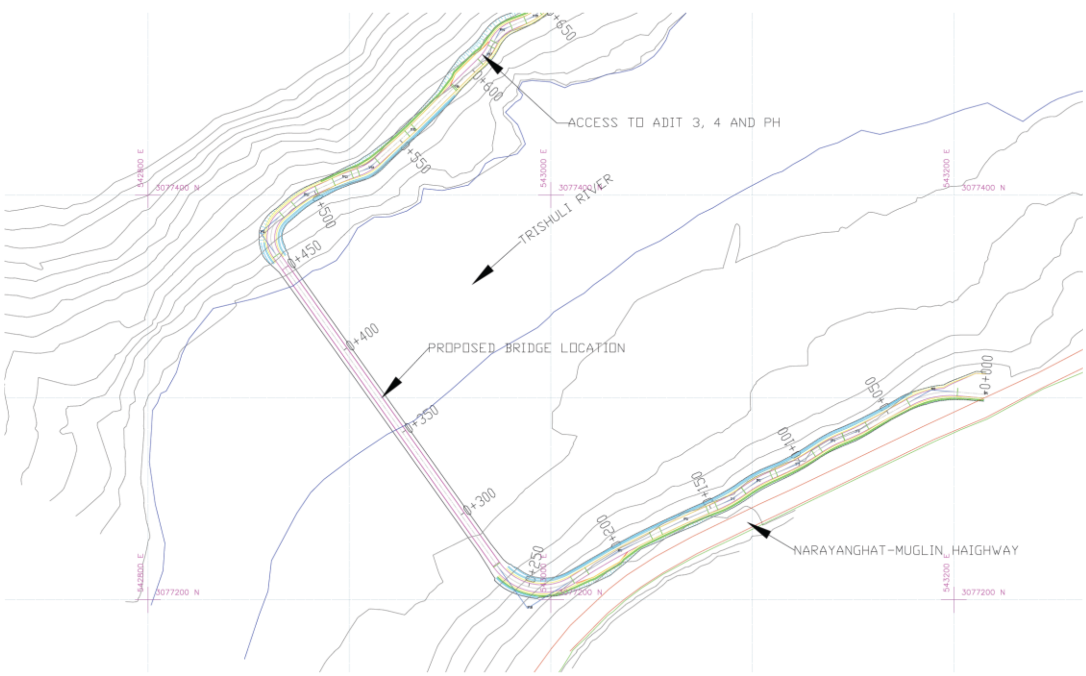


Figure 15: Proposed location of bridge at powerhouse site (Source: Detail Design Report, 2021)

2.10.3 Quarries/Borrow Areas

The estimated total requirement for construction materials includes 1,127,700 m^3 of coarse aggregates and 650,165 m^3 of fine aggregates. To fulfill this demand, it is projected that approximately 2 million m^3 of materials will be obtained from 2 identified Rock Quarries (RQ) with areas measuring 5.37 ha and 1.25 ha.

Likewise, the fine aggregates will be sourced from 5 identified river borne materials (RBM) with areas of 5.75 ha, 13.89 ha, and 6.65 ha, as well as from 2 old alluvial deposits covering an area of 4.28 ha. Approximately, 0.6 million m^3 of fine aggregates are expected various identified quarries, while the remaining amount will be obtained by crushing the potential muck generated from the excavation sites.

Total Concrete	= 1,088,620 m^3
Total Coarse Aggregates	= 1,127,700 m^3
Total Fine Aggregates	= 650,165 m^3
Total Cement	= 372,376 MT

Two rock quarries (84.4032248 E/ 27.860857 N and 84.464200 E/ 27.835911 N) and 3 river borrow sites have been identified, except for one old alluvial deposit located near the dam site. It shall, however, be noted that an approach road is needed to facilitate the transportation of quarry materials.

2.10.4 Muck Disposal Sites

The excavation works for the project will result in a substantial amount of muck, totaling approximately 1.87 million m^3. To manage tis waste, designated disposal sites have been identified. However, the rugged terrain of the project area limits the availability of flat or gently sloping areas suitable for muck disposal. As a solution, some gently sloping private lands near the left bank of the Seti River and right bank of the Trishuli River have been selected as disposal sites.

For this purpose, 3 disposal sites have been identified (542996.931, 3077663.461 meters; 53201.26, 3081803.65 meters and 539397.052, 3081536.42 meters). One of these sites is located 0.83 km downstream from the proposed D-1A site, while the other is situated about 0.55 km downstream from the powerhouse site. The estimated areas of these disposal sites cover 12.31 ha, with a capacity to accommodate around 2.18 million m^3 of muck. However, further consideration is being given to explore alternatives sites along the banks of the rivers for potential disposal locations.

To safeguard the environment, the spoil disposal will be carried out in a controlled manner, ensuring that no disposal will be done in the rivers or below the FRL level of the reservoir. Moreover, the retaining measures will be employed at the toe of the disposal piles, using suitably designed gabion walls over concrete bases or conventional masonry/concrete toe walls. Gabion walls, constructed with locally available stones/boulders from the muck itself, offer ease of construction and do not require additional setting/strengthening time. Restoration of the muck disposal sites will be carried out on the completion of the construction works.

The muck excavated from underground is usually moist in condition, and promptly transportation to the disposal sites. Since no dust will be generated during transportation, cover the truck will be optional. The disposal process, however, will involve continuous trips by dump trucks, generating high noise levels, and potentially affecting ambient air quality. Therefore, regular monitoring of air quality and noise level will be carried out. It is also advisable that the sprinkling of the access roads with water sprinkling tanks time-to-time will help control the dispersion of particles.

2.10.5 Project Colonies

Owner's building and colonies

The owner's colony is designed to accommodate both residential and office needs for its staff during both pre and post construction stages. Along with residential complexes, the colony will provide various essential facilities, which include medical aid facility, places of worship, firefighting services, educational and vocational resources, banking and telecom services, shopping outlets, sports and recreational amenities, community function areas, fuel dispensing outlet, materials testing laboratory, and others. To support the upkeep of automobiles, a small workshop or auto shop will also be present within the colony.

The permanent camp at the headworks is proposed to be situated downstream of the barrage, approximately 304 meters downstream of the damsite, adjacent to the suspension bridge, along the left bank of the Seti River. The selected area for the camp covers around 0.44 ha. The HW camp will have a total of 4 buildings. The water supply to the camp is proposed to be supplied from existing springs around the areas or water tapped from Seti river and treated to appropriate standards. The headwork camp is proposed to house one field office with family residence on the first floor and one Type F dormitory. A health post for first aid and a guard house for the security of the camp is also proposed.

Figure 16: Location of Headworks camp (Source: Detail Design Report, 2021)

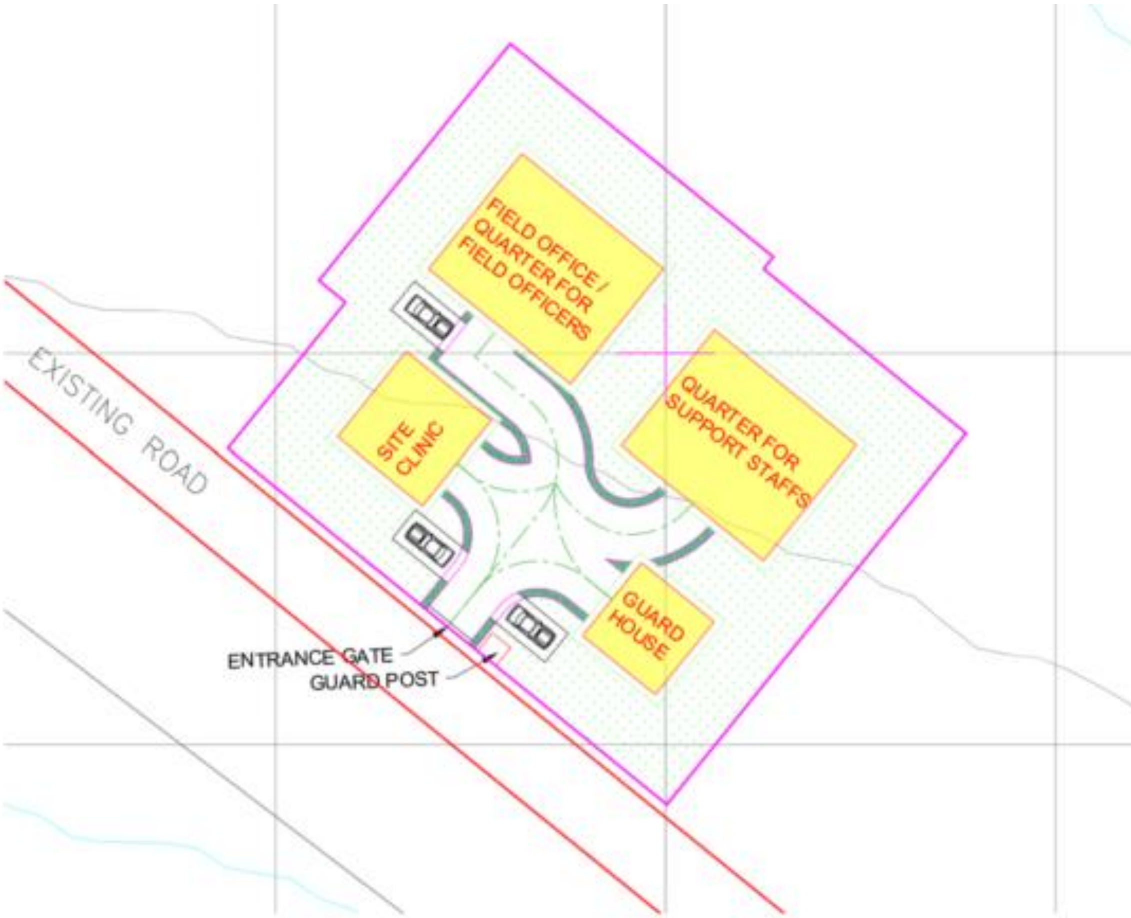


Figure 17: Plan view of the Headworks Camp (Source: Detail Design Report, 2021)

The permanent camp for the powerhouse is strategically planned to be located at the right bank of the Trishuli River in Gaighat, Devghat-4. The PH camp will be located inside the powerhouse complex. The area required for this camp will be 2.28 ha. The road distance of the camp from the powerhouse is about 300m. This camp will serve as a comprehensive facility to meet various accommodation and operational needs. The powerhouse camp is proposed to house two office blocks, one guest house, one project manager's residence, one consultant's residence, two family residences, two engineer's residence, and two dormitories. The camp will also include one health post, a grocery shop, a warehouse, a workshop, two messes and a guardhouse.

The two office blocks are proposed, one for the Owner's and the other for the consultants with two open type office space, project manager's room, administration and accounts section's room, meeting room and a hall.

Figure 18: Location of Powerhouse Main camp (Source:Detail Design Report, 2021)

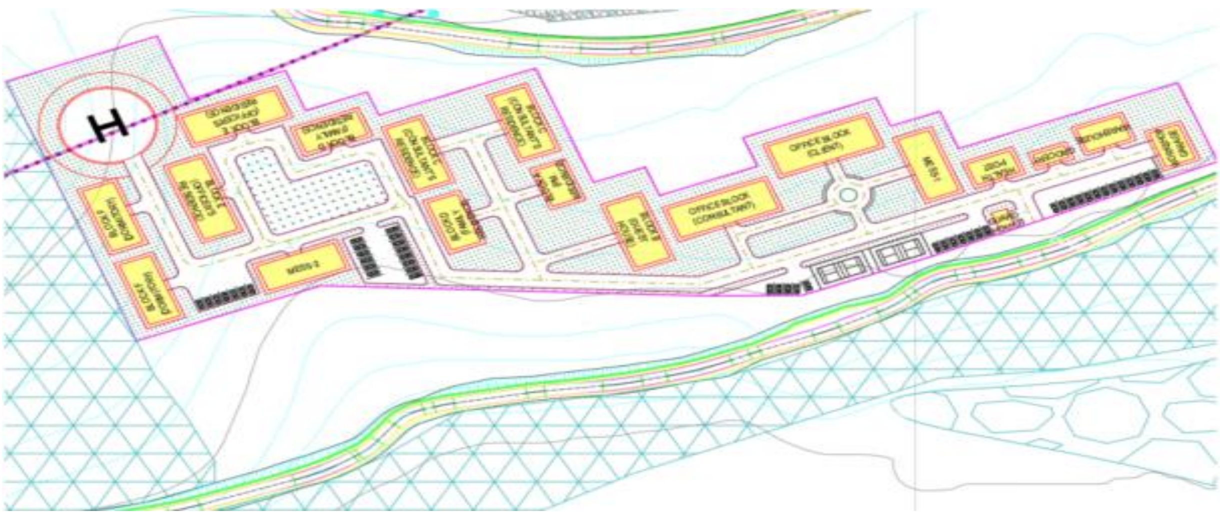


Figure 19: Plan view of Powerhouse camp (Source:Detail Design Report, 2021)

2.10.5.1 Contractor's colonies and buildings

Temporary buildings will include contactors colonies which would serve the purpose of residence and offices, facilities for social activities like shopping, social gatherings, worship, etc. for the contractors and their families engaged in project. Ample space for colonies of civil, H&M and E&M contractor has been marked near both the headworks and powerhouse locations. The same location shall be partially shared by a proposed medical clinic building and first aid center during project execution phase.

2.10.5.2 Labor Camps

The number of engineers, officers, and workers deployed by the contractors from various disciplines will be determined by them based on the requirements of each construction phase. To accommodate the labor force, three labor camps have been designated—one at each dam site, one at the HRT (Headrace Tunnel), and one at the powerhouse location.

All contractor establishments are expected to be temporary in nature. The total area required for these contractor setups is estimated to be approximately 3.06 hectares. These camps will serve as temporary bases to facilitate smooth construction operations and provide the necessary facilities and resources for the workforce during the project's different stages.

2.10.5.3 Workshops

Considering the layout of civil components, both the dam site and powerhouse areas will serve as major construction hubs throughout the project’s implementation period. Due to their distance from each other, it is more practical and efficient to establish separate job facilities of significant nature near each of these work zones.

To facilitate earth moving, concreting, and drilling operations, two separate workshop bases have been proposed: one at the dam location and another near the powerhouse area. As the entire construction process will be highly mechanized, self-sufficient repair and service facilities will be set up at the project site. There are no external mechanical services or facilities available nearby, so all mechanical repairs and servicing will be done in-house. Sufficient space will be allocated for workshops, maintaining an ample inventory of spares (both fast and slow-moving), consumables, and other materials. Skilled manpower will be deputed to ensure efficient operations and minimize downtime.

The separate workshops will cater to various equipment categories, including:

- Earth-moving machinery mounted on tracks such as excavators and dozers.
- Earth-moving machines mounted on tires, including dumpers, loaders, and graders.
- Pneumatic equipment and concreting equipment like boomers, wet shotcrete machines, and concrete pumps.
- Transport equipment, comprising buses, trucks, transit mixers, ambulances, and light vehicles.
- A dedicated penstock fabrication yard near the powerhouse area.

Each workshop will have a partly covered area in addition to open space. Equipment requiring major overhaul or repairs will be parked under cover, while open areas will serve as parking spaces for equipment undergoing minor repairs. Under the covered space, there will be provisions for a store to stock equipment spares, an office, and toilet facilities. Additionally, each work site will have a first aid post that caters to the requirements of the workshop crew.

These well-equipped and strategically located workshops will ensure the smooth functioning and top operational condition of the construction fleet, contributing to the overall efficiency of the project implementation.

2.10.5.4 Stores and Warehouses

Efficient management of material and spares required for various project activities is a critical aspect of the project's success. To ensure a smooth supply chain, three central warehouses have been strategically planned. One warehouse will be established for the powerhouse complex, while the other two will serve the dam complexes on each limb. These central warehouses will receive and manage all incoming supplies.

Additionally, specific items such as cement, reinforcement steel, explosives, and other job-specific materials may be sent directly to the respective sites based on their demand. To maintain organization and ease of access, the warehouses will also stock electrical items separately, ensuring that all necessary materials are readily available for the project's smooth execution.

2.10.5.5 Aggregate processing plants/batching and mixing plants

The total concreting demand for various structures has been calculated as 1,088,620 m3, based on design requirements. The construction quantities for both the dam and powerhouse areas are substantial. The construction activities will primarily concentrate in three areas: the dam areas, the Headrace Tunnel (HRT), and the powerhouse area. These three working zones are approximately 13 km apart from one another. Given this considerable distance, it is more efficient and practical to establish independent services at these major working zones.

To cater to the concrete needs, three aggregate processing/batching plants and laboratories are proposed, each designated for the headworks, tunnel, and powerhouse. The raw aggregates from the borrow areas will be transported to the aggregate processing plants using 25T dumpers. This approach ensures streamlined and dedicated services for each working zone, contributing to the project's overall efficiency and success.

2.10.6 Explosive Bunker

To ensure the safe storage and handling of explosives necessary for drilling and blasting operations, a permanent bunker will be constructed. The project authority will obtain all the required approvals from the concerned authorities before establishing the bunker. Transporting explosives from the bunker to the work sites will be done using specialized explosive vans, adhering to all safety codes and regulations prescribed by the government. To maintain constant security, the bunker will be appropriately guarded round the clock.

Safety is a top priority in the project area, and adequate arrangements for lighting and security will be made to ensure a safe working environment. The project will take all necessary preventive measures against accidents as per various IS (Indian Standard) Codes. Access to the project work site will be restricted, and only visitors with permits issued by relevant competent authorities will be allowed entry. To ensure accountability and safety, all workforce and personnel will carry identity cards and passes issued by the project authority, which will be checked at entry check posts located at suitable places.

Based on assessments, a single bunker with a 20 MT capacity will suffice to meet the project's requirements for explosive storage. The location of the explosive bunker complex has been strategically planned to minimize the distance traveled by explosive vans. In accordance with the Explosive Rules of 1983, a safe distance of 300 meters from public roads will be maintained, ensuring the safety of nearby areas.

2.11 Activities related to the project

2.11.1 Excavation and spoil disposal

The project involves excavation of materials for the construction of its structures, some of which can be reused, while others will eventually require proper disposal. The relevant data is summarized in the table provided below:

Table 2. 2: Excavation source and volume (cub m) - structure wise (Source: Detail Design Report, 2021)

SN	Details	Quantity
	Diversion dam	
1	Excavation in boulder mixed material	360,236 m^3
2	Excavation in soft rock	63,571 m^3
3	Total Excavation	423,807 m^3
4	Concreting	336,114 m^3
5	Reinforcement steel	13410 MT
	Power Intake	
1	Excavation in soil and soft rock	3276 cum
2	Open excavation in rock	4914 cum
3	Concreting	9701 cum
	Headrace Tunnel	
1	Underground excavation by tunneling method	
2	Removing over break fallen muck	24,231 m^3
3	Drilling Grout Holes & drainage holes	245,736 m^3
4	Cement Grouting	11,772 T
5	Rock Bolts	388,000 m
6	Permanent supports	3,428 MT
7	Concreting	95,061 m^3
8	Reinforcement	
9	Shotcrete	39,274 m^3 with 153720 m^2 Wire Mesh
	Adits	
1	Open excavation	115,594 m^3
2	Excavation by tunneling	12,843 m^3
3	Rock Bolts	106,311 M
4	Shotcrete	7786 m^3 with 51,908 Sqm Wire Mesh
5	Steel Ribs	In class 4 and 5

	Surge shaft	
1	Open excavation	119,290 m^3
2	Excavation of shaft	150,575 m^3
3	Rock Bolts	105,183 m
4	Shotcrete	5,323 m^3
5	Concreting/ RCC Lining	5303 m^3
6	Reinforcement	424 MT
	Lattice Girder/ Steel Ribs	For class V & VI

	Penstock tunnel and shaft	
1	Excavation in soft rock	4495 Cum
2	Excavation in rock	6743 Cum
6	Concreting	2083 m
7	Reinforcement	156 MT
8	Penstock Steel	775 MT

	Powerhouse, tailrace	
1	Overburden Excavation	17,817 Cum
2	Rock Excavation	338,538 Cum
3	Backfilling	27950 Cum,
4	Concrete	48,161 Cum
5	Reinforcement	3612 MT
6	Structural Steel	35 MT

Table 2. 3: Equipment requirement (Source: Detail Design Report, 2021)

S.no.	Consolidated equipment	Capacity	Dam/Cofferdam		Tunnel	Surge shaft	Pressure shaft	Power house	TRC	Total
1.	Excavator	1.57 cum	2					1		3
		2 cum								1
		3 cum	2							2
2.	Rear end Dumpers	25 MT	4			4		6		14
		15MT			13					21
3.	Concrete Pump	40 cum/hr	4							4
		25cum./hr						1		2
		30 cum/hr-			2	1				3

4.	Concrete Mixer	6 cum	8							8
5.	Crane	8 MT	1							1
		35 MT	1							1
		40 MT						1		1
6.	Tower Cranes (3 cum bucket)	10 T	2							2
7.	Tractor Trollies	-	8							8
8.	Diesel compressors	300 cfm	2							2
		1600 cfm	2							2
9.	D.G. Set	500 kVA:	1		1					2
		1010 kVA	1					1		2
10.	Rock bolter		2			2	1	2		8
11.	Dozer (Track)	324 HP	1							1
		90 HP						1		2
12.	Tire Dozers		1							1
13.	Motor Graders		1							1
14.	Water Sprinkler		2							2
15.	Backhoe Loader (JCB)		4							4
16.	FE Loader	3 m^3								1
		2 m^3				3				3
17.	Grout pumps	200 cfm	18				2			20
18.	Grouting equipment		1		6	1				8

19.	B&M plants	160 cum /hr	1							1
		90 cum/hr						1		1
		60 cum/hr			1					1
20.	Aggregate processing & screening plant	500 T/hr	1					1		2
21.	Transit Mixers	6 cum	6		9			5		23
22.	Needle Vibrator	65mm dia Needle	18							18
23.	Shotcrete machine With robotic arm	10cum/ hr	2		7	1		1		11
		(5cum/h r)				1	1			3
24.	Drilling equipment - Jack Hammers		6		6	6	2	2	2	26
25.	Hydraulic Hammer		1		1			1	1	4
26.	Drill jumbo 2 Boom		1		5	1		1		9
27.	Bobcat excavator	0.5cum.			1					2
28.	Concrete placers				3					4
29.	Shutters Overt & Invert 12m long				2					2
30.	Traveler for above				2					2
31.	Shutters for Overt & Invert 6m long				2					2

32.	Shutter Vibrators				24					24
33.	Raise Borer					1				1
34.	Hydraulic Platform				3	1	1	1		6
35.	Slipform shutter for surge shaft					1				1
36.	Dewatering pumps of sort	LOT								
37.	Welding sets	LOT								
38.	Winch	10T						2		2
		30T						1		1
39.	Rib bending machine				2	1				3
40.	Penstock plate bending machine							1		1
41.	Testing equipment (Ultrasound, radiography, X ray)	LOT								
42.	Sand Blasting accessories	Set					2			2

2.12 Construction plan

The construction of this project involves three main civil work activities, which are as follows:

(a) Headworks:
- Barrage with gated low-level spillways
- Stilling Basin
- Intake

(b) Underground Works:
- Head Race Tunnel

- Adit
- Surge Shaft
- Inclined and Horizontal high-pressure tunnel

(c) Powerhouse:

- Powerhouse Complex
- Switchyard
- Tail Race Channel

While ideally, one construction agency would be suitable for coordinating and interfacing all the works to ensure the target commissioning dates, it is recommended to divide the works into the following packages for better efficiency and management:

Lot1: All Civil Works & H&M Works
Lot 2: E& M Works Transmission Line and Substation Works
Lot 3: Infrastructure Works/ Bridges & Township, Construction Power

The construction project includes the building of two bridges: one downstream of the dam and the other downstream of the Powerhouse, aimed at facilitating the overall construction process. Additionally, certain infrastructural works will be carried out before commencing the main project construction. The responsibility for the upgradation of access roads and the construction of access roads to project components will be assigned to the concerned Civil Contractor.

2.13 Type of land to be occupied by the project.

The project will necessitate a total of 271.45 hectares of land on a permanent basis, comprising 54.32 hectares of forest land, and 27.02 hectares of cultivated land. The project will require 61.15 ha of land on a temporary basis. The total land required for the project is 271.45 ha. The impacted forested area is currently under the management of community forest user's groups and leasehold forest users' groups. The project is expected to affect a total of 15 community forests and 5 leasehold forests.

Table 2. 4: Land requirement for the project [ha] (Source: GIS Analysis and Land Demarcation Survey)

Project Component	Government Land			Private Land	Total Land Acquisition Type	
	National Forest	River and River Bank	Public Land	Cropland	Permanent	Temporary
Ownership	MoFE	MoFE	MoLCPA			
Reservoir 275 m	30.29	72.68	40.25	14.23	157.45	-
Reservoir Buffer 278m	-	-	23.95	-	23.95	-
Clay Area	6.81	-	-	-	-	6.81
RBM-1	-	5.54	-	-	-	5.54
RBM-2	-	7.34	-	-	-	7.34
RBM-3	-	6.28	-	-	-	6.28
Old Alluvial Deposits and Coarse Agreegate	2.79	-	-	-	-	2.79
Intake	3.19	-	5.44	-	8.63	-
Rock Quarry - B	5.37	-	-	-	-	5.37
Additional Dumping area at Intake	0.23	2.68	-	-	-	2.91
Batching Plant and Laboratory for Tunnel B	0.54	-	0.56	-	-	1.10
Permanent Camp Area - A	-	-	-	0.44	0.44	-
Temporary Labor Camp - A	0.25	-	0.33	0.82	-	1.40
Explosive Store House/Barrack	-	-	-	0.41	-	0.41
Access Road to Adit 2	1.06	-	-	-	-	1.06
Adit 2	-	-	0.09	-	-	0.09
Batching Plant and Laboratory A	0.49	-	0.03	-	-	0.52
Temporary Labor camp B	0.10	-	0.41	-	-	0.51
Powerhouse Area	0.46	-	9.93	6.30	16.69	-
Surge Shaft	-	-	0.78	0.08	0.86	-
Adit - 3	-	-	0.04	0.03	-	0.07
Adit - 4	-	-	0.01	0.16	-	0.17

Project Component	Government Land			Private Land	Total Land Acquisition Type	
	National Forest	River and River Bank	Public Land	Cropland	Permanent	Temporary
Temporary Labor Camp C	-	-	-	1.15	-	1.15
Access Road to Surge Shaft, Adit 3 and Adit 4	-	-	1.15	0.91	-	2.05
Dumping Area - PH	2.30	-	-	0.22	-	2.52
RBM-4	-	3.91	-	-	-	3.91
RBM-5	-	2.28	-	-	-	2.28
Employer Camp Alternative - 2	-	-	-	2.28	2.28	-
Dumping Area - HW	0.44	6.44	-	-	-	6.88
Total	54.32	107.14	82.97	27.03	210.30	61.16

As a result of the land intake by the project, 285 families are expected to be affected, necessitating proper compensation and resettlement measures to mitigate the impact on the affected communities.

2.14 Requirement of the project

2.14.1 Human resource

The construction of the project will require a total of 1,293 laborers, comprising both skilled and unskilled workers. The workforce details are summarized in the table provided below:

Table 2. 5: Human resource requirement (Source: Detail Design Report, 2021)

Works	Managers and Supervisors	Highly Skilled	Skilled	Unskilled	Total
Dam and Desander	20	20	40	80	160
H R T	35	50	90	100	275
Surge Shaft and Penstock	8	20	40	80	148
P H and TRC	30	50	85	100	265
E&M	10	35	30	60	135
H&M	6	10	15	20	51
Transmission Line and SS	6	10	10	50	76
Road/Bridge/Township Maintenance	1	10	10	20	41
Finance	5	10	4	0	19
HR	2	6	0	0	8
Safety and Security	2	12	0	0	14
Environment	1	4	0	0	5
Construction Power	4	8	12	16	40
QA/QC	5	12	12	24	53
Geologist	3	-	-	-	3
Total	**138**	**257**	**348**	**550**	**1293**

2.14.2 Construction material (quantity and source)

The project's construction materials encompass stone, coarse aggregates, and sand. The potential sources and tentative estimations of the quantities of these construction materials are provided below:

Table 2. 6: Construction material requirement (Source: Detail Design Report, 2021)

SN	Consolidated Quantities	Diversion Dam	Power Intake	Head race Tunnel	Adits	Surge Shaft	Penstock & Shaft	Power house and TRC	Total
1	Excavation in soil/boulder mixed	360,236	3,276		115594			17,817	496,923

	material (m^3)								
2	Excavation in soft rock (m^3)	63,571				119290	4,495		187,356
3	Excavation in hard rock(m^3)		4,914	484,638	12,843	150,575	6,743	338,538	998,251
4	Concrete (m^3)	336,114	9,701	95,061		5,303	2,083	48,161	496,423
5	Reinforcement steel (MT)	13,410				424	156	3612	17,602
6	Structural Steel (MT)			3,428				35	3,463
7	Drilling Grout Holes & drainage holes (m)			245,736		12032		12172	269,940
8	Cement Grouting (T)			11,772					11,772
9	Rock Bolts (m)			388,000	106,311	105,183	3956	12172	615,622
10	Shotcrete (m^3)			39,274	7,786	5,323	592.239	1796.7	54,772
11	Wire mesh (m^2)			153,720	51908				205,628
12	Penstock Steel (MT)						775		775
13	Plum (cum)							27,950	27,950
14	Lattice Girder/Steel Ribs								

2.15 Construction schedule

The project construction is planned to commence in the second quarter of 2025, with an estimated completion time of 5 years. Project commissioning is projected to begin in the second quarter of 2030. The detailed project schedule can be found in the provided Annex M.

2.16 Energy to be used in the construction (source, amount to be consumed)

The existing 132kV substation at Damauli will be utilized to draw construction power to the required extent at the headworks site. This power supply will support construction activities in various areas, including the dam site, tunnels, surge shaft, penstocks, and powerhouse. The load consumption will cater to plants like the batch plant, aggregate processing plant, concrete pumps, dewatering pumps, running and maintenance of water supplies, residential lighting, and workshop loads, among others.

To ensure a reliable power supply, a diesel generator with a suitable capacity of around 10 MW will be provided as a backup through DG sets. This backup supply will serve as a contingency plan in case of any disruptions to the primary power source.

During the construction phase, both gasoline and electrical energy will be used. The energy required for construction works will primarily involve kerosene, diesel, and petrol usage. These energy sources will fuel various construction equipment and machinery, facilitating the smooth progress of the project.

Table 2. 7: Construction power requirement (Source: Detail Design Report, 2021)

S.No	Name of Equipment	Quantity	Rating(hp)	Rating(KW)	Total Power KW)	KVA/1000= MVA
1	Hydraulic Excavator	2	140	104.4	208.8	0.25
2	Batching Plant	3	147.5	110	330	0.39
3	Transit Mixer	2	120	89.5	178.97	0.21
4	Concrete Pump	9	80.5	60	540	0.64
5	Concrete Vibrator	2	15.4	11.5	23	0.03
6	Welding Machine	2	88.5	66	132	0.16
7	Air Compressor (Electric)	2	169	126	252	0.3
8	Air Compressor - Portable (Diesel)	2	60	44.7	89.48	0.11
9	Wagon Drill	2		20	40	0.05
10	Concrete Mixer	8		7.5	60	0.07
11	Shotcrete Machine (Robotic)	2		50	100	0.12
12	Hydraulic Boomer	2		93	186	0.22
13	Raise Borer Machine	2		75	150	0.18
14	Crushing Plant	2		160	320	0.38
15	Tower Cranes	2		63.75	127.5	0.15
16	Rock bolter	8		70	560	0.66
17	Grout pump	20	27	20.1339	402.68	0.47
18	Grouting equipment	8	5	3.7285	29.83	0.04
19	Aggregate processing & screening plar	2		100	200	0.24
20	Needle Vibrator	18	3	2.2371	40.27	0.05
21	Shotcrete machine	14		50	700	0.82
22	Drill jumbo 2 Boom	9		119	1,071.00	1.26
23	Traveler for above	2	5	3.7285	7.46	0.01
24	Shutter Vibrators	24	5	3.7285	89.48	0.11
25	Raise Borer	1		352	352	0.41
26	Hydraulic Platform	6		2	12	0.01
27	Dewatering pumps of sort	1	300	223.71	223.71	0.26
28	Welding sets	20		66	1,320.00	1.55
29	Winch	3	60	44.742	134.23	0.16
30	Rib bending machine	3	10	7.457	22.37	0.03
31	Penstock plate bending machine	1	20	14.914	14.91	0.02
32	Testing equipment (Ultrasound, radiography, X ray)				-	-
33	Sand Blasting accessories	2			-	-
34	Lightening load	40		1	40	0.05
Total				**2,165.80**	**7958**	**9.36**

2.17 Project implementation schedule

The Project is planned to be commissioned within 54 months from the zero date. A comprehensive construction program is provided in Annexure - Project Schedule. Prior to the construction phase, pre-construction activities, including field surveys, borehole drilling, trial pits, material testing, public hearings, obtaining necessary clearances, and achieving financial closure, are anticipated to take approximately 6 months.

Following this, the tendering process for Civil, Hydro Mechanical, Electro-Mechanical, and Transmission Lines is projected to span about 5 months. However, to expedite the construction timeline, the Developers will undertake certain infrastructure development activities during this period. This proactive approach aims to optimize the overall construction efficiency and save valuable construction time.

Upon receiving the work award, the contractors will mobilize within one month and proceed to develop the additional infrastructure required within three months. The main components of the project work include:

- Barrage
- Power Intake
- Head Race Tunnel
- Surge Tank
- Penstock
- Powerhouse, Tail Race Channel, and Switch Yard works
- Transmission Lines
- Electro-Mechanical Works, including erection, testing, and commissioning of Units.

Hydro Mechanical works will be conducted in coordination with the civil works of the various components. This synchronized approach aims to ensure efficient progress and seamless integration of all project elements.

2.18 Mode of execution

Hydropower projects are executed through two primary modes: EPC (Engineering, Procurement, and Construction) mode and package contracts. In the package contract approach, eligible contractors are selected based on their past satisfactory performance in completing and commissioning hydro projects, considering their capabilities. The civil and hydro-mechanical works are bundled into one package and awarded to a single company, consortium, or joint venture, limiting the owner's responsibility. Similarly, the Electro-mechanical and Transmission line works form another package, also awarded to a single company, consortium, or joint venture.

The decision regarding the number of packages considers minimizing interference between different work areas and ensuring adequate space for various contractors' camps and construction facilities. In preparation for contractor mobilization, essential infrastructure construction work will be undertaken in advance to ensure availability when the contractor(s) begin their operations. This proactive approach facilitates smooth project execution and timely completion.

3 Methods and materials

3.1 Project Area

The ‘project area’ basically refers to the river valleys of Seti River and its tributaries and the adjoining farmland, forest and settlement areas where project impacts or influences are both ‘direct’ and ‘indirect’. This would also include the primary project sites and related facilities that the proponent (including its contractors) develops or controls; areas potentially impacted by cumulative impacs from further planned development of the project; areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; and associated facilities that are not funded as part of the project (funding may be provided separately by the proponent or a third party including the government), and whose viability and existence depend exclusively on the project and whose goods or services are essential for the successful operation of the project. The area of influence does not include potential impacts that would occur without the project or independently of the project.

The area within the boundary of affected municipality-wards is considered as the project influenced area and will be hereafter referred to as the project area. A total of 11 wards of 6 municipalities were identified within the project area out of which 10 wards belong to the Tanahu district and 1 ward to Chitwan district.

Table 3. 1: District, Municipality and ward of the Project area.

District	Municipality - ward
Tanahu	Rhising 1, Rhising 3, Byas 13, Byas 14, Devghat 2, Devghat 3, Devghat 4, Bandipur 6, Anbukhairini 5, and Anbukhairini 6.
Chitwan	Bharatpur 29

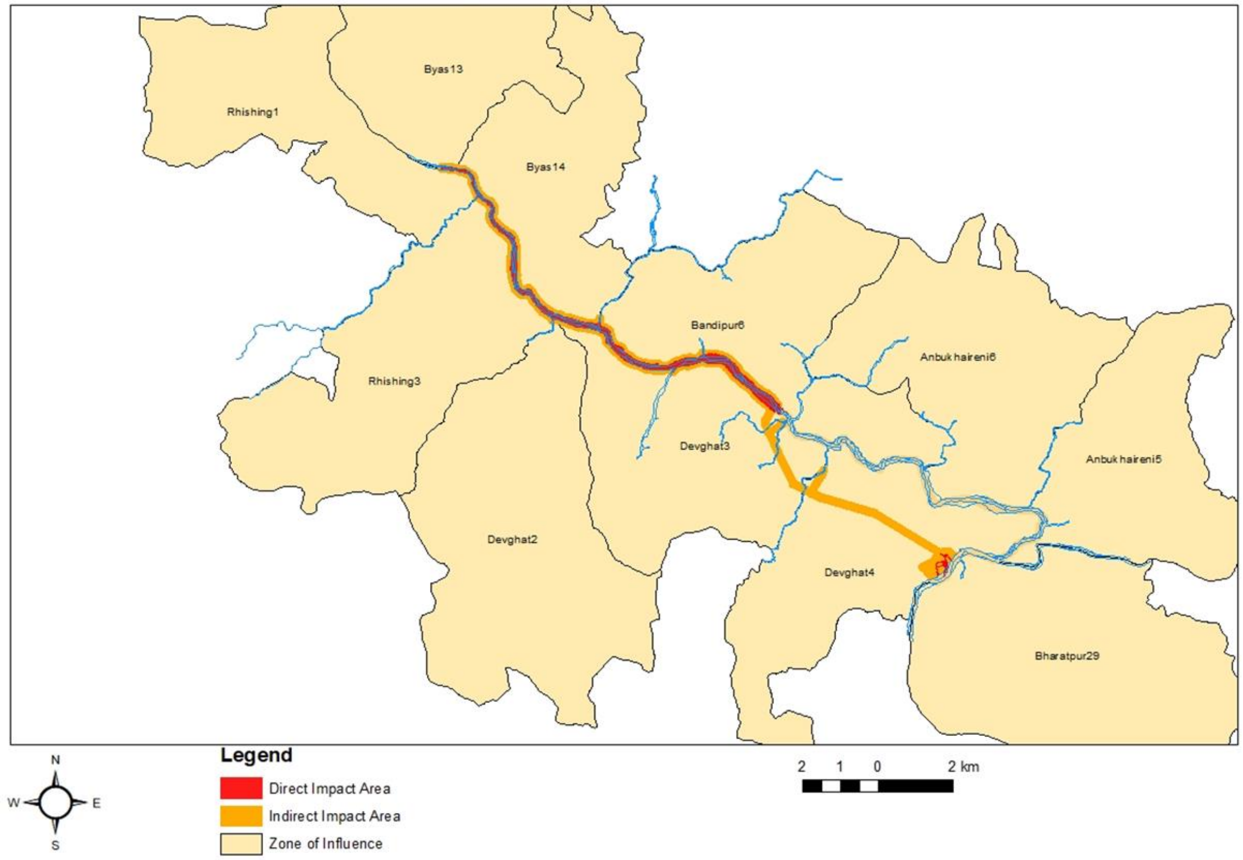


Figure 20: Project affected wards (Source: Department of Survey, 2021)

The project area comprises and is further classified into two areas the 'Direct Impact Area' and the 'Indirect Impact Area' on the basis of the magnitude and extent of impacts. The direct impact area is further broken down to specific areas and these are defined below.

Direct Impact Area

Direct impact area refers to a direct alteration in the existing environmental condition as a consequence of project activity. In general, the project areas to be inundated in the reservoir, areas to be occupied by project structures and facility sites, quarry sites, spoil disposal area, the low flow area downstream from the dam, physically high risk area, and the access and haul road to various sites area are categorized as Direct Impact Areas. This study considers five types of areas as direct impact area:

- Inundation Area: This is the area covered by the reservoir at operation level. This is the permanent impact area where the local inhabitants will lose their land and assets on land, and physical and productive infrastructures and facilities. There could be irreversible losses to natural resources requiring re-establishment in another area. The land in this area will have to be acquired by the proponent for the proposed HEP.
- Project Structure and Activity Area: The 'Project Structure and Activity Area' would include areas with permanent and temporary project structures/activity such as power

house site, adit sites, permanent project camps, temporary campsites, quarry and spoil disposal sites, access road, rig areas etc. These areas have been given identification codes that are used in the report.

- Low Flow Area: The 'Low Flow Area' includes the stretch of the Seti and Trishuli Rivers between the dam site and the tailrace outlet where the flow will be significantly reduced during project operation. The local inhabitants using riverine resources for their socio-cultural and economic activities will be directly affected. The major concern is the aquatic ecosystem and the fisheries.

Indirect Impact Area

The areas with environmental components having repercussions by other environmental components affected/changed by the project component or its activity are considered as the 'Indirect Impact Area'. The areas of the project influenced wards, where project structures are proposed to be placed are regarded as indirect project impact areas. People in the indirect impact area may partially lose their land or dependable natural resources such as forests and grazing lands or partially or fully deprived of community infrastructure and facilities, built-in structures, religious or cultural sites, market centers etc which could be permanently lost in the reservoir area or in other direct impact areas. Habitat fragmentation in such areas may result and influence wildlife mobility and limit food resources.

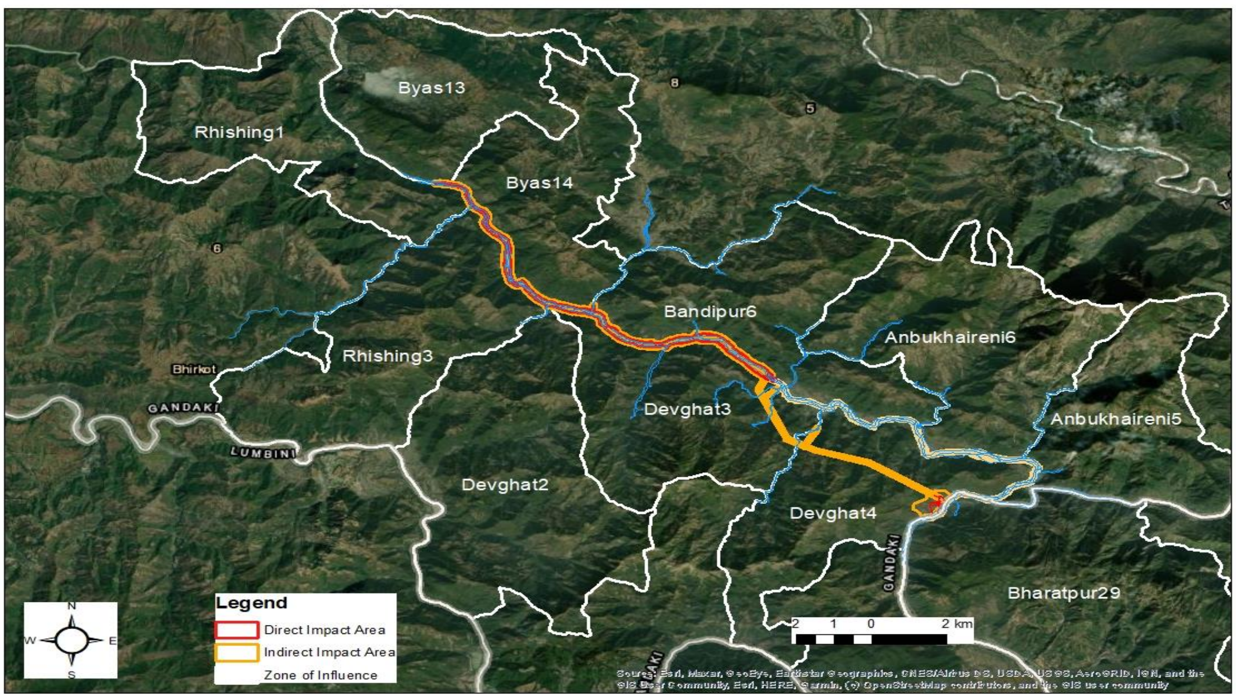


Figure 21: Impact Area Delineation Map (Source: GIS Analysis)

3.2 Project Affected Families

The term "Project Affected Families (PAF)" refers to households impcated by the project, either directly or indirectly, whose land, property, or livelihoods may be affected by the project construction and/or operation. This term is not limited to those subjected to physical displacement but includes, depending on the case, those affected by:

i) The involuntary acquisition of land that leads to (a) dispalcement or loss of housing; (b) loss of property or access to property; (c) loss of income sources or means of livelihood, whether the affected persons must move to another location.

ii) The involuntaty restriction from accessing legally designated parks and protected areas, which can result in negative impacts on their livelihoods.

The categorization of PAF into four classes based on the severity of impact is essential for developing effective mitigation strategies. This classification allows for the prioritization of resources and interventions, ensuring that all most severely impacted families receive appropriate support and assistance. The severity of impact is determined by the percentage of land, property, or livelihoods lost, with families grouped accordingly.

Project Affected Families (PAF):
Families who lose less than 10% of their entire landholding within and outside the project area and affected landowners currently residing in the project area or those sharecropper families who have land outside the project affected area or sharecroppers who are residing in the inundated government land and having land outside the project affected area.

Severely Project Affected Families (SPAF):
SPAFs refers to a household/familiy that faces substantial negative imapcts due to permanently losing more than 10% of their total landholding or source of livelihoods.

3.3 Data Requirement for the preparation of EIA report and methodology of data collection

The following approach, methodology and procedure were followed according to the provision of the EPR2020.

To conduct a thorough environmental impact assessment (EIA) study, it is necessary to review, study, and compile a database on the various environmental resources in the direct and indirect impact areas. This will enable the evaluation of the current environmental conditions or baseline status of the project.

3.4 Physical and Chemical Environment

- Physiography and Geomorphology.
- Geology and Soil.
- Land Use.
- Climate and Meteorology.
- Hydrology.

- Land Stability, Erosion and Sedimentation.
- Watershed Conditions and Natural Hazards.
- Air quality.
- Water quality.
- Noise Level.

The data were used to provide, among others, the following information regarding the physical environment of the project and its impact areas:

- Likelihood of triggering – existing landslides, formation of new slides/ slope instabilities, and further aggravating soil erosion due to construction activities.
- Slope stability and drainage and minimization of soil erosion and surface water runoff during construction works are needed adequately to be considered in the detailed design.
- Earthworks of varying extent at project sites are required to provide a level platform for construction.
- At the project sites, construction works involving cutting and filling in the hilly areas may lead to drainage, soil erosion, instability of slope, and localized water logging issues as well as pollution risk due to leaching to soil, groundwater, or surface water if any fuel, oil, or chemical spill occurs.
- At all the project sites digging, excavation and, on the access road transportation led to dust emissions.
- Noise levels during the construction stages need to be assessed.

Source of all data and information presented in the EIA report were identified: if the source is field survey, year and specific methodologies used were given; and if source is published report or literature then standard reference format were used with reference list. Any statement or data whose source has not been identified wre not accepted.

The following information was recorded/prepared for all field data collected (while presenting the existing environmental condition in EIA information shall be used).

- YY-MM-DD, and time of sampling/observation.
- Location of the entire sampling site (distance) with respect to project structures. (Data collection sampling sites and sample plots must be attached in the report. Photographs of sample site must also be attached).
- Methodologies, tools, and techniques used in sampling/ observation / survey. (Some of information can be discussed in chapter on Data Requirement and Study Methodology; however, in such a case, they must be briefly discussed).
- Sampling location shall be given in Google-kmz file format as well as geographical coordinates.

3.5 Biological Environment

- Forest Type Distribution and habitat conditions
- Forest Management Practices and Present Status

- Local and Regional Floral Diversity
- Rare, Protected and Threatened Species of Flora
- Wildlife Habitats and Ecological Conditions
- Plants of Ethno botanical Significance and Argo-biodiversity
- Faunal Diversity and Distribution along the Project Alignment
- Rare, Protected and Threatened Species of Terrestrial and Avian Fauna
- Invasive and Alien species
- Aquatic ecosystem, aquatic macro-vertebrates, fish, and fishery

The data were used to provide, among others, the following information regarding the biological environment of the project and its vicinity area.

- **Potential of Non-Timber Forest Products (NTFPs):** Identification of plant species wirth medicinal, agro-forestry, and ethno-botanical values, along with their composition in both the core project areas (where project structures are located) and the surrounding areas. This also involved identification of forest types (as specified by the Forest Act) with the potential for NTFPs.
- **Wildlife Habitat Data:** Depending on site conditions, biodiversity richness of the forest, and project location, data on terrestrial and aquatic wildlife habitat were gathered. This included mapping wildlife movement/migration corridors affected by the project, as well as habitat mapping in the project area influenced the project components and construction activities, as well as the surrounding areas.
- **Site Description:** Information on water bodies, holes, vegetation cover, ground features, and soil/rock features within the project area.
- **Important Habitat Type/ Features:** – Tree/Herb/Shrub/Epiphyte/Others.
- **Habitat Use:** Classification of habitat usage, distinguishing between active, temporary, and migratory corridors, and identifying purposes like breeding, feeding, hunting, resting, and more.
- **Habitat continuity and habitat connectivity**: Assessing the continuity and connectivity of habitats in the project area and surrounding regions.
- **State the habitat:** Evaluating the state in terms of degradation, fragmentation, and human encroachments.
- **Threat and Conservation status:** Determining the conservation status of flora and fauna based on Government of Nepal list, National Park, and Wildlife Conservation Act (1973); IUCN's Red Data Book and CITES list.

We had collected data and information pertaining to the following aspects of the project area's biological environment:

- Identification of common flora present in the site, surrounding locality, and the wider the region.
- Forest data pertaining to the core project area, considering the parameters outlines in the Forest Act.
- Assessment of tree density and basal area of tree species within the project construction site.
- Estimation of the number of trees, wood volume and biomass in the area.

- Documentation of the current uses of vegetation, including ethno-botanical and medicinal plant utilization, as well as other relevant applications.
- Identification and information on non-timber forest products found in the project area.
- Evaluation of the ecological value of goods and services that may be lost due to project implementation.
- Analysis of forest coverage and the regeneration status in the project area.
- Examination of cumulative impacts on the loss of vegetation, forest resources, and habitat of protected and other species.
- Study of the distribution and abundances of wildlife, including terrestrial, aquatic, and avian fauna, within the project area.
- Assessment of wildlife habitat condition.
- Investigation of fishes and fishery practices in the project area.

3.6 Socio-economic and Cultural Environment

The socio-economic and cultural environments of the project area were delineated using the following data:

- Demographic characteristics, including population, ethnicity, literacy, religion, health and sanitation conditions, occupational status, migration patterns, gender-related issues, child labor, income and expenditure patterns, and economic activities within the project-affected area and households directly impacted by the project.
- Economic status of the project site, including land ownership, landholding, land use, and the utilization of other natural resources such as water and forests.
- Assessment of infrastructure and support service facilities available in the proposed project area and its surrounding regions.
- Study of agriculture practices and production in the proposed impact area.
- Analysis of land use patterns in the ward municipalities affected by the project and directly impacted areas.
- Gathering the opinions and perceptions of the local population regarding the proposed project, as well as their preferred modes of resettlement and rehabilitation.
- Investigation of the prevailing market prices of land and property in the project-affected area.
- Identification and documentation of historical and archaeological resources within the project impact areas.
- Exploration of the culture and traditions of the people residing in the proposed project impact areas.

3.7 Methodology of Data Collection and Analysis

3.7.1 Literature Review

The baseline environmental database of the project area was compiled through the collection and review of various available literature sources. These sources included reports from entities such as the Central Bureau of Statistics (CBS), university publications, and other relevant publications. Additionally, various maps, such as topographic maps, land use maps, land capability maps, and land system maps, were used to enrich the database. Aerial photographs and Google images were also utilized in the process.

Furthermore, published, and unpublished reports concerning Environmental Standards, Acts, Regulations, and Guidelines of the Government of Nepal were gathered and carefully reviewed to ensure compliance with the requirements of the Environmental Impact Assessment (EIA) study. During the examination of secondary literature, any gaps in data were identified, guiding the focus of the subsequent field-level study.

To facilitate field study and verify the collected data, specific formats and checklists were developed and employed. This approach ensured a comprehensive and systematic approach to the data collection process, laying a strong foundation for the baseline environmental database.

3.7.2 Field Study and Site Inspection

As a part of the assessment study, the proposed area underwent comprehensive field studies aimed at addressing the data gaps identified during the literature review. The field studies were crucial in ensuring a thorough and accurate assessment of the area.

3.7.2.1 Physical Environmental Survey

A comprehensive physical environment survey was conducted to assess the potential impact of the proposed project activities during both the construction and operation phases. The survey focused on areas directly or indirectly affected by the project's main components and support facilities. Various field studies were undertaken to gather site-specific information on topography, geomorphology, geology, soil, and land stability. These studies aimed to identify physically critical areas, particularly those prone to erosion, and mark them on maps.

Given that a significant portion of the project alignment traverses the Siwalik range, ensuring land stability in this region was of utmost importance. Thus, a physical environmental expert conducted an extensive field study, paying special attention to the stability of the alignment, including the towers and other permanent structures.

To assess soil erosion, landslides, and other forms of degradation, identified land degradation sites from land use and topographic maps were visited and directly observed. Moreover, consultation tools like Key Informant Surveys (KIS), Focus Group Discussions (FGD), and Rapid Rural Appraisal (RRA) were employed to gather information from local communities about seasonal geomorphic agencies' activities, such as rain, water, and air, which influence soil erosion and land degradation.

The project area was thoroughly observed, and if necessary, laboratory analysis was carried out to evaluate air, water, and noise levels in both the direct and indirect impact areas of the project. Air quality and noise level data were collected from nearby settlements that might be affected by the project, and the data collection extended for 24 hours in those locations. The sample locations are depicted on the map provided below.

The ambient air quality data was sampled using the "Air Visual Pro Sensor" by IQAir that provided the real-time measurements of fine (PM2.5) and coarse (PM10) particles along with the data of Air Quality Index (AQI) and CO^2.

These comprehensive field studies and data collection efforts were essential in developing a comprehensive understanding of the physical environment and potential impacts of the proposed project, enabling informed decision-making and necessary mitigation measures.

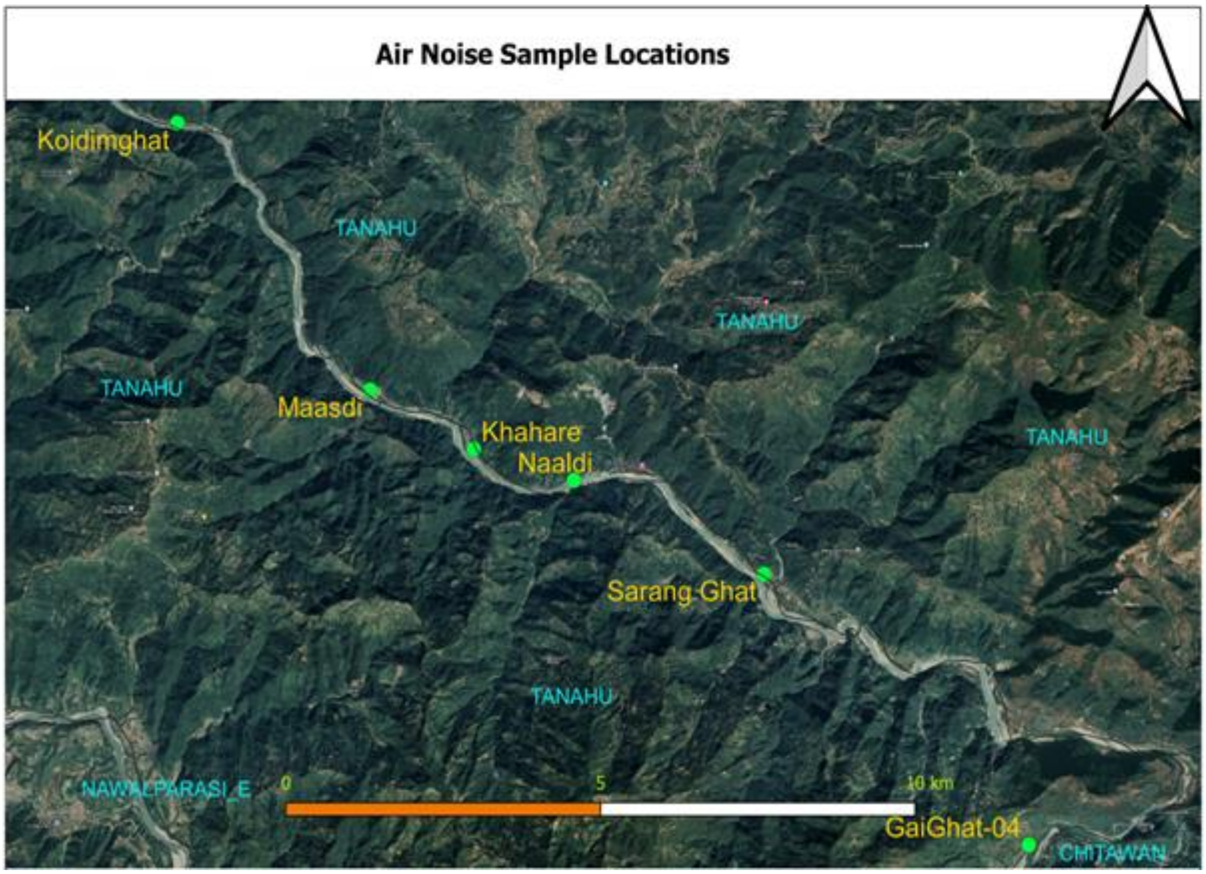


Figure 22: Air and noise sampling points (Source: Baseline Survey, EIA Study)

(a) Koidim Ghat, Byas-13
(b) Masdi, Byas-14
(c) Khahare, Byas-14
(d) Naldi Ghat, Bandipur-06
(e) Sarang Ghat, Bandipur-06
(f) Gai Ghat, Devghat-04

The selection of sample sites for air quality and noise data collection was determined based on several factors:

- ***Proximity to the project***: Sample sites were chosen in areas that are near the proposed project structures, as they are likely to be directly affected by project implementation.

- ***Topography***: The sample sites were strategically located to represent the diverse topography found within the project area.
- ***Sensitivity of receptors***: Sample sites were situated in areas where sensitive receptors, such as settlement areas and schools, are present. This consideration was given to assess the potential impacts on vulnerable populations and ensure the protection of such sensitive areas.

Water samples were collected from various representative stretches of the Seti River for analysis. The samples underwent testing at a nationally accredited laboratory in Kathmandu. The analysis encompassed six physical parameters: temperature, pH, turbidity, total dissolved solids (TDS), total suspended solids (TSS), and electrical conductivity. Additionally, eight chemical parameters were examined, including Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Sulphate, Nitrate, Nitrite, Phosphate, Total Nitrogen, and Ammonia. Two microbial parameters, total coliform, and fecal coliform were also tested.

To ensure the quality of the water samples, the results of the analysis were compared with the National Drinking Water Quality Standards (NDWQS) of 2079, as well as with the standards set by the World Health Organization (WHO). This comparison serves as a benchmark for evaluating the suitability of the water for various purposes and its compliance with established health and environmental guidelines.

3.7.2.2 Forest and Vegetation Field Survey

After concluding desk studies, we proceeded with field studies to gather pertinent data and information concerning the biological environment in the project area. The following data and their collection techniques were employed specifically for the forestry sector.

Floral sampling

Enough forest sample plots were taken to assess the status of the natural vegetation and biodiversity within the TSHPP project sites and immediate vicinity. Representative units of the major forest types or vegetative areas were selected for the assessment, as followed by the topography. The forest and vegetated area were divided into different forest strata before distributing sampling plots for measurements. Each plot covered an area of 500 m^2 horizontal equivalent, using quadrats of 25 m X 20 m, as suggested by the FRTC (2019).

For measurement purposes, Circumference at Breast Height (CBH) was measured at 1.3 m from the ground and later converted to Diameter at Breast Height (DBH) for volume and basal area estimation. Alternatively, the diameter was measured directly using a diameter tape. Ground conditions, such as status of regeneration, gregariousness of the herbaceous vegetation, presence of rock-outcrop, and richness of the ground flora, were also noted.

To measure the height of trees, either a Clinometer compass or a non-instrumental method (*e.g.*, ocular estimation) was used, especially is difficult topography. Ecological parameters like crown coverage, aspect, and slope inclination were recorded for further ecological analysis. Crown coverage was estimated using a Densiometer and ocular estimation is sites with challenging topography.

Ground flora was identified in the field, and any trees or other species that could not be identified on-site were later identified in the National Herbarium using collected sample specimens and standard literatures such as FRTC (2021), (Joshi, Dhakal, & Saud, 2017) (Polunin & Stainton, 1984) and others.

Resource use data

To gather information about the resource use pattern of plants in the forest and settlements, a questionnaire survey was conducted. In cases where samples of plants with various uses were uncertain, identification was sought with the help of consultations with locals. Additionally, various ethno-botanical information, as well as the status of Non-Timber Forest Products (NTFP) and local agro-diversity were also collected to explore the specific uses of plants in the project area.

Biomass estimation

For analyzing forest data, we have utilized the Quarter Girth Formula specified in the Forest Rules (MoFE, 2022). This method involves using the formula Volume = girth^2/16 x height x form factor, which is based on Smalian's formula, widely used for estimating the volume of a tree. Another method employed was to multiply basal area by the tree's height and form factor, yielding Volume = basal area x height x form factor. The data analysis adhered to the Forest Rules and involved converting volume measurements to biomass. The study team meticulously examined and discussed the findings obtained through these methods to ensure accuracy and reliability.


Figure 23: Consultation with community officials and local community

3.7.2.3 Wildlife field survey

The field survey involved conducting line transects along local roads and wildlife trails surrounding the project area, including the reservoir, dam site, dewatering area, audit sites, and powerhouse sites. The specific locations of these transects are indicated in the figure provided below.

During the transect survey, observations were made on species of amphibians, reptiles, and mammals, focusing on their indirect signs such as scats, pellets, diggings, rootlings, dens, burrows, tracks, pugmarks, and carcasses found along both sides of the routes. These signs were recorded along the transect.

It is worth noting that the method employed for the transect survey was slightly modified from Sutherland (1996), as there was no fixed length and width for the transects. Instead, the observations were recorded without constraints on distance, allowing for a more comprehensive assessment of wildlife presence in the project area.

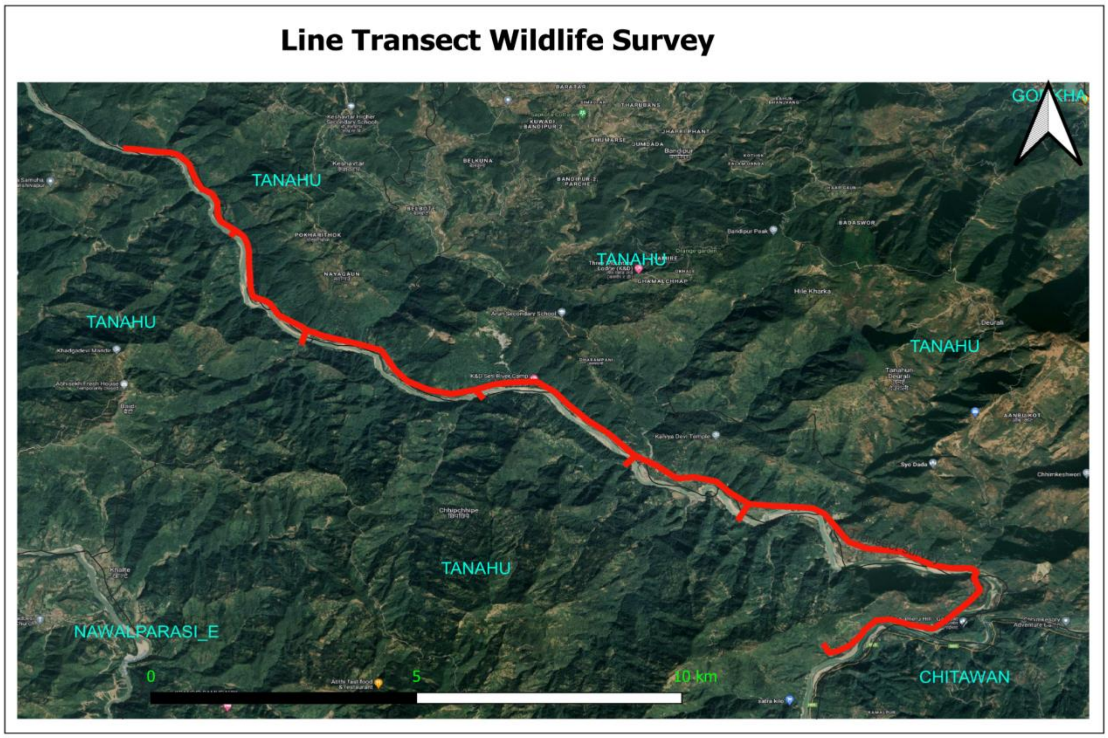


Figure 24: Line transect carried out for wildlife survey (Source: Baseline Survey, EIA Study)

The study extended to the adjacent areas of the Seti River, encompassing various land uses such as forests, grasslands, agricultural lands, and settlements. In these areas, the focus was on recording wildlife and their indirect signs. The survey also included an assessment of local water bodies and banks to record the presence of wildlife, particularly amphibians and reptiles.

To identify resting animals, particularly herpetofauna, various techniques were employed, including lifting stones, logs, and digging burrows, as well as disturbing vegetation. These methods allowed for the observation and documentation of wildlife in their natural habitats.

Additionally, the study team engaged with the local community by showing them color photographs of potential amphibians, reptiles, and mammals known to occur in the area. This interactive approach served to confirm the occurrence of these species based on the community's local knowledge.

By combining these methods, the study sought to comprehensively document the wildlife and their habitats in the vicinity of the Seti River, providing valuable insights into the biodiversity of the region.

3.7.2.4 Avian Survey

In accordance with the requirements outlined in the scoping study report, a comprehensive study on bird diversity thriving in the Tallo Seti (Tanahun) Hydropower project area was conducted from 5th to 12th May 2022. The bird study encompassed various locations within the hydropower project site, including the reservoir or impounding site, Barrage site, Dewater Zone, Adits, Head race tunnel site, and Powerhouse. Additionally, a visit was made to the abandoned cow rescue center at *Sisuwavateri*, situated along the bank of Madi River, 20 km away from the project location, to better understand vulture mobility and population between the project area and the abandoned cow rescue center.

A total of 17 line transects, each 1 km in length, were established along the river corridor and nearby forest, covering different hydropower components to ensure spatial independence (Figure 4). The bird study was conducted from 07:00 AM to 07:00 PM, with a casual break in the afternoon. Opticom Binoculars of 10x50mm magnification were used to locate birds, while a Canon EOS 90D with Canon 55-250mm and Tamron 150-600mm Telephoto lenses were utilized to photograph the observed birds. Bird identification was carried out following "Birds of Nepal" (Grimmett et al, 2016), and scientific nomenclature was followed as per "Birds of Nepal - An Official Checklist - 2018" (DNPWC and BCN, 2018). The migratory status of each species was determined based on "Birds of Nepal" (Grimmett et al, 2016), and their migratory patterns were noted from the IUCN Redlist (IUCN, 2022). Migratory birds were categorized as full migrant (free movement within the country), altitudinal migrant (vertical movement), and winter or summer visitor (cyclic, seasonal movement between breeding grounds and wintering grounds). The global threatened status of birds was noted from the IUCN Redlist (IUCN, 2022), and their national status was recorded based on the National Redlist of Birds (Inskipp et al, 2016). The species compositions were classified as farmland birds, riparian birds, forest birds, urban birds, and open country/raptors based on their close associations with different habitats.

Various parameters such as bird encounter rate, diversity index (H’), evenness (e), and richness were calculated from the field data. The compiled checklist of bird species present in the project area includes records from both the scoping field study conducted in January 2022 and the detailed baseline field study carried out in May 2022. However, it is important to note that more bird species could potentially be present in the project area due to the varied habitats, including wetland, forest, farmland, and settlement.

Table 3. 2: Bird study transect and points in the Tallo Seti (Tanahun) Hydropower Project Area

S.N	Transect Code	Geographic position (DD)		Project Component
		Start Point	End Point	

		Latitude	Longitude	Latitude	Longitude	
1	RT1	27.917988°N	84.300915°E	27.916195°N	84.311284°E	Reservoir Zone
2	RT2	27.909026°N	84.317217°E	27.901584°N	84.321754°E	
3	RT3	27.893732°N	84.324332°E	27.886390°N	84.328614°E	
4	RT4	27.880018°N	84.338333°E	27.876759°N	84.349448°E	
5	RT5	27.871026°N	84.357421°E	27.869833°N	84.368245°E	
6	RT6	27.871114°N	84.377877°E	27.865498°N	84.386315°E	
7	BT	27.860078°N	84.393873°E	27.855182°N	84.401693°E	Barrage site
8	A2T	27.848221°N	84.407949°E	27.840714°N	84.403832°E	Adit-2
9	DT1	27.851393°N	84.407368°E	27.855554°N	84.405767°E	Dewater Zone
10	DT2	27.848146°N	84.416868°E	27.845871°N	84.425574°E	
11	DT3	27.843805°N	84.435147°E	27.837200°N	84.448008°E	
12	DT4	27.833679°N	84.462033°E	27.827714°N	84.463488°E	
13	DT5	27.824135°N	84.464216°E	27.820731°N	84.455734°E	
14	HT1	27.820577°N	84.441473°E	27.824782°N	84.440857°E	Head race Tunnel Area
15	HT2	27.827030°N	84.443415°E	27.826853°N	84.434449°E	
16	HT3	27.823805°N	84.433118°E	27.818409°N	84.434242°E	
17	HT4	27.819574°N	84.440300°E	27.817495°N	84.437341°E	

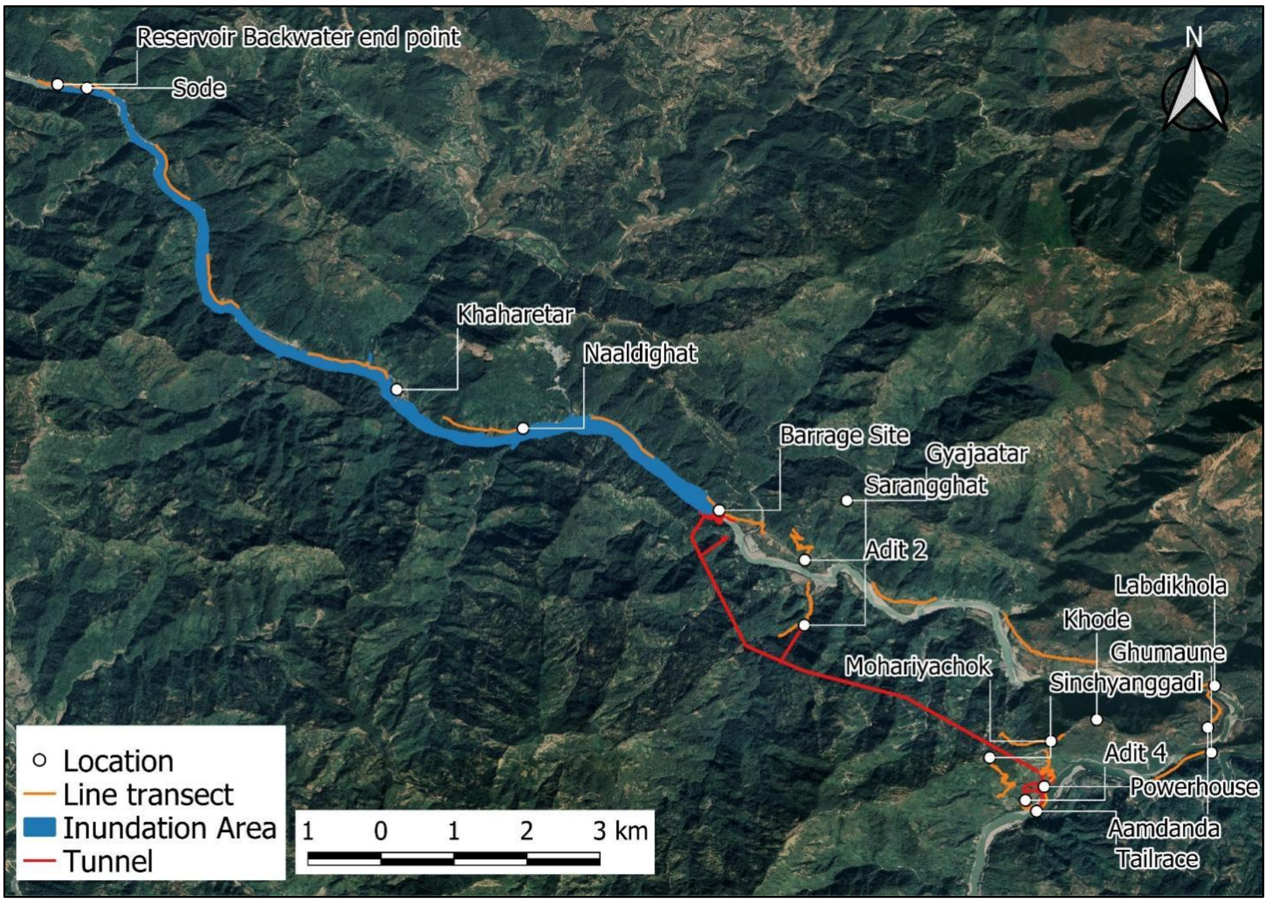


Figure 25: Bird study transect overlay map in Google Earth Image. (Source: Baseline Survey, EIA Study)

3.7.2.5 Aquatic Life Sampling

Baseline data on aquatic life, including fish, plankton, and benthic macroinvertebrates, was obtained through surveys conducted in the project area in February and May 2022. The sampling surveys were specifically carried out in selected sampling sites situated along the Seti and Trishuli rivers. The criteria for selecting these sites were based on factors such as altitude, major confluence points, river habitats, and areas likely to be impacted by the project in future, as well as accessibility to the sampling locations. To gather valuable insights, consultations with local people were also an integral part of the survey process.

Fish

The baseline study was conducted during two periods, in February 2022 and May 2022, at ten different sampling sites along the Seti and Trishuli Rivers. Among these sites, 6 were situated in the Seti River, while the remaining 4 were in the Trishuli River (see Figure 23). Electrofishing sampling method was employed for collecting fish specimens.

Sampling in February and May represents the winter and post-monsoon seasons, facilitating a comprehensive fish study. Sampling in February (winter) is vital for comprehending seasonal population, post-spawning behaviors, and habitat usage, all of which are essential for informed fish management. May (Pre-monsoon) sampling aids in the analysis of pre-spawning migratory behavior in the targeted fish *Tor putitora* and post-breeding behavior in another targeted fish, *Schizothrax richardsonii*. This collected data offers a valuable seasonal population snapshot and fish behavior greatly assisting in the planning of effective fisheries management strategies.

In the electrofishing method, a 300-meter wadable area at each sampling site was divided into two sections: a 150-meter upstream area and a 150-meter downstream area from the midpoint. A total of 30 minutes of fish sampling was conducted within these designated areas using an SAMUS RICH P-2000 electrofisher with a 40 cm anode ring diameter. Specifically, 15 minutes of sampling took place in the upstream area, followed by another 15 minutes in the downstream area (IFC, 2021). Stunned or sampled fishes within the designated areas were promptly collected using two dip nets with a mesh size of 10 mm. The captured fishes were then transferred to a water container for further morphological and taxonomic studies. After data recording, the fishes were released back into the same sampling site to maintain the ecological balance.

To ensure consistency and comparability, sampling was standardized using the same equipment, methods, personnel, habitat types, and duration of fishing across all sampling sites. This approach allowed for a systematic and reliable assessment of the aquatic life in both rivers during the baseline study.

In addition to the sampling conducted, data generation also involved using fish caught by local fishermen, as well as fresh, frozen, and dried fish obtained from local shops. Moreover, photographs of fish provided by local people and fishermen were utilized to complement the dataset. This comprehensive approach ensured a more inclusive and diverse representation of the fish population in the study area.

Fish abundance is calculated as[1]:

$$\text{Catch Per Unit Effort (CPUE)} = \frac{\text{Number of fish caught in each site}}{\text{Number of efforts in hour in each site}}$$

IFC (2021)

Planktons and Benthic Macroinvertebrates (BMI)
In February 2022, samples of Phytoplankton, Zooplankton, and Benthic macroinvertebrates were collected from eight fish sampling sites: S-1, S-2, S-4, S-6, T-1, T-2, T-3, and T-4 (Fig. 3.5), located in the Seti and Trishuli rivers.

For Phytoplankton, a 10-L composite sample was prepared by collecting samples from 20 different microhabitats (500 ml from each habitat) at each sampling site. Additionally, substratum/rocks present in one square meter were collected from each station, and planktons attached to these were scrubbed with a toothbrush. From the thoroughly mixed composite sample, 250 ml was taken to the laboratory for identifying the taxa, and 1% Lugol's solution was added for preservation.

Regarding Zooplankton, at each station, 200 liters of river water from 20 different microhabitats was filtered through a 64 µm plankton net (Nitex nylon net, 20 cm mouth diameter, 80 cm length, slotted cod end assembly lined with Nitex nylon) using a 10-liter capacity plastic bucket. From the collected sample at the cod end assembly of the net, 100 ml was taken to the laboratory for identifying the taxa, and a 5% formaldehyde solution was used for preservation.

For Benthic macroinvertebrates, samples were collected from twenty different microhabitats at each sampling station using a D-net sampler (30.5 cm width, 53.3 cm height, and 500-micron mesh size) (Tachamo, 2020). The substrata in front of the net were disturbed by boots, and rocks were scrubbed with a brush. The collected Benthic macroinvertebrates were transferred to a bucket, sorted, preserved (in 70% ethanol), and then carried to a biological laboratory for identification.

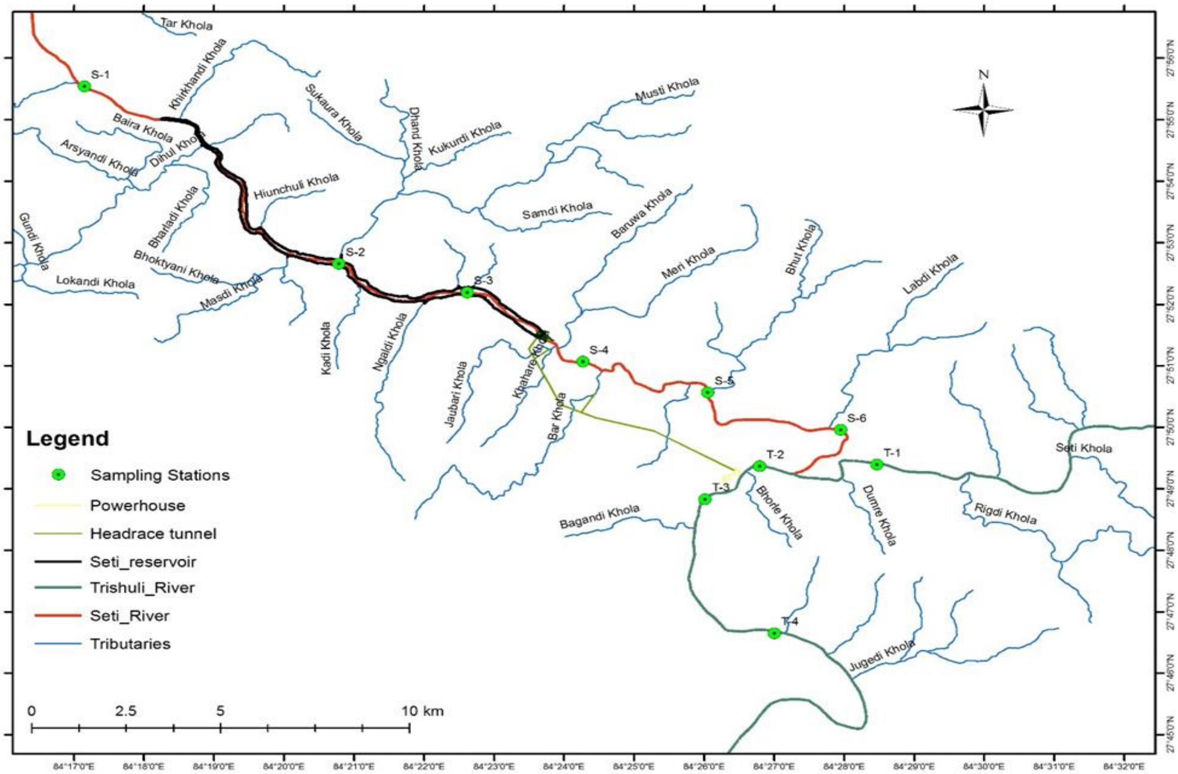


Figure 26:: Aquatic life sampling sites (Source: Baseline Survey, EIA Study)

Table 3. 3: Description of fish sampling stations

Station	Name of Station	Latitude Longitude	Elevation (masl)*	Riverbank	Municipality	District	Water Temp.
S-1	Seti River, upstream of the Seti reservoir	27.92563°, 84.28583°	318	Left	Byas Municipality	Tanahu	18^0C
S-2	Seti reservoir, upstream of dam (Dhand khola confluence)	27.87755°, 84.34642°	282	Left	Bandipur Rural Municipality	Tanahu	18^0C
S-3	Seti reservoir, upstream of dam	27.86979°, 84.37697°	270	Left	Bandipur Rural Municipality	Tanahu	18^0C
S-4	Seti River, downstream of the dam (Downstream of Bagar khola confluence)	27.85101°, 84.40452°	252	Left	Bandipur Municipality	Tanahu	18^0C
S-5	Seti River, downstream of dam (Bhut khola confluence)	27.84267°, 84.43425°	242	Left	Anbukhaireni Rural Municipality	Tanahu	18^0C
S-6	Seti River, downstream of dam (downstream of Labdi khola confluence)	27.83254°, 84.46585°	228	Left	Anbukhaireni Rural Municipality	Tanahu	17^0C
T-1	Trishuli River, upstream of the confluence between Seti and Trishuli Rivers	27.82311°, 84.47444°	238	Left	Bharatpur Metropolitan City	Chitwan	16^0C
T-2	Trishuli River, upstream of tailrace area (downstream of the confluence between Seti and Trishuli Rivers)	27.82266°, 84.44656°	216	Left	Bharatpur Metropolitan City	Chitwan	16^0C
T-3	Trishuli River, downstream of tailrace area (downstream of the confluence between Seti and Trishuli Rivers)	27.81374°, 84.43357°	207	Left	Bharatpur Metropolitan City	Chitwan	17^0C

T-4	Trishuli River, downstream of tailrace area (downstream of the confluence between Seti and Trishuli Rivers)	27.7774°, 84.45004°	210	Right	Devghat Rural Municipality	Tanahu	17^{0}C

Source: Field Survey, EIA of Tallo Seti (Tanahun) Hydropower Project (126 MW), February 2022.
* Elevation from Google Earth Pro

3.7.2.6 Socio-economic and Cultural Environmental Study

The project team conducted an extensive collection of socio-economic and cultural data primarily within the project influence zone. The approach used for data collection was comprehensive, encompassing both indirect and direct impact areas. In addition to this, the team utilized various secondary sources, such as CBS 2011 and 2021 census data, District Profile, District Agricultural Profile, and more, to gain insights into the demographics, quality of life, and economic activities of the project-affected municipalities, rural municipalities, and districts.

Consultations and HH survey

To ensure the accuracy of the gathered information, the team took several measures. They verified the secondary data through direct observations and interactions with officials from respective districts and wards. Moreover, the team engaged with local communities through various means, including focus group discussions (FGD), consultation meetings, and key informant surveys (KIS).

Recognizing the importance of stakeholder involvement, the project team developed a stakeholder engagement plan. This plan aimed to identify the relevant stakeholders and determine the appropriate level of engagement required for the success of the project.

A comprehensive socio-economic survey was carried out among the HHs impacted by the project their living conditions. The survey utilized various methods, including:

- Identification of affected plots involved analyzing cadastral maps and superimposing the project's footprint onto them to pinpoint the impacted areas.
- Determination of landownership for the affected plots was achieved by consulting records from the Land Revenue Office.
- Structures questionnaires were administered to conduct the socio-economic survey among the affected HHs, gathering essential data.
- The socio-economic data obtained from the HH survey underwent rigorous statistical analysis. This analysis aimed to characterize the socio-economic conditions of the affected HHs and predict the potential impacts of the project.

The stakeholder consultation process employed various tools, which included but were not limited to Focus Group Discussions (FGD), consultation meetings, and Key Informant Surveys (KIS). To gather general socio-economic data of the project municipalities and wards, secondary information was also utilized.

The survey of the affected households (HHs) was conducted using a structured questionnaire, covering a wide range of topics such as family size, education, health, religion, economic activities, landholdings, agricultural practices, livestock, income, expenditures, toilet facilities, and other properties. This comprehensive data provided valuable insights into the living conditions of the affected households.

Furthermore, data collected from the ward and/or municipality offices underwent analysis to assess the current state, adequacy, and the number of beneficiaries served by social infrastructures like schools, health posts, drinking water facilities, sanitation facilities, and others.

To develop plans for the protection, conservation, or relocation of religious, cultural, and historical sites, visits were made to these sites in consultation with local communities. Additionally, a market survey was conducted to obtain price lists of commodities and assess the inflation rate.

These data collection efforts helped ensure a well-rounded understanding of the project's impact on stakeholders, living conditions of affected households, and the assessment of existing social infrastructures and resources in the project area.

3.8 Discussion and Consultation

3.8.1 Forest and Vegetation

The project team conducted interviews with various members of the local community, representing diverse social statuses. These interviews included individuals from CFUGs, livestock grazers, farmers, shopkeepers, hoteliers, Municipalities. Group meetings and interactions were organized to gather valuable insights.

For the ethnobotanical study and forest resource use pattern, the individuals consulted and listed in the table below.

Table 3. 4: Details of locals consulted for ethnobotanical usage of flora

SN	Participant for discussion	Address	Position
1.	Mr. Khem Bahadur Rana	Koidimghat, vyas 13, Tanahu	Member, CFUG
2.	Ms. Narimaya Magar	Masdighat, Vyas 14, Tanahu	Member, CFUG
3.	Ms. Bhomaya Rana	Naldighat 3, Devghat, Tanahu	Member, CFUG
4.	Mr. Min Bahadur Gurung	Bandipur-6, Saranghat, Tanahu	Member, CFUG
5.	Ms. Shanti Gurung	Bandipur-6, Saranghat, Tanahu	Member, CFUG
6.	Mr. Shree Bahadur Gurung	Anbu Khaireni-5, Labdi Khola, Tanahu	Chairman, Community Forest
7.	Mr. Padam Bahadur Gurung	Devghat, Tanahu	Member, CFUG
8.	Mr. Durgaman Gurung	Gaighat 4, Devghat, Tanahu	Member, CFUG

3.8.2 Wildlife

The study involved interviews and consultations with locals such as members of CFUGs, livestock grazers, farmers, shopkeepers, hoteliers, officials of the local government – ward offices and Municipalities. The primary objective of these interactions was to assess the diversity of wildlife in the project area. Additionally, these interactions also tried to tease out the extent of human-wildlife conflicts such as the issue of crop and livestock depredation and hunting/poaching. The religious and cultural significance of wild animals to the locals was also explored during these interactions.

Throughout the interactions, a methodical classification of amphibians, reptiles, and mammals was conducted, adhering the categorization system provided by Shah and Tiwari (2004) and Baral and Shah (2008).

Table 3. 5: Participants of the focal group discussion

Participant for discussion	Address	Position
Mr. Kiran Kumar Shrestha	Managing Director	Tanahu Hydropower Ltd, Jhaputar, Tanahu
Mr. Shyam Krishna Karki	Engineer	Tanahu Hydropower Ltd, Jhaputar, Tanahu
Mr. Milan Gurung	Hotelier	Saranghat, bandipur RM, Ward No.6
Mr. Basant Magaar	Local Fish Collector	Pulchowk, Ghumaune, Tanahu
Mr. Bris Raj Gurung	Farmer	Kuiding, Sande pul tole, Byas Municipality, ward no. 13.
Mr. Chandra Bahadur Gurung	Ex-Chairman	Dharampaani
Mr. Mohan Kumar Shrestha	Hotelier	Khahare, Bandipur RM, ward no. 6,Tanahu
Mr. Tak Bahadur Rana Magar	Hotelier	Kuidimbas, Byas Municipality, ward no.13 Tanahu
Mr. Sita Maiya Thapa	Hotelier	Kuidimbas, Byas Municipality, ward no.13,Tanahu
Mr, Man Bahadur Thapa Magar	Farmer	Goman tal, Tanahu
Mr. Purna Ale	Farmer	Goman tal, Tanahu
Mr. Sant Bahadur Ale	Farmer	Kuidim village, Byas Municipality, ward no.13 Tanahu
Mr. Samsher Bahadur Rana	Shopkeeper	Naldighat,Devghat Municipality, ward.no.3
Mr. Man Bahadur Magar	Farmer	Namdi village, Devghat Municipality, ward.no.3
Mr. Kumar Ale	Farmer	Namdi village, Devghat Municipality, ward.no.3
Mr. Durga Man Gurung	Ward member	Gaighat, Devaghat RM, ward no. 4
Mr. Prem Bahadur Gurung	Chairman	Gaighat,Tole Development committee
Mr. Chandra Bahadur Gurung	Shopkeeper,	Gaighat, Devaghat RM, ward no. 4

Mr. Ram Prasad Bote	Member, Drinking water committee,	Gaighat
Mr. Padam Bahadur Gurung	Ward Chairman,	Gaighat, Devaghat RM, ward no. 4

3.8.3 Aquatic Life

Locals were consulted to gather information about the habits, habitats, distribution, and diversity of fishes and aquatic animals found in the project area. During these consultations, a field guidebook, Shrestha (2009), was utilized, which contained colored photographs of various fish species from Nepal. This guidebook proved to be an extremely useful reference for the discussions.

The data/ information obtained through these consultations were carefully compared with existing secondary literature and thoroughly reviewed to ensure accuracy and reliability.

3.9 Impact Identification, Prediction and Evaluation Methods

The study has relied on the standard evaluation methods outlines by the EPR 2020 and National EIA Guidelines 1993, which are wildlife accepted and utilized in Nepal for assessing impacts.

The impact evaluation process for this project considered its impact on social, economic, cultural, biological, and physical aspects of the existing environmental conditions of the project area, encompassing both negative as well as positive impacts.

To gain a deeper understanding of these impacts, these were categorized into different types:

(a) Direct impacts – which occur immediately and directly because of the project implementation.
(b) Indirect impacts – which are secondary impacts resulting from the project.

To ensure a comprehensive impact assessment, the entire process can be divided into three stages, providing a structured framework for addressing impact assessment needs:

(a) Impact identification
(b) Impact evaluation
(c) Impact prediction

3.9.1 Impact Identification

3 aspects of environment were considered as a part of the impact identification, namely – physical, biological, and socio-economic. These were based on the thematic environmental components that are likely to be affected by the project. By categorizing impact in this way, it becomes comprehensive to assess the specific area that will be affected by the project.

Additionally, the impacts were further categorized based on the nature of the interaction between the project and environmental components and categorized as – direct, indirect, and cumulative. Direct impacts refer to immediate and tangible effects resulting from the project activities. Indirect impact are secondary effects that occur because of the project but are not directly caused by it. Cumulative impacts consider the cumulative effects that accumulated over time due to the project activities and/or in combination with other developmental works being undertaken in the project area.

To visually represent the relationship between the proposed activities and the potentially affected environmental components, an interaction matrix has been used. This matrix serves as a tool to display and analyze the connection between specific project activities and the corresponding environmental components that may be impacts.

3.9.2 Impact evaluation

The EIA process has considered the varying intensities of impacts, which can range from low to high. The EPR2020/NEIAG1993 provides detailed criteria to assess the intensity of impacts based on 4 factors – magnitude, extent, duration, and importance.

- Magnitude of impact referred to the severity of the impact and indicated whether it is reversible or irreversible. It also provided an estimate of the potential rate of recovery. The magnitude of impact is often classified as High (H), Moderate (M), and Low (L).
- Extent of impact pertained to the spatial scope or zone of influence of an impact. It can be Site-specific (SS) and limited to the project area, locally occurring (L) within the watershed of the project, Regional (R) extending beyond the watershed, National (N) affecting resources on a national level, or Transboundary (T) affecting resources of more than one country.
- Duration of impact referred to the temporal dimension and can be categorized as Short-term (ST), Medium-term (MT) and Long-term (LT).
- Importance of impact assesses the significance of the impact in terms of its value to biodiversity, ecosystem service, cultural aspects, or the ecosystem itself. It is classified as High (H), Moderate (M) and Low (L).

Once the baseline environmental data of the project area was fully documented, each environmental parameter was examined in relation to the project activities at different stages of project development. Appropriate methods and tools were utilized to assess the impact specific to each environmental parameter under consideration.

Table 3. 6: Impact assessment criteria and ranking (Source: EPR 2077)

Magnitude		Extent		Duration	
Description	Rank	Description	Rank	Description	Rank
High/Major	60	Regional	60	Long Term	20
Medium	20	Local	20	Medium Term	10
Low/Minor	10	Site Specific	10	Short Term	05

The magnitude, extent, duration, and Importance of each impact were considered and weighed in relation to one another to determine the significance of the impact. This process involved assigning relative importance to each factor and assessing how they collectively contribute to the overall predicted impacts.

For the identification and prediction of impact significance, the following scoring method will be employed based on expert judgment.

Table 3. 7: Categorization of impact significance (Source: EPR 2077)

Categorization of impact significance	Highly significant	Moderately significant	Low significant
Score	Greater than 75	45 to 75	Less than 45

By ranking the impacts and evaluating their significance, the assessment provided a comprehensive understanding of the potential effects of the project. This information was crucial for both mitigation efforts and decision-making processes related to the project.

3.10 Public Participation

One of the fundamental principles of EIA is to prioritize genuine and meaningful engagement of stakeholders, especially those from the project area and affected communities. This approach is essential to promote transparency, inclusivity, and cooperation between the project proponents and the public. As a result, the EIA study has ensured extensive participation of stakeholders as a part of the EIA study.

3.10.1 Consultations

Stakeholder consultations served multiple purposes in the EIA process. It helped in fostering community trust by allowing affected individuals and communities to have a say in the decision-making process. It was reported that the stakeholders felt heard and valued, thus enhanced their confidence in the project. These consultations also helped in identifying key stakeholders and affected families. By engaging with them, we were able to pinpoint their interests in designing the mitigation measures. For instance, most of the stakeholders showed interest in receiving cash compensation in comparison to the land for land compensation. Insights from consultations with concerned stakeholders, especially the committee of concerned stakeholders, highlighted cultural sensitivity, values, and concerns regarding the connection of locals with the river and forests, that might be affected by the project. These inputs were important in devising the mitigation measures.

These consultations help establish mechanisms for on-going and regular engagement with communities. Continuous communication keeps the public informed about the project's progress, potential impacts, and mitigation measures. This openness has ensured that the stakeholders remain engaged throughout the study period, facilitating a collaborative relationship.

Additionally, gathering crucial baseline data from communities is imperative to establish two-way communication with the residents. Furthermore, effective stakeholder consultation helps validate the baseline information acquired through baseline surveys.

The EIA study involved the following stakeholders during the consultation process. These stakeholders were identified by the study team by collaborating with local leaders in the project area, representatives from local governments, and residents:

1. Local Government: Offices of all project municipalities and wards, consisting of 1 Urban Forest user groups (LFUG)
2. Local Community and affected families: Local communities, women's groups, youth groups, farmers' groups, Indigenous youth groups, *Dalit* groups, and the general TSHPP community.
3. municipality, 4 Rural Municipalities, 1 Metropolitan city, and 11 ward offices.
4. District Level Offices: Chief District Office, Divisional Forest Office, Land Revenue Offices and District Survey Offices.
5. Community Organizations: all affected community forest user groups (CFUG) and Leasehold

The identified stakeholders were engaged in prior and informed consultations to gather their perspectives and concerns regarding the hydropower construction, understanding their expectations from the project, and inform them about project activities. As stakeholders directly or indirectly affected by the project, they hold significant influence over its construction and operation.

A total of 11 Key Informant Interviews (KIIs) and 8 Focus Group Discussions (FGDs). 2 CFUG level, 2 ward official level, 1 School level, and 3 community level FGDs were done. The FGDs included 98 number of participants which consisted of 79 male and 19 females. Out of the participants, 86 people represent Indigenous community classification.
The details of these consultations are given in table below:

Table 3. 8: Details of Consultation

SN	Consultation Details	Type	Number of Participants	Indigenous People Participant Number	Male	Female
1.	CFUG Consultation at Masdi	FGD	29	26	20	9
2.	CFUG Consultation at Naldi	FGD	35	34	29	6
3.	Consultation at Sondhe	FGD	5	5	5	-
4.	Consultation at Dhap, Ker and Downey Resort	FGD	3	3	3	-
5.	Consultation at Damauli Bazar, Aansan Chautari	FGD	6	4	5	1
6.	Consultation at Devghat RM office	FGD	5	4	4	1

7.	Consultation at Saranghat	FGD	11	9	11	-
8.	Shree Bhrikuti Secondary School	FGD	4	1	2	2
9.	Consultation at Gaighat, Powerhouse site	KII	-	-	-	-
10.	Consultation with Shree Seti Ganga Basic School	KII	-	-	-	-
11.	Consultation at Soil Conservation Office, Tanahun	KII	-	-	-	-
12.	Consultation at Division Forest Office, Tanahun	KII	-	-	-	-
13.	Consultation at Vyas Municipality	KII	-	-	-	-
14.	Consultation at CTEVT, Tanahun	KII	-	-	-	-
15.	Consultation at Land Revenue Office, Tanahun	KII	-	-	-	-
16.	Agricultural Knowledge Centre, Bhorle, Bharatpur-29	KII	-	-	-	-
17.	District Administration Office, Tanahun	KII	-	-	-	-
18.	Rhising Rural Municipality	KII	-	-	-	-
19.	Indigenous People Office, Tanahun	KII	-	-	-	-
20.	Aadibasi Janajati Mahasangh, Chitwan	KII	-	-	-	-

3.10.2 Public Hearing

According to EPR2077, Chapter 2, Rule 6, it is mandatory to conduct ***public hearing*** in the project area before finalizing the EIA report. This process allows to share the findings as well as collect consent, suggestions, and comments on the EIA report.

To promote active stakeholder participation, it was important to inform them in advance about the public hearing. This early notification enabled community members, affected households/population, and concerned stakeholders to plan their attendance and prepare their concerns and feedback regarding the project's environmental and social impacts. Pre-informing stakeholders has also fostered trust and transparency within the community, showcasing the project team's dedication to involving stakeholders throughout the EIA process. As a part of this pre-informing initiative, comprehensive planning and actions were taken.

Public notice: In accordance with Rule 6 of the EPR2077, a 7-day public notice was issued, inviting stakeholders to participate. The notice was published in Nepal Samacharpatra, a national daily newspaper, on 2080/03/03 BS (20 June 2023 AD). The notice is provided in the figure below:

तल्लो सेती (तनहुँ) जलविद्युत आयोजनाको वातावरणीय प्रभाव मुल्यांकन प्रतिवेदन तयारी सम्बन्धि सार्वजनिक सुनुवाईको सूचना

(प्रथम प्रकाशित मितिः २०८०/०३/०३)

गण्डकी प्रदेश, तनहुँ जिल्लाको बन्दीपुर गाउँपालिका, ब्यास नगरपालिका, देवघाट गाउँपालिका, ऋषिङ्ग गाउँपालिका, आँबुखैरेनी गाउँपालिका र चितवन जिल्लाको भरतपुर महानगरपालिकामा नेपाल विद्युत प्राधिकरणको पूर्ण स्वामित्वको सहायक कम्पनी तनहुँ हाइड्रोपावर लिमिटेड प्रस्तावक रहेर निम्न बमोजिमको प्रस्ताव कार्यान्वयन गर्न लागिएको छ ।

प्रस्तावकको नाम र ठेगाना	**तनहुँ हाइड्रोपावर लिमिटेड** तल्लो सेती (तनहुँ) जलविद्युत आयोजना चुनदेवी मार्ग, महाराजगंज, काठमाण्डौ, नेपाल ई-मेलः info@thl.com.np, lowerseti@gmail.com फोन नं: ०१४७२००४९, ०१४७२०३३१
प्रस्तावको व्यहोरा	तनहुँ हाइड्रोपावर लिमिटेड द्वारा हाल निर्माणाधीन तनहुँ जलविद्युत आयोजनाको टेलरेसबाट १८ किलोमिटर तल्लो तटिय क्षेत्रमा अवस्थित बन्दीपुर गाउँपालिकाका वडा नं ६ तथा देवघाट गाउँपालिका वडा नं ३ मा अवस्थित साराङ्घाट नजिक सेती नदीमा ३२ मि. अग्लो बाँध (Barrage) निर्माण गरि पानीको प्रवाहलाई देवघाट गाउँपालिकाको वडा नं ३ र ४ हुँदै जाने ६.८ किलोमिटर लामो सुरुङ्ग मार्ग (Headrace Tunnel) मार्फत नदीको प्रवाहलाई फर्काइ त्रिशुली र सेती नदीको संगम देखि करिब १.५ किलोमिटर तल्लो तटिय क्षेत्रमा पर्ने देवघाट गाउँपालिका वडा नं ४ मा त्रिशुली नदीको दाँया किनारमा बन्ने अर्ध भूमिगत विद्युतगृहमा खसाली १२६ मेगावाट जडित क्षमता भएको तल्लो सेती जलविद्युत आयोजना विकास गर्ने परिकल्पना गरेको छ ।
प्रभाव पर्न सक्ने जिल्ला/न.पा./वडा	**जिल्ला** — **नगर/गाँउ पालिका, वडा** तनहुँ — बन्दीपुर गाउँपालिकाः ६ ब्यास नगरपालिकाः १३, १४ देवघाट गाउँपालिकाः २, ३, ४ ऋषिङ्ग गाउँपालिकाः १, ३ आँबुखैरेनी गाउँपालिकाः ५, ६ चितवन — भरतपुर महानगरपालिकाः २९

माथि उल्लिखित प्रस्ताव कार्यन्वयनबाट आयोजना क्षेत्रमा भौतिक तथा रासायनिक प्रणाली, जैविक प्रणाली, सामाजिक तथा सांस्कृतिक प्रणाली र आर्थिक प्रणालीहरुमा के कस्तो प्रभाव पर्दछ यकिन गर्न बातावरण संरक्षण ऐन २०७६ र बातावरण संरक्षण नियमावली २०७७ ले निर्देशन गरे बमोजिम प्रस्तावकले बातावरणीय प्रभाव मुल्यांकन (EIA) प्रतिवेदन र सुझावहरुको लागि प्रभावित हुने स्थानिय तहका प्रतिनिधिहरु समेतलाई सहभागी गराई सार्वजनिक सुनुवाई गर्नुपर्ने भएकोले यस प्रस्तावसंग सरोकार राख्ने सरोकारवालाहरुलाई निम्न स्थान, मिति र समयमा उपस्थित हुन अनुरोध गर्दै यो सूचना प्रकाशित गरिएको छ ।

सार्वजनिक सुनुवाई हुने मिति, स्थान र समय	स्थान : आमा समूह भवन, खहरे, बन्दीपुर गाउँपालिका-६, तनहुँ	मितिः २०८०/०३/१४	समयः बिहान ११ बजे

Figure 27: Public notice calling for participation in the public hearing program

Pasting of the notice in the project area: To ensure widespread dissemination of the notice, a team of research assistants was assigned the responsibility of physically pasting the notice in prominent public locations within the project area. This involved placing notices on the notice boards of all project municipalities and ward offices. This approach aimed to enhance the visibility and accessibility of the information to the local community and stakeholders. By utilizing the service of research assistants, the project team sought to effectively reach a broader audience and raise awareness about the public hearing.

Besides public notice, the list of affected parcels to be acquired permanently and temporarily was also pasted on the boards of all project municipalities and ward offices.

Invitation letter of the public hearing: The project team tool great care in identifying and selecting key stakeholders for the EIA study, ensuring their participation in the public hearing. Invitation letters were meticulously prepared and delivered to each stakeholder. These letters provided a comprehensive project introduction along with detailed information about the public hearing's venue, time, and date. The following stakeholders were among those who received the invitation letter.

1. All Project Municipalities and ward offices.
2. Divisional Forest Offices of all project districts.
3. District coordination committee office
4. District Administration Offices of all project districts
5. All project affected Community Forest User Groups and Leasehold Forest User Groups
6. Shree Seti Ganga Basic School and Shree Janata Basic School
7. Local and national newspaper journalists.

Announcement of the public hearing by the local FM stations: To extend the reach of information, the project team employed local FM stations to broadcast the announcement of the public hearing. This strategic approach aimed to engage a wider audience within the project districts, 2 FM stations, namely - Damauli FM and Bharatpur FM, with coverage in the project area, were specifically chosen for this purpose. Leveraging the popularity and reach of these FM stations, the project team effectively disseminated the public hearing announcement to a broader population, including regular listeners who rely on these stations for news and entertainment.

Location, date and time of the public hearing

The public hearings were successfully conducted at the Khahare, Bandipur-6, ensuring coverage across all affected districts, as well as accessibility for the stakeholder to reach the venue. The dates and venues of the public hearing are presented below:

Venue: Khahare, Bandipur-6, Tanahun
Date: 14/03/2080 (29/06/2023)
Coverage/ number of participants:

Table 3. 9: Participants of the public hearing

SN	Municipality/ Ward	Male	Female	Total
1	Bandipur	34	14	48
2	Vyas	26	12	38
3	Devghat	32	7	39
4	Rhising	8	1	9
5	Anbu Khaireni	1	-	1
6	Other	8	-	8
7	THL	3	-	3
8	TMS	6	-	6
9	Unidentified	11	3	14
	Total Number of Participants			166

Table 3. 10: List of participants by Caste and Ethnicity

Cast	Male	Female	Total
B/Ct.	14	0	14
Gurung	52	15	67
Magar	41	15	56
Newar	3	1	4
Thakuri	4	0	4
Others	15	6	21
Total	129	37	166

Issues raised at the public hearing.
The issues raised during the public hearing are summarized below.

Table 3. 11: Issues raised during the public hearing.

SN	Area	Issue	Issues addressed section
1	Slope stability	Fluctuations in the reservoir's water level can increase the vulnerability of the slopes along its bank, posing a higher risk to the houses and cultivated lands adjoining the reservoir's boundary. To address this risk, it is important to include a buffer zone around the reservoir as part of the land acquisition process. This buffer zone will help mitigate potential impacts and	Section 8.2.3: Slope stabilization in the riparian areas of the reservoir

SN	Area	Issue	Issues addressed section
		provide additional protection to the surrounding areas. The tunnel construction can potentially cause damage to the houses along its alignment. Therefore, it is imperative to conduct a comprehensive study of the conditions of the houses/ other infrastructures to accurately determine the appropriate mitigation including compensations in case the structures are affected during the construction.	
2	Forest resources	The project will require the clearance of forest in certain sections where the project components shall be built. There are also forests that will be inundated by the creation of reservoir U/S of the dam. It is imperative that forest clearance activities should be coordinated with the respective CFUGs, LFUGs, DivFO and Sub-DivFOs, so that to ensure their participation, consent and endorsement. The trees and vegetation cleared from the project area will be allocated to the respective CFUGs. Chuiri-bhanjgyamg CF earns upto 10-12 lakhs annually from selling the fallen trees. Some of the area of this CF will be impacted by TSHPP Some of the area of Shree Kanyaraha Leashold forest, Beldanda Leasehold Forest and Chinepani Leasehold Forest will fall under the reservoir which will impact activities such as grazing activities and inundation of Sal, Khayar and other trees.	Section 8.3.1.1: Compensation for removl of trees and vegetation and lost forest area
3	Compensation for the loss of properties	The project must offer land-to-land or land-to-cash compensations to the owners of the titled-private land. Meanwhile, there are households	Section 8.4.1: Land acquisition adhering to the regulatory framework

SN	Area	Issue	Issues addressed section
		without formal land titles who have been utilizing the land for generations, and some HHs are in process of obtaining the titles. Adequate compensations, either in the form of land-to-land or land-to-cash, will be provided to these HHs as well. The project must provide adequate compensations for the forest and grazing land that would be lost to the project, which have been utilized by the locals. It is imperative to ensure that all the affected land parcels are meticulously included in the EIA report.	Section 8.4.5: Purchase of stranded or residual land plots Section 8.4.10: Compensation for Non-titleholders
5	Agriculture	The creation of reservoir will inundate agricultural lands. Construction of other permanent and temporary project components may require acquisition of fertile agricultural lands. Hence, agricultural compensation should be provided to the affected land owners. . The project should distribute hybrid seeds and livestock as a means of livelihood enhancement through agricultural compensation.	Section 8.4.13: Compensation for the loss of standing crop and agricultural productivity
6	Employment opportunity	The project should primarily employ people from the PAFs according to their qualifications and skills by the project during construction and operation period of the project. For this, the project should consult and coordinate the local key persons like ward chairperson, chairperson or nominated persons from the concerned stakeholders while selecting the workers for the project.	Section 8.4.20: Employment Opportunity
7	Ensure rights of the indigenous people	Should consult the local coordination committee (sarokar samite) before starting any works related to the project	Section 8.4.21: Ensuring Law and Order Section 8.4.23.1: Equal opportunity for men and women in the project

SN	Area	Issue	Issues addressed section
		The name of the project should be decided in consultation with local stakeholders The project must adhere to the guidelines outlines in the ILO 169, The EIA report must also comply with the ADB's SPS 2009.	 Section 4.5.6: ADB safeguard policy on resettlement
8	Cultural identity and issues	Nam Devi Temple, Jhakrithan Temple and Gorkha Kalika Temple will be inundated by the reservoir. Other cremation sites will also be impacted. The project should take great care in managing the relocation of these culturally important sites.	Section 8.5.1 Restoration of the Cultural and Religious Structures
9	Adequate participation	The project ought to employ a language specialist from the indigenous committee within the project area to facilitate the preparation of suggestions, recommendations, and EIA studies in their native language. Free Prior Informed Consent (FPIC) should be conducted in the EIA process. The project must adhere to the guidelines outlines in the ILO 169, The EIA report must also comply with the ADB's SPS 2009.	Section 4.5.6: ADB safeguard policy on resettlement
10	Non-titleholder issues	Provision of land-to-land compensation for the affected people who have been using the non-titled land for a long time for farming and herding purpose.	Section 8.4.10: Compensation for non-titleholders
11	Livelihood	• Alternative livelihood options should be provided to the affected HHs whose livelihood will be directly impacted by the project	Section 8.4.14: Social Assistance Program to the affected HHs

SN	Area	Issue	Issues addressed section
		• Rafting activities will be impacted in the dewatered section • Capacity building trainings should be provided to both men and women targeting the current market trends and demands.	
12	Loss of infrastructures and services	• Proper management of cremation sites • Ensure alternative site for sand and gravel extraction • Proper management of schools, bridges and other infrastructures that will be directly impacted by the project • Various stretches of Buddhasingh marga will be inundated by the reservoir. Responsibility for construction of new route should be clear and route should be finalized after consultation with local people. • Laxmi primary school and 5/6 HHs near this school can be impacted by the project activities	Section 8.4.6: Temporary Acquisition and Compensation for Land Section 8.4.7: Restoration of Temporary Acquired Sites Section 8.4.8: Compensation for the private structures Section 8.4.15: Relocation of the Janata Primary School Section 8.5.5.1: Rerouting of the Buddhasingh Marga
13	Others	• Activities that will have adverse impact on water, forest and land should not be implemented • Project should provide share of the project and royalty generated by the project • Should consult the local coordination committee (sarokar samite) before starting any works related to the project • The name of the project should be decided in consultation with local stakeholders • Impacts on spring water sources drying up during the	Section 8.3.2.1: Prevent pressure on the forests Section 8.3.1.1: Compensation for removal of trees and vegetation and lost forest area

SN	Area	Issue	Issues addressed section
		construction of tunnels should be studied. • The project should manage a motorable bridge connecting Byas-14 and Devghat-2 • The project will increase air pollution • The project construction activities will impact biodiversity of the area	Section 8.1.4: preserving springs during the tunnel construction Section 8.1.5: Mitigating air pollution in the construction sites

Public notice for recommendation letter along with suggestions

A public notice regarding the recommendation letter and suggestions, in accordance with Rule 7(2) of the EPR2077, was published in the Nepal Samacharpatra for 7 days. This approach aimed to ensure extensive dissemination of the information to the public. By adhering to these regulations, the project aimed to promote transparency and offer stakeholders an opportunity to review and provide feedback on the recommendation letter and suggestions.

तल्लो सेती (तनहुँ) जलविद्युत आयोजनाको वातावरणीय अध्ययन प्रतिवेदन तयारी सम्बन्धी सार्वजनिक सूचना

(प्रथम प्रकाशित मिति : २०८०/०३/२१)

गण्डकी प्रदेश, तनहुँ जिल्लाको बन्दीपुर गाउँपालिका, ब्यास नगरपालिका, देवघाट गाउँपालिका, ऋषिङ्ग गाउँपालिका, आँबुखैरेनी गाउँपालिका र चितवन जिल्लाको भरतपुर महानगरपालिकामा नेपाल विद्युत प्राधिकरणको पूर्ण स्वामीत्वको सहायक कम्पनी तनहुँ हाइड्रोपावर लिमिटेड प्रस्तावक रहेर निम्न बमोजिमको प्रस्ताव कार्यान्वयन गर्न लागिएको छ ।

प्रस्तावकको नाम र ठेगाना	**तनहुँ हाइड्रोपावर लिमिटेड** तल्लो सेती (तनहुँ) जलविद्युत आयोजना चुनदेवी मार्ग, महाराजगंज, काठमाण्डौ, नेपाल ई-मेल : info@thl.com.np, lowerseti@gmail.com फोन नं : ०१४७२००४९, ०१४७२०३३१
प्रस्तावको व्यहोरा	तनहुँ हाइड्रोपावर लिमिटेड द्वारा हाल निर्माणाधीन तनहुँ जलविद्युत आयोजनाको टेलरेसबाट १८ किलोमीटर तल्लो तटिय क्षेत्रमा रहेको बन्दीपुर गाउँपालिका वडा नं ६ तथा देवघाट गाउँपालिका वडा नं ३ मा अवस्थित साराङ्गघाट नजिक सेती नदिमा ३२ मि. अग्लो बाँध (Barrage) निर्माण गरी पानिको प्रवाहलाई फर्काई देवघाट गाउँपालिकाको वडा नं ३ र ४ हुदै जाने ६.८ किलोमिटर लामो सुरुङ्ग मार्ग (Headrace Tunnel) मार्फत त्रिशुली र सेती नदि संगम देखि करिब १.५ किलोमीटर तल्लो तटिय क्षेत्रमा पर्ने देवघाट गाउँपालिका वडा नं ४ मा त्रिशुली नदीको दाया किनारामा बन्ने अर्ध भूमिगत विद्युतगृहमा खसाली १२६ मेगावाट जडित क्षमता भएको तल्लो सेती जलविद्युत आयोजना बिकाश गर्ने परिकल्पना गरेको छ ।
प्रभाव पर्न सक्ने जिल्ला/न.पा./वडा	**जिल्ला** — **नगर/गाँउ पालिका, वडा** तनहुँ — बन्दीपुर गाउँपालिका: ६ ब्यास नगरपालिका: १३, १४ देवघाट गाउँपालिका: २, ३, ४ ऋषिङ्ग गाउँपालिका: १, ३ आँबुखैरेनी गाउँपालिका: ५, ६ चितवन — भरतपुर महानगरपालिका: २९

माथि उल्लेखित प्रस्तावको वातावारणीय अध्ययन प्रतिवेदन तयारी गर्ने क्रममा सो क्षेत्रको प्राकृतिक भौतिक प्रणाली, जैविक प्रणाली, सामाजिक प्रणाली, साँस्कृतिक प्रणाली र आर्थिक प्रणालीबीच के कस्तो प्रभाव पर्दछ भनी यकिन गर्न सो स्थानको महानगरपालिका/नगरपालिका/गाउँपालिका तथा त्यस क्षेत्रका बिद्यालय, अस्पताल, स्वास्थ्य चौकी तथा सरोकारवाला ब्यक्ति वा संस्थाको लिखित राय सुझाव लिन आवश्यक भएकोले यो सार्वजनिक सूचना प्रकाशन भएको मितिले सात दिनभित्र निम्न ठेगानामा आई पुग्ने गरी लिखित राय सुझाव उपलब्ध गराई दिनु हुन अनुरोध गरिन्छ ।

राय सुझावको लागि पत्राचार गर्ने ठेगाना

प्रस्तावकको नाम र ठेगाना	**तनहुँ हाइड्रोपावर लिमिटेड** तल्लो सेती (तनहुँ) जलविद्युत आयोजना चुनदेवी मार्ग, महाराजगंज, काठमाण्डौ, नेपाल ई-मेल: info@thl.com.np, lowerseti@gmail.com फोन नं: ०१४७२००४९, ०१४७२०३३१
परामर्शदाताका नाम र ठेगाना	Joint Venture of WAPCOS Limited & Nippon Koei Co.Ltd in association with Total Management Services Pvt.Ltd and GEOCE Consultants (P).Ltd, कमलपोखरी, काठमाडौं, नेपाल ई-मेल : lowersetihpp@gmail.com फोन नं : +९७७-०१-४४३५८२५

Figure 28: Public Notice for collecting recommendations

3.10.3 Recommendation Letters

As required by EIA, the project requested all the affected municipalities, and wards, Division Forest Offices, Community Forests, Leaseholds Forests, and other stakeholders to provide recommendation letters through an invitation request letter. The invitation request letter is attached in Annex E.

The recommendation letters are presented in Annex F.

4 Legislation requirements

Environmental and social policies and legislative provisions related to Hydropower Project are described in this chapter. The Hydropower Project might affect flora and fauna, agriculture production, physical and community infrastructures and facilities, socio-cultural lifestyle and traditions, socio-economic conditions, and livelihoods of people etc. in the project influenced area.

The Government of Nepal (GoN) has passed Sectoral National Policies, enacted Acts and Regulations, developed Guidelines and Manuals, and has signed International Agreements and Conventions related to use and management of social and biological resources. The GoN has set aside environmental requirements that might affect planning, construction, and operation of the hydropower projects. Besides, the multilateral and bilateral agencies financing the hydropower projects need to ensure that their environmental and social policies, guidelines, and directives are also integrated into the planning or implementation of the projects. Thus, these policies, acts and rules, guidelines, international conventions etc. that might be relevant to EIA study to this project have been reviewed by EIA team and described here.

4.1 The Constitution of Nepal

The Constitution of Nepal was promulgated by the Constitutional Assembly of the Federal Democratic Republic of Nepal in September 2015. This constitution has 35 parts, 308 articles and 9 schedules.

4.2 Plan and Policy

The key environmental policies of the GoN that have direct relevance to the project are listed below:

1. Policy on Land Acquisition, Resettlement and Rehabilitation for Infrastructure Development Projects, 2071
2. 16th Five Year Plan (2081/82-2085/86))
3. Hydropower Development Policy, 2058
4. Nepal Biodiversity Strategy and Action Plan, 2014-2020
5. Nepal Water Plan, 2062
6. Forest Policy 2075
7. National Water Strategy, 2059
8. Nepal Environmental Policy and Action Plan, 2050
9. National Conservation Strategy Nepal, 2045
10. Rastriya Urja Sankat Nibaran Tatha Bidhyut Bikas Karyayojana, 2072
11. Land Use Policy, 2075
12. National Environment Policy, 2076
13. Climate Change Policy, 2076

Key policy instruments of the GoN relevant to the Project are summarized below.

Table 4. 1: Policy instrument of GoN related to the project

SN	Name of Policy	Triggered Policy instruments
1	Policy on Land Acquisition, Resettlement and Rehabilitation for Infrastructure Development Projects, 2071	Recognizes the need of resettlement and rehabilitation plan to ensure the livelihood of the project affected persons or households at least above the pre-project conditions;
		Emphasizes that the project development agency conducted meaningful consultation with the project affected persons, community and sensitive groups particularly poor, landless, senior citizens, women, children, indigenous/*Janajati* groups, disabled, helpless and persons having no legal rights on the operated land while preparing land acquisition, resettlement and rehabilitation plan;
		Requires completion of compensation, resettlement, rehabilitation and other benefits to the project affected person/households prior to the physical and economical displacement by the project;
		Emphasizes land acquisition process as far as possible through negotiation with the project affected persons/households through transparent, free, fair and justifiable process;
		Requires land-based compensation and resettlement to persons/households who lose all of the property or whose livelihood is agriculture based;
		Requires relocation and resettlement of the affected persons/households close to the current place of residence until and otherwise he/she willingly prefers to relocate him/herself;
		Requires inclusive programs for the enhancement of socio-economic development of disadvantageous groups such as facility less groups (*Dalit*, Indigenous or *Janajati* groups, single women etc.);
		Requires compensation of built properties including resettlement and rehabilitation benefits for persons/households who do not have land or legal right for the currently operated land;
		Requires determination of compensation rates for affected land and property based on scientific methods such that the compensation rates are not less than the minimum market price; the affected persons/households for projects where return on investment is potential;

SN	Name of Policy	Triggered Policy instruments
		Requires provisioning of subsidized rates to the project affected persons/households for projects providing services;
		Requires the following additional project assistance on the top of the compensation and resettlement: - residential facilities - transportation assistance - relocation assistance for housing, business - rental assistance - Additional assistance as recommended by plan to seriously project affected households and vulnerable groups (*Dalit*, *Janajati* or marginalized Indigenous, single women, helpless, disabled, senior citizen etc.)
		Employment opportunity to the seriously project affected households and Vulnerable groups (Dalit, Janajati or marginalized Indigenous, single women, helpless, disabled, senior citizen etc.) based on their skills and capabilities.
		Requires livelihood restoration plan to seriously project affected households and Vulnerable groups (Dalit, Janajati or marginalized Indigenous, single women, helpless, disabled, senior citizen etc.);
		Requires an adequate mechanism to listen, register and resolve grievances of the project affected persons and communities;
		Requires an effective institution to ensure that the objectives of land acquisition, compensation, resettlement and rehabilitation action plans are achieved and to evaluate and monitor the effects on the livelihood of the project displaced persons;
		Requires project development agency to ensure the allocation of resources required for resettlement/rehabilitation and livelihood restoration of the project affected persons/households.
2	16th Five Year Plan (2081/82-2085/86))	The Sixteenth Plan to be implemented from the fiscal year 2081/82 plans to achieve an economic growth rate of 7.3 % and per capita income of 2,413 USD. This plan targets reducing absolute poverty to 20.3 %, consumer inflation to 5 % by fiscal year 2085/86 and take Nepal' human development index to 0.650 from the current 0.601, human wealth index from 76.3 to 78 and to reduce the economic and environmental risk index from 29.7 to 24. The plan aims to increase the average life expectancy of Nepalese to 73 years from the present 71.3 years within five years. The target is to achieve an economic growth rate of 7 to 8.5 %.

SN	Name of Policy	Triggered Policy instruments
3	Nepal Biodiversity Strategy, 2059 BS	Chapter 5, Section 5.1, sub-section 5.1.1 relates to landscape planning; sub-section 5.1.4 relates to in-situ conservation of habitat and species; sub-section 5.1.8 relates to cross sectoral co-ordination for bio-diversity conservation; subsection 5.1.13 relates to IEE/EIA of development projects to avoid significant impacts on bio-diversity and implement the provisions to minimize the impacts; Section 5.2, subsection 5.2.1 (5.2.1.2) relate to cross-sectoral co-ordination for Protected Area conservation.
4	Forest Policy, 2075	At present, Forest Policy, 2015 is the main policy document which guides sub-sectoral programmes relating to forests, plant resources, wildlife, biodiversity, medicinal plants, and soil and watershed conservation. Periodic assessment and updating of information on forest resources of the country is also included in the forest policy.
5	Nepal Water Plan, 2062 BS	Part D, Section 6 relates to environmental management, inclusive of impact identification, mitigation actions, monitoring, auditing and institutional mechanism. Section 7 of the NWP highlights the Environment Management Plan (EMP) as a strategic document for the implementation, monitoring and auditing of environmental protection programs. It emphasizes on the need of Strategic Environmental Assessment to streamline Nepal's development.
6	National Water Strategy, 2059	Section 4 relates to social development principles and environmental sustainability principles; Section 5, strategic output 2relates to sustainable management of watersheds and aquatic ecosystems; strategic output 5 relates to cost effective and sustainable hydropower development.
7	Nepal Biodiversity Strategy Implementation Plan, 2063	The action plans FO1 relates to Forest biodiversity conservation through community participation. PA1 relates to species conservation and habitat management in protected area and CS² relates to landscape level biodiversity conservation.
8	Nepal National Biodiversity Strategy and Action Plan 2014-2020	On this action plan chapter 3 relates to threats to biodiversity in Nepal, chapter 5 relates to strategy for management of biodiversity and chapter 6 relates to arrangement for implementation of the strategy.
9	Nepal Environmental Policy and Action Plan, 2050	The five policy principles aim - to manage efficiently and sustainably natural and physical resources; - to balance development efforts and environmental conservation for sustainable fulfillment of the basic needs of the people;

SN	Name of Policy	Triggered Policy instruments
		- to safeguard natural heritage; - to mitigate the adverse environmental impacts of the development projects and human actions; and - to integrate the environment and development through appropriate institutions, adequate legislation and economic incentives , and sufficient public resources.
10	National Conservation Strategy Nepal, 2045	The policy principles aim - to ensure the sustainable use of Nepal's land and renewable resources; - to preserve the biological diversity of Nepal in order to maintain and improve the variety and quality of crops and livestock and to maintain the variety of wild species both plant and animal and - to maintain the essential ecological and life-support systems such as soil regeneration, nutrient recycling and the protection and cleansing of water and air.
11	Rastriya Urja Sankat Nibaran Tatha Bidhyut Bikas Karyayojana, 2072	The Government of Nepal has prepared a plan to address the energy crisis the country has been facing. The plan has tried to address the following issues: a) Identification and implementation of immediate actions to end current energy crisis with in a year as the government has committed b) Securing sustainable energy generation in Nepal within a decade c) Prioritizing hydroelectric projects to address energy generation, at the same time adapting other alternative sources of energy such as – solar, wind, biomass, etc.
12	Land Use Policy, 2075	The policy is formulated to improve social and economic status by ensuring fair and adequate compensation, appropriate resettlement and rehabilitation assistances/allowances while acquiring land for infrastructure development projects. It aims to ensure the optimum use of land and portions of land, and aims to encourage optimal use of land for agriculture. The policy also talks of adopting the concept of aggregating parcels of land to acquire land for development projects.
13	National Environment Policy, 2076	Nepal Government has endorsed the National Environment Policy-2076 to control pollution, manage wastes and promote greenery so as to ensure citizens' right to live in a fair and healthy environment. The policy was framed to guide implementation of the environment related laws and other thematic laws, realize international commitment and enable collaboration between all concerned government agencies and non-government organizations on environmental management actions. This policy aims to lessen and prevent

SN	Name of Policy	Triggered Policy instruments
		all types of environment pollutions, manage wastes emanated from all sectors including home, industry and service, expand parks and greenery in urban area and ensure environment justice to the pollution affected population. In order to meet the policy goals and objectives, the policy has specified special measures, including setup of effective systems for checking and reducing pollution of all types, encouragement for the use of environment-friendly technology in industry, hospital and vehicles, regulation of harmful pesticides in production and protection of human health from unauthorized food intake. The ministry has envisaged devising environment-friendly technology to manage pollutant dust, smoke, water emanating from industries and other business promote the use of solar stove, electric stove, bio-gas, improved stove and chimney for the prevention of pollution at homes and lay emphasis on energy effective housing.
14	Climate Change Policy, 2076	It includes climate adaptation and disaster risk reduction; low carbon development and climate resilience; access to financial resources and utilization; capacity building, peoples' participation and empowerment; study, research, technology transfer, climate friendly natural resources management and institutional set up with legal provisions, and importance of monitoring and evaluation.
15	Hydropower Development Policy 2058	The Hydropower Development Policy, consisting of six sections, shall be developed to achieve the following objectives: to generate electricty at low cost by utilizing the water resources available in the country, to extend reliable and qualitative electric service throughout Nepal at a reasonable price, to tie-up electrification with the economic activities; to render support to the development of rural economy by extending the rural electrification, to develop hydropower as an exportable commodity.

4.3 Acts, Rules and Regulations

Acts, Rules and Regulations listed below have a direct relevance to the proposed project development and operations.

- Environment Protection Act, 2076
- Environment Protection Rules, 2077
- Electricity Act, 2049 and Electricity Regulations, 2050
- Soil and Watershed Conservation Act, 2039
- Forest Act, 2076
- Forest Regulation, 2079
- National Parks and Wildlife Conservation Act, 2029
- Wildlife Reserve Rules, 2034

- Water Resources Act, 2049
- Water Resources Regulations, 2050
- Land Acquisition Act, 2034
- Ancient Monument Protection Act, 1956
- Local Government Operation Act, 2074
- Labor Act, 2074
- Land Reform Act,1964
- Control of International Trading of Wild Fauna and Flora, 2073
- Solid Waste Management Rules, 2070
- Working Policy for Construction and Operation of Physical Infrastructure within Protected Area, 2080
- Performance based social security Act, 2074
- Muluki Aparadh Samita, 2074
- Muluki Debani Samita, 2074
- Aquatic Animal Protection Act, 2073
- National Foundation for Upliftment of *Aadibasi/Janjati* Act, 2058
- Land Use Act, 2076
- Right to Information Act, 2064

Table below highlights the important provisions of Act, Rules, and Regulations related to the Project.

Table 4. 2: Acts, rules and regulations related to the project

SN	Acts, Rules and Regulations	Related Provision
1	Environment Protection Act 2076	As per the Environment Protection Act (GON 2076) – Article 2 stipulated the need of preparation of an environmental study of a development or construction work or project relating to development, construction work or project pertaining to a matter falling under the jurisdiction of the Local Level. It further states the need of a public hearing and proposition of analysis of alternatives in the study. Article 3 prohibits the emission of pollutants beyond the prescribed standards along with the management of hazardous substances; Article 5 prescribes the need for the protection of national heritages and Environmental Protection Area; Article 6 stipulates the fines and compensations provisions arising from any harm to the environment.
2	Environment Protection Rule 2077	As per Environment Protection Regulations (GoN 2077) - Schedule 2 for the water resources and energy sector, an Initial Environmental Examination (IEE) is required for

SN	Acts, Rules and Regulations	Related Provision
		the construction and implementation of a transmission line and substation of more than 132 kV. Article 2 mandates IEE/EIA study for development projects; Article 3 prohibits emission of pollutants beyond the prescribed standards; Article 6 stipulate provisions for the protection of natural heritage and Environmental Protection Area; Article 7 stipulates compensation provisions arising from the discharge of waste and pollution;
3	Electricity Act (2049) and Electricity Regulations, 2050	Section 4, sub-section 1 of the Act requires any person or corporate body who wants to conduct survey, generate, transmit or distribute electricity over 1 MW to submit an application to the designated authority along with the economic, technical and environmental study report. The environmental study report refers to the IEE/EIA report as per EPA and EPR. The proponent will have to show in the IEE report that the proposed development project is not likely to cause soil erosion, flood, landslide and air pollution or any other forms of environmental degradation. Electricity Regulation, 1993 under Rule 12 (f) and 13 (g) related to EIA/ IEE, emphasizes the report should include measures to be taken to also elaborate utilization of local labour, source of materials, benefits to the local people after the completion of the project, training the local people in relation to construction, maintenance and operation, facilities required for construction site and safety arrangements. Rule 50 and Schedule-13 of the Rule, 2050 defines the minimum distance to be maintained on either side of the electric wire, which in fact defines the RoW for transmission and distribution lines and associated safety clearance corridors. Rule 66 is regarding restrictions on the utilization of buildings and land under power lines (transmission as well as distribution lines). Rule 68 to 74 are related to safety measures relating to electrical works. Rule 87 is related to compensation for the affected property and Rule 88 is related to the compensation fixation committee.
4	Soil and Watershed Conservation Act, 2039	Article 10 stipulates provisions to prohibit actions within any protected watershed area decelerated pursuant to Article 3 of this Act; Article 24 stipulates provision of no

SN	Acts, Rules and Regulations	Related Provision
		obstacle to use and developing of waters resources by the government of Nepal.
5	Forest Act 2076	The Forest Act, 2076 defines forest area as the grass land, grazing land; snow covered and uncovered barren cliff, road, pond, lake, wetland, river, flood plain and unregistered land except the land under private ownership and land managed by prevailing laws. According to Section 3 of this Act, no one can change the land use pattern, use the forest land and take the land on lease without the permission of Nepal Government. Section 42 of this Act empowers the government to permit the use of any part of the National Forest for the implementation of a plan or project of national priority without significantly affecting the environment, if there is no alternative except to use the forest area. According to Sub Section 2 of Section 42, the project has to compensate for the National forest land equivalent to the land occupied by the project. Instead the project can pay the cash amount for the land used by the project (Sub Section 5 of Section 42). According to Sub Section 6 of Section 42 of this Act, the project proponent itself will be responsible to plant the saplings, take care and protect the planted tree for five years with the coordination with the concerned forest office.
6	Forest Regulation, 2079	Following sub-rules 4 ka, 4 kha and 4 ga has been added under sub-rule 4 under the rights of Section 72 of Forest Policy 2049. Sub rule 4 (ka) allows private forest owners to sell timber and firewood of various tree species listed in Annex 26 of private forest without any permission from the government. Similarly, sub rule 4 (kha) states unregistered Private forest owners can import or export herbs that are listed in annex-27 of private forest. Likewise sub rule 4 (ga) stresses about the verification of the imported or exported NTFPs, medicinal herbs, or timber; firewood from private forest through respective Ilaka Forest office.
7	National Parks and Wildlife Conservation Act, 2029	Article 5 stipulates provisions of restriction on damage to forest product and to block, divert any river or stream flowing through national park or reserve, or any other source of water, or use any harmful or explosive materials without obtaining a written permission; Article 9 lists the protected wildlife prohibited for hunting; Article 13 prohibits collection of samples from National parks and Reserves without obtaining license.

SN	Acts, Rules and Regulations	Related Provision
8	Wildlife Reserve Rules 2034	Rule 4 stipulates provision of entry pass to enter into the Parks or Reserve; Rule 6 stipulates restricted activities within the Parks and Reserves; Rule 11 stipulates prior approval for any research activities or study within the parks or reserves.
9	Water Resources Act 2049	Article 3 stipulates the water resource right to the Government; Article 4 prohibits use of water resources without obtaining license except the specified uses under the Act; Article 7 establishes the priority order on the utilization of water resource; Article 8 stipulates procedure for water resource licensing; Article 16 empowers Government to utilize the water resources and acquisition of others land and property for the development of water resource as stipulated in the Act; Article 18 stipulates the right of the Government to fix the quality standards of water; Article 19 prohibits pollution of water resource above prescribed pollution tolerance limits Article 20 stipulates not to cause harm and adverse effect on environment while developing the water resource project.
10	Water Resources Regulations 2050	Rule 12 to 21 stipulate provisions and procedures of licensing for the water resource utilization; Rule 32 to 35 stipulate provisions, procedures and responsibilities for the acquisition of land and property for the development of water resources.
11	Land Acquisition Act 2034	Article 3 stipulates power to the Government to acquire any land anywhere for public purpose subject to compensation under this Act; Rule 4 empowers Government to acquire land upon request by institutions subject to the payment of compensation and all other expenses under this Act; Rule 5, 6, 7 and 8 stipulate provisions and procedures for initiating initial land acquisition process and estimating compensation rates; Rule 9 and 8 stipulate procedures and provisions for notification to land acquisition; Rule 11 stipulates provision of right to file complain by the affected on the public notice with regard to the land right; Rule 13, 14, 15 stipulate procedures and provisions of compensation fixation; Rule 16 and 17 stipulate criteria for compensation fixation; Rule 19 stipulates disclosure of the compensation entitlement through public notification; Rule 25 stipulates provision of complain against the compensation rates to the Ministry of Home affairs. The decision of the Ministry of Home affairs on the complaint is final.

SN	Acts, Rules and Regulations	Related Provision
12	Solid Waste Management Rules, 2070	The Government of Nepal has issued various Rules by exercising the power conferred by section 50 of the Solid Waste Management Act, 2068. Article 3 stresses on segregation and management of solid waste. It states; (1) The Local Body shall, while fixing segregation at least of organic and non-organic solid waste at its source under Section 6, have to make management and segregation of harmful or chemical waste separately. If it is prescribed as above, the individual, organization or agency generating such solid waste, shall have to make segregation as prescribed. (2) The responsibility of managing the chemical or harmful solid waste under Sub-Rule (1) shall be of the concerned generator. (3) The Local Body shall conduct programs for increasing people's awareness in relation to applying appropriate technology for making segregation through reduction of generation of solid waste at its source and management under Sub-Rule (1). Similarly, Article 5 (1) states that no one shall discharge solid waste by mixing harmful, chemical, organic or inorganic waste with other waste.
13	Ancient Monument Protection Act 1956	Section 2 defines the ancient monuments; Section 3 and 17 empower the Government to declare any place or area as monument site/area; Section 13 restricts transfer, transaction export or collection of ancient monument and archaeological object or curio without prior approval of the Government.
14	Local Government Operation Act 2074	This Local Government Operation Act 2017 was introduced to accommodate Nepal's federal structure by defining the roles, responsibilities and authorities of the local governments as the previous Local Self Governance Act 1999 became obsolete after promulgation of Constitution of Nepal 2015. It was formulated in accordance with the spirit of Constitution of Nepal, grants the local level units legislative, executive and judicial rights. The local legislature has the power to formulate local laws in line with the Act drafts provided by the Centre, while the local judiciary can decide cases related to irrigation, daily wages and pastures, among others. The smallest units among three tiers of the government can set up their own city police force, issue land ownership certificates and collect revenue on property, besides registering births, deaths and marriages. They are also allowed to levy the taxes on house rent, entertainment,

SN	Acts, Rules and Regulations	Related Provision
		property, tourism, among others, in compliance with the tax laws of the Central and Provincial governments.
15	Labor Act 2074	The Labour Act, 2074 has received the assent of president and become effective from the date Bhadra 19, 2074. The Labour Act, 2074 has replaced the previous labor law completely i.e. Labor Act 2048 has ceased to be in effect. The New Labour Act has been passed for provisions for the rights, interest, facilities and safety of workers and employees working in enterprises of various sectors. Unlike previous provision, the new Act is applicable to all entities regardless of number of workers/employees.
16	Land Reform Act 1964	Section 7 relates to land ceiling and rights of tenant; Section 12 relates to exemption from upper ceiling; Section 25, 26, and 29 relates to tenancy right; Section 51 relates to land use, control of land fragmentation and plotting.
17	Control of International Trade of Endangered Wild Fauna and Flora 2073	This act has been enforced to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
19	Working Policy for Construction and Operation of Physical Infrastructure within Protected Area, 2080	This policy describes the terms and conditions required for implementing projects inside the National Park, Wildlife Reserves and Conservation Areas. This policy states that no land will be made available for construction of any development work except of national priority within the protected area. It further states that for a hydropower project utilizing the water flowing inside the National Park or along the boundary of the National Park, all the hydropower components should be constructed outside the National Park, and a minimum of 10% of the monthly discharge as well as the discharge quantified by the EIA report should be released. Implementation of mitigation measures, allocation of royalty for the protection of the National Park, payment for the use of natural resources and monitoring are some of the conditions mentioned in this policy. Similarly, for any water diversion project within the National Park or Wildlife Reserves, a minimum of 50% of the monthly discharge should be released. This policy has made the provision of 17 compensatory plantation of 25 seedlings for every tree or pole loss from the protected areas.

SN	Acts, Rules and Regulations	Related Provision
20	Performance Based Social-Security Act 2074	It ensures the social security rights of workers based on their contribution. It requires that the listed employer should deposit funds regularly as per their contract or deposit additional amount to the workers' contributable income as mentioned in Article 7. According to sub-section 1, the amount should be deposited from the day the worker is listed to the last day of his/her employment. If a situation arises where the labor does not receive remuneration and cannot deposit the amount to be deposited by him/her then the listed employer should deposit the funds for a maximum of 3 months. The listed employer can deposit the amount by deducting from the laborer's remuneration, allowance or other facility as prescribed. If the employer does not deposit the fund within the cited period, then s/he will have to pay an interest of 10% of contribution amount in addition to the contribution amount.
21	Muluki Aparadh Samhita, (2074	The Criminal Code was adopted in 2017 alongside five other Acts, designed to replace the Civil Code, 2021. It outlaws the practice of Chhaupadi as was the evangelization of citizens to other religions.
22	Muluki Debani Samhita, 2074	This act came into action from 1st Bhadra, 2075. Clause 617 states that the tenure of lease contract lasts for forty years for the construction, development and operation of infrastructure like electricity generation. Clause 640 states about the age of the person engaging in the manual work. It states that a person under 16 years should not be forced to engage in physically challenging work. Clause 641 states that workers should not be liable to work more than 8 hours a day and 48 hours a week without extra time payments.
23	Aquatic Animal Protection Act 2073	Section 5 (5B) - provisions of fish ladder and fish hatchery while constructing water diversion structures and requirement of prior permission from the government.
24	National Foundation for Upliftment of *Aadibasi/Janjati* Act, 2058	The Act prescribes a number of provisions to overall improve the lot of the *Aadibasi* / *Janjati* by formulating and implementing programs relating to the social, educational, economic and cultural development through: Creating an environment for social inclusion of disadvantaged and indigenous people ensuring participation of disadvantaged groups in the mainstream

SN	Acts, Rules and Regulations	Related Provision
		of overall national development of the country, by designing and implementing special programs for disadvantaged groups; Protecting and preserving their culture, language and knowledge and promoting the traditional knowledge, skills, technology and special knowledge of the *Aadibasi / Janjati* and providing assistance in its vocational use.
25	Land Use Act 2076	According to Section 2, 6 (1) before the formation of land use plan, the Nepal government, provincial government and local government must study the increase in demand of the land for wildlife, population growth rate, necessity of food and shelter, economic development and infrastructure construction. According to Section 3, 8 (1) Article 4 states the land use cannot be changed by using the land that has been classified for another purpose. According to Section 3, 8 (7) irrespective of the fact whatever is written in sub article 1, Nepal government can change the current land use of the places where national priority development projects, industrial area, special economic area, etc. are to be established
26	Right to Information Act 2064	The aim of this act is to make the functions of the state open and transparent in accordance with the democratic system and to make it responsible and accountable to the citizens. It intends to make the access of citizens to the information of public importance held in public bodies simple and easy and to protect sensitive information that could have an adverse impact on the interest of the nation and citizens. Clause 3 of the act ensures the Right to Information. It says that every citizen shall, subject to this Act, have the right to information and they shall have access to the information held in the public Bodies unless confidentiality has been maintained by laws. Clause 4 of the act describes the Responsibility of a Public Body to disseminate information. It mentions that each Public Body has to respect and protect the right to information of citizens. Public Bodies shall have the following responsibilities for the purpose of protecting the right to information of citizens: - to classify and update information and make them public, publish and broadcast to make the citizens' access to information simple and easy; to conduct its functions openly and transparently;0020to provide appropriate training and orientation to its staffs.

SN	Acts, Rules and Regulations	Related Provision
		Public bodies may use different national languages and mass media while publishing, broadcasting or making information public. A Public Body shall arrange for an Information Officer for the purpose of disseminating information held in its office. The clause 7 of the act prescribes the Procedures of Acquiring Information. It states that a Nepali Citizen, who is interested to obtain any information under this Act, shall submit an application before a concerned Information Officer by stating the reason to receive such information.

4.4 Government of Nepal's Guidelines, Manuals, and Standards

The EIA team, during preparation of the environmental reports including study procedures, impact identification and prediction, design of the mitigation prescriptions, formulation and monitoring of protocols and compliance standards during project construction and operation, will comply with the following Guidelines, Manuals and Standards of the GoN.

- National EIA Guidelines (2049)
- Department of Electricity Development Manuals (2058)
- Forest Produces Collection, Sale and Distribution Guidelines (2057)
- EIA Guidelines for Forestry Sector, (2051)
- Community Forest Guidelines, (2058)
- Guidelines for Community Forest Inventory (2061)
- Guidelines for Using Forest Area for National Priority Projects (2074)
- Environmental Management Guidelines (Road) (2056)
- Guidelines for the Physical Infrastructure Development and Operation in the Protected Areas (2065)
- Nepal Vehicle Mass Emission Standard (2069)
- Tolerance Limits for Industrial Effluents to be discharged into Inland Surface Waters, (2059)
- Nepal Ambient Air Quality Standards, 2069
- Nepal Noise Standards, 2069

A brief highlight of the above sectoral and cross-sectoral Guidelines, Manuals and Standards are presented in Table below:

Table 4. 3: Guidelines, manuals and standards related to the project

SN	Guidelines, Manuals and Standards	Related Matters
1	National EIA Guidelines, 2049	An EIA is to be prepared for the development projects which may cause significant impact on the environment, whose impact may be known easily and for which mitigation measures may be discovered easily. An EIA must provide for a definite solution to the identified environmental problem likely to appear by the implementation of the project. For the preparation of the report, an EIA should provide for a list of various activities in the course of project implementation and the natural resources which will be affected by the project.
2	Department of Electricity Development Manuals, 2058	The Department of Electricity Development, GoN, in collaboration with the United States Agency for International Development and International Resource Group has developed a series of manuals for the conduction and preparation of EIA and IEE documents in the power and transmission line development sector. They are respectively: Manual for Preparing Scoping Document for Environmental Impact Assessment (EIA) of Hydropower Projects, (2001); Manual for Public Involvement in the Environmental Impact Assessment (EIA) Process of Hydropower Projects,(2001); Manual for Preparing Terms of References (ToR) for Environmental Impact Assessment (EIA) of Hydropower Projects, with Notes on EIA Report Preparation, (2001); Manual for Preparing Environmental Management Plan (EMP) for Hydropower Projects, (2002); Manual for Developing and Reviewing Water Quality Monitoring Plans and Results for Hydropower Projects, (2002); Manual for Conducting Public Hearings in the Environmental Impact Assessment Process for Hydropower Projects, (2004); Manual for Addressing Gender Issues in Environmental impact Assessment/Initial Environmental examination for Hydropower Projects, (2005).
3	Forest Produces Collection, Sale and Distribution Guidelines, 2057	These guidelines specify various procedures and formats for getting approval for vegetation clearance, delineation of lands for vegetation clearance, evaluation of wood volume etc.

SN	Guidelines, Manuals and Standards	Related Matters
4	EIA Guidelines for Forestry Sector, 2051	These guidelines specify the EIA/IEE procedures to be followed while undertaking environmental studies that involve forest areas.
5	Community Forest Guidelines, 2058	These guidelines set process and procedures to identify and capacitate the community forest user groups, preparation of the community forest management plan and implementation of community forest management plan.
6	Guidelines for Community Forest Inventory, 2061	Community Forest Inventory Guidelines detail process and procedures for evaluating the forest stock and its harvesting potentials in the community forest.
7	Environmental Management Guidelines (Road), 2056	These guidelines for roads focus on the major issues for environmental management while developing or upgrading a road corridor. They set procedures for environmental assessment and highlight the potential impacts and mitigation measures for the road.
8	Guidelines for Using Forest Area for National Priority Projects, 2074	These guidelines clarify the procedure for acquiring forest area for national priority projects related to feasibility study, requirements, demand for using the forest area for the aforesaid purposes, *etc*.
9	Guidelines for the Physical Infrastructure Development and Operation in the Protected Areas, 2065	These are guidelines for infrastructural development in the protected areas.
11	Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters (2059 BS)	The MoFE has set tolerance limits for the industrial to be discharged into the inland surface water since the project is considered as an industry; it will have to comply with the tolerance limits set in the standards prior to the discharge of the effluents into the inland surface water during the construction and operation period.
12	Nepal Ambient Air Quality Standards (2069 BS)	The national Ambient Air Quality Standard 2012 has set standards for nine parameters, namely total suspended particles (TSP), particulate matter (PM10), Sulphur dioxide, nitrogen oxide, carbon monoxide, lead and benzene, PM 2.5 and ozone for maintenance of the ambient air quality. The project during its construction and operation will have to comply with the set standards for the ambient air quality.
13	Nepal Noise Standards (2069 BS)	The National Noise Standards 2012 gives noise level standards for the following areas: industrial, commercial, rural residential, urban residential and mixed residential and quiet areas. It further gives standards for noise generating equipment, namely water pump, diesel generator and entertainment equipment.

4.5 ADBs Safeguard Policy and Categorization

Specific to environmental aspects, the objective of the ADB's Safeguard Policy Statement (2009) is to "ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process."

ADB's Safeguard Policy Statement (2009) defines the requirements to be followed with regards to project screening and classification, information disclosure, consultation and participation, due diligence, monitoring and reporting, local grievance redress mechanisms and ADB's Accountability Mechanism.

4.5.1 Project screening and classification

ADB's Safeguard Policy Statement (2009) requires screening as early as possible to

- determine the significance of adverse impacts
- identify the level of assessment and institutional resources required;
- determine disclosure requirements.

A project's category is determined by its most environmentally sensitive component, including direct, indirect and cumulative impacts in the project's area of influence. Each project is scrutinized as to its type, location, scale, sensitivity and the magnitude of its potential environmental impacts. Projects are then assigned to one of the following three categories:

Category A: A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.

Category B: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required.

Category C: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

4.5.2 Category of the project

The project has been evaluated considering the outcome of the environmental assessment. The magnitude of potential impacts and the presence of environmentally sensitive areas in the project influence areas of all project components have been critically analyzed to determine likely significance. The potential environmental impacts are all well understood and can be mitigated through adherence to national requirements and international measures and standards. Considering this under ADB's Safeguard Policy Statement (2009), the project is classified as category A on environment requiring the preparation of an EIA.

4.5.3 Information disclosure

ADB's Safeguard Policy Statement (2009) requires information about environmental safeguard issues to be made available in a timely manner, in an accessible place, and in a form and language(s) understandable to affected people and to other stakeholders, including the general public, so they can provide meaningful inputs into project design and implementation. For illiterate people, suitable communication methods will be used. During project implementation THL will need to submit the following for posting on ADB's website:

- final and updated EIA and corrective action plans upon receipt by ADB
- environment monitoring reports submitted by THL during project implementation upon receipt by ADB.

4.5.4 Consultation and Participation

ADB's Safeguard Policy Statement (2009) requires communities, groups, or people affected by proposed projects, and civil society to be engaged by THL through information disclosure, consultation, and informed participation in a manner commensurate with the risks to and impacts on affected communities. Meaningful consultation processes are defined as those that

- beginning early in the project preparation stage and being carried out on an ongoing basis throughout the project cycle;
- providing timely disclosure of relevant and adequate information that is accessible to affected people;
- being free of intimidation and coercion.
- being gender inclusive and responsive; and
- enabling the incorporation of all relevant views of affected people and other stakeholders in decision making.
- The consultation process and its results are to be documented and reflected in the EIA report.

4.5.5 Monitoring and reporting

ADB's Safeguard Policy Statement (2009) requires that THL implement the safeguard measures and relevant safeguard plans, as provided in the legal agreements, and submit periodic monitoring reports on their implementation performance. Given the Project is category A for environment, THL is required to;

- establish and maintain procedures to monitor the progress of implementation of safeguard plan
- verify the compliance with safeguard measures and their progress toward intended outcomes;
- document and disclose monitoring results and identify necessary corrective and preventive actions in the periodic monitoring reports;
- follow up on these actions to ensure progress toward the desired outcomes; and
- submit periodic monitoring reports on safeguard measures as agreed with ADB, in this case given environmental sensitivities semi-annual safeguards monitoring reports are required to be submitted up until the completion of construction and throughout the operation period until project closure.

In addition to recording information to track environmental performance, THL will need to undertake inspections to verify compliance with the EMP and progress toward the expected outcomes.

Environmental monitoring reports should describe progress with implementation of the EMP and compliance issues and corrective actions, if any, and the findings disclosed locally in a location accessible to the public. ADB will also monitor projects on an ongoing basis until a project completion report is issued.

4.5.6 ADB safeguard policy on resettlement

ADB Safeguard Policy Statement, 2009 (SPS) sets out the policy objectives, scope and triggers, and principles for three key safeguard areas i.e. (i) Environmental Safeguards, (ii) Involuntary Resettlement Safeguards, and(iii) Indigenous Peoples Safeguards. The objectives of Involuntary Resettlement Safeguards are to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups. Similarly, the objectives of Indigenous Peoples Safeguards is to design and implement projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the Indigenous Peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

Regarding Involuntary Resettlement Safeguards, the SPS covers both physical displacement i.e. relocation, loss of residential land, or loss of shelter and economic displacement i.e. Loss of land, assets, access to assets, loss of income source or means of livelihoods due to involuntary land acquisition, land use restriction and access to legally designated parks and protected areas. It covers all the displaced people without considering such losses or involuntary restrictions are partial or full and permanent or temporary. As per the SPS, all the ADB assisted projects should recognize and address the resettlement and rehabilitation (R & R) impacts on all the physically or economical displaced people irrespective of their titles and requires for the preparation of an appropriate Resettlement Plan (RP) in the case where involuntary resettlement unavoidable.

ADB's SPS is the guiding principle to identify impacts and to plan measures for mitigating various losses likely to occur due to resettlement impacts. Some of the key provisions of the SPS on Involuntary Resettlement Safeguards are:

- Where Involuntary Resettlement (IR) is unavoidable, the impact should be minimized by exploring project and design alternatives,
- Enhance or at least restore the livelihoods of all displaced persons in real terms relative to pre-project levels,
- Improve the standards of living of the poor and other groups,
- Gender analysis is required to identify related resettlement impacts and risks,
- Resettlement Plans (RP) should be prepared in full consultation with Affected Persons (APs), host communities, and stakeholders,

- Preference will be given to land-based resettlement for displaced persons whose livelihoods are land-based. However, if the land is not the preferred option or the land is not available at reasonable price, the APs will be provided opportunities for employment, or self-employment in the project works, in addition to the reasonable cash compensation for land and other assets lost,
- Cash compensations for the loss of structures, other assets and incomes should be based on full replacement cost,
- Absence of formal legal title to land or non-recognized or recognizable claims to such land by the Displaced Persons (DPs) should not be a bar to compensation,
- The rate of compensation for land, structures and other assets should be calculated at full replacement cost based on fair market value; transaction cost; interest accrued; transitional and restoration cost, and other applicable payments, if any,
- All compensation payments and related activities must be completed prior to the commencement of the civil work, and
- Special attention should be paid to the needs of indigenous people, vulnerable groups especially those below the poverty line, the landless, the elderly, women, and children and those without legal title of land.

4.6 International Conventions

International Conventions applicable to the Project are:

- Convention on Biological Diversity 1992 (2049 BS)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973 (2029 BS)
- Convention (No.169) Concerning Indigenous and Tribal Peoples in Independent Countries 1989 (2046 BS
- United Nations Framework Convention on Climate Change 1992 (2049 BS)

The key provisions of the International Conventions related to the Project are briefly highlighted below in Table below.

Table 4. 4: Key provision of the international convention

SN	International Conventions	Related provisions
1	Convention on Biological Diversity, 1992 (2049 BS)	Power projects that may be planned for lands that are designated as UN Biosphere Reserves, National parks, nature reserves or conservation areas fall under UN Charter. Besides, the convention also emphasizes on the conservation of biodiversity in any other sites while implementing and operating a project in compliance with the National IEE/EIA procedures. Article 14 of the Convention introduces appropriate procedures required for EIA/IEE studies.

SN	International Conventions	Related provisions
2	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973 (2029 BS)	The Convention classifies species according to the criteria where access and control is important (e.g. I – species threatened with extinction; II – species which could become engendered; III – species that are protected; E – Engendered; V – Vulnerable; R – Rare. Project will have to minimize impacts on the CITES species as far as possible.
3	Convention (No.169) Concerning Indigenous and Tribal Peoples in Independent Countries 1989 (2046 BS)	Article 7 relates to the right of the indigenous and tribal people to decide their own priorities for the process of development. Article 12, 13, 14 and 15 relate to the safeguards of rights of the indigenous people in the land and natural resources in territories traditionally occupied by them. Article 16 relates to participation in the decision making process and resettlement process with full compensation of the resulting loss or injury.
4	United Nations Framework Convention on Climate Change 1992 (2047 BS)	Article 4 (f) relates to impact assessment to avoid or mitigate or adapt to climate change.

5 Existing environmental condition

5.1.1 Physical environment

5.1.2 Landscape, terrain, and geology

The project area is situated in Middle Mountainous Zone, which is characterized by a series of mountains and valleys. The primary mountain ranges have a general orientation of west-north-west to east-south-east, while the Seti River Valley runs due west-north-west to east-south-east before turning southwards to joint the Trishuli River.

In terms of topography, the project area has an elevation range of 194 to 2069 m asl. The highest point is located at the tip of the reservoir, which is located at an elevation of 316 m asl. A small settlement named – Hattisodhe – is located at an immediate upstream of this point on the left bank of the Seti River. The proposed location for the barrage, at the immediate upstream of the settlement of Sarag Ghat, has an elevation of around 260 m asl. The suugested site for the powerhouse, situated at Gai Ghat, has an elevation of 210 m asl, which is located on the right bank of the Trishuli River. The head gained between the FSL and Powerhouse is 80 m.

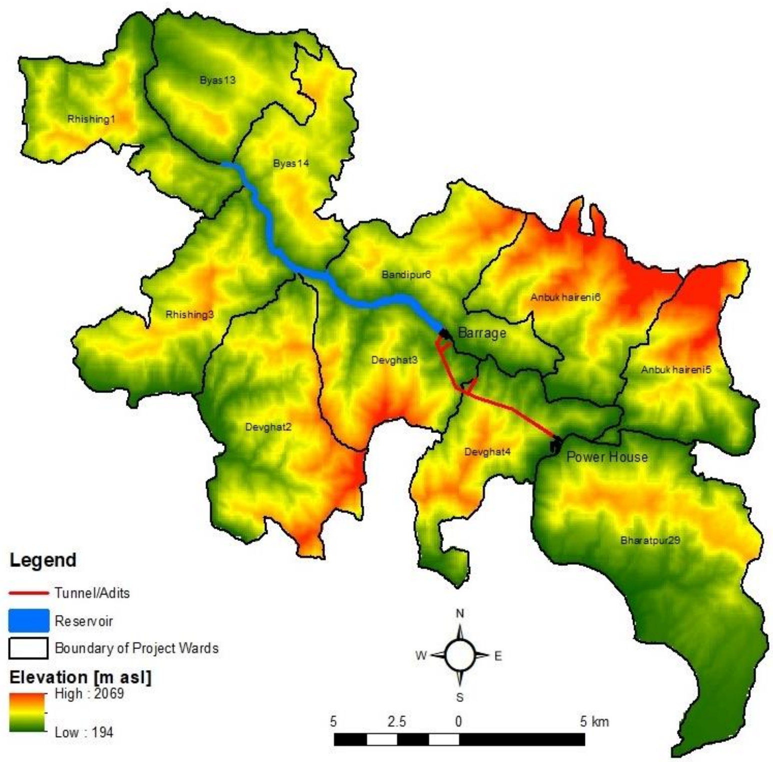


Figure 29: Distribution of elevation in the project municipality – wards (Source-Survey Department, 1990)

The project area is situated in the Lesser Himalaya zone, which is marked by immature topography of young, folded mountain belts, prevalent erosion, transportation, and deposition processes, massive mass wasting, and evolving gullies that widen and deepen over time. Consequently, the region is known for both slow and rapid landform development, including upliftment and deepening of terrain and valleys, which can be challenging to discern at times.

The primary geomorphological characteristics of the area, including the project sites, consist of fluvial, hillslope, and tectonic processes. Although glacial and aeolian processes could have been active in the past, they are no longer present. Two distinct geomorphic processes can be identified in the area: one that occurs over a short period and can be observed, such as the development of channel bars and terraces, and another that occurs continuously over a long period, such as the gradual upliftment and deepening of valleys, which can only be perceived over time.

The topography of the project area consists mainly of valleys and mountains. The Seti River has carved deep "V" shaped gorges that are occasionally bordered by alluvial terraces at two to three levels. The valley floor has steep slopes that rise to the flanking mountains, which have gently sloped middle slopes and relatively steep upper slopes near the ridge axis. The alluvial terraces at the valley bottom and the gentler middle mountain slopes are mainly used for agriculture and human settlements.

Upstream of the dam site, the river valley at the confluence of the Seti River with the Madi River is wide. However, downstream of the confluence, the Seti River flows through a deep gorge until it meets with the Trishuli River. Sediments are mobilized and transported by the Seti River in the form of bed load, suspended load, or dissolved load. The sediment deposits are visible along the channel bed, in the form of channel bars, point bars, and various terraces at different levels. Additionally, other features were also observed such as meandering river, erosional and depositional banks.

5.1.3 Geology of the project area

The project area is situated in the Lesser Himalayas, which is of Proterozoic age. The exposed litho units in the region are classified under Nuwakot complex, which is divided into the Upper Nuwakot Group and Lower Nuwakot Group, according to (Stocklin & Bhattarai, 1977) (Stocklin & Bhattarai, 1977). The Dhading Dolomite Formation and Benighat Slate Formation are further subdivision of thes groups, of which project area contains well exposed slate/phyllite. The project area is located within a regional syncline that trends from east to west and moderately plunges towards the north.

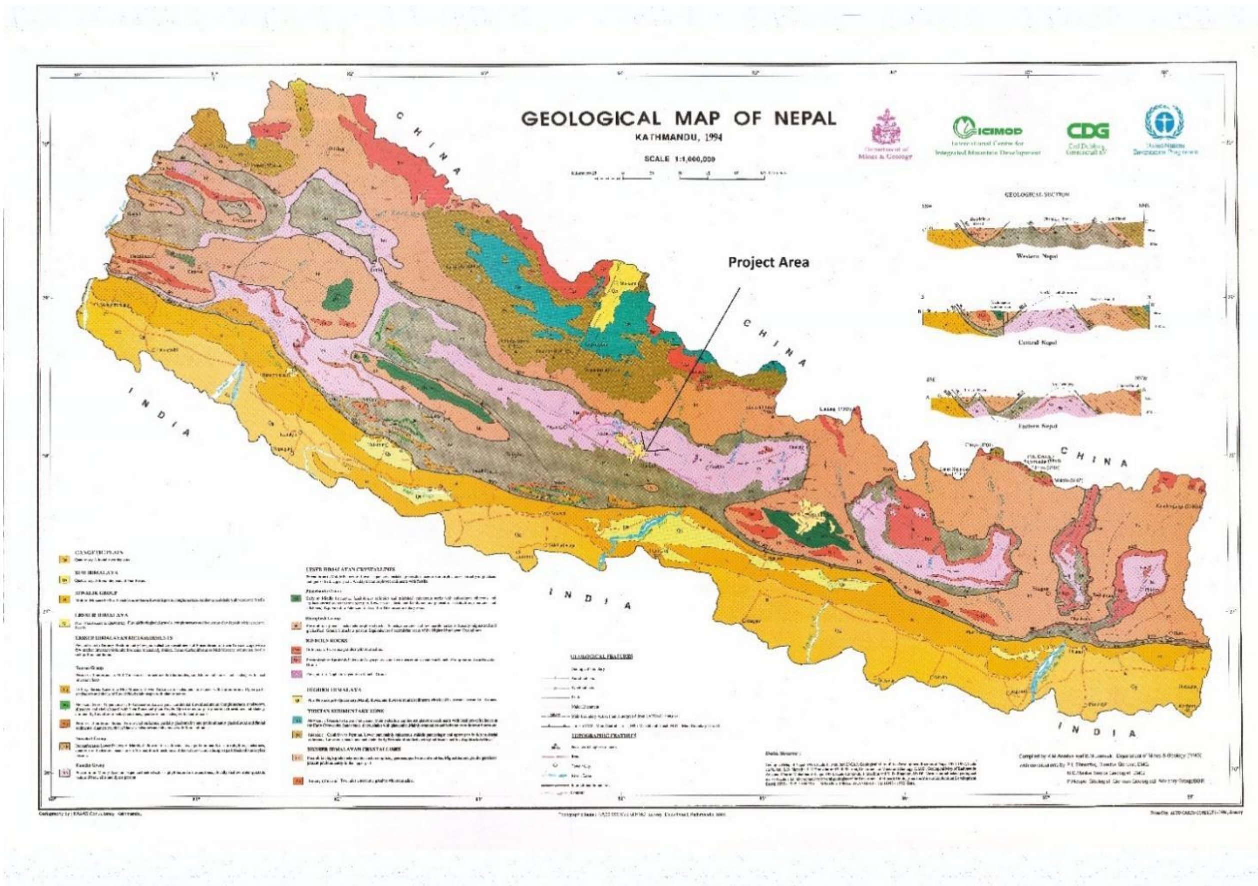


Figure 30: Location of project area in Geological Map of Nepal (Source: DMG, 1994)

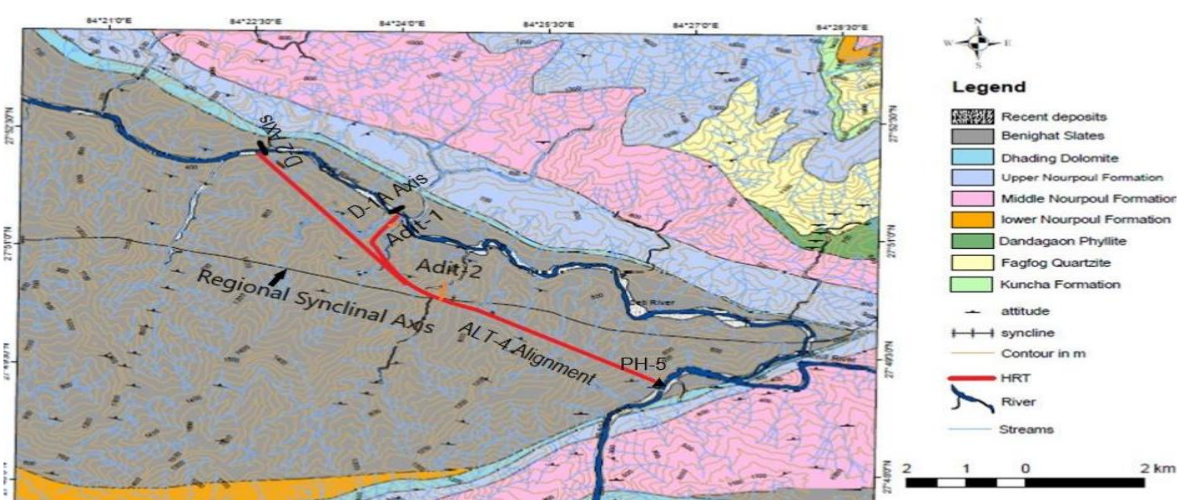


Figure 31: Regional geology of the project area (DMG, GON)

The geology of the project area consists mainly of sedimentary rocks such as slate, phyllite, quartzite, quarzitic phyllite, and calcareous phyllite. The predominant rock types found in the diversion structure site, headrace tunnel, powerhouse, and tailrace tunnel areas are slates interbedded with quartzite. The rock tern generally runs north to south with a dip range of 40 to 70 degrees.

Upstream of the dam site, a wide valley is formed by the confluence of the Madi River with the Seti River, while a deep gorge is present downstream until the Seti River meets the Trishuli River. Point bar deposits, which are wide, are developed on both banks at the concave side of the gentle meanders, both upstream and downstream of the proposed barrage. The riverbanks, along the Seti and Trishuli Rivers, are composed mainly of phyllite with bands of carbonaceous phyllites. On the left bank of the Seti River, the phyllite forms a relatively steep cliff covered by landslide debris and colluvium, while on the right bank, the slopes are generally covered by colluvial deposits and alluvial terraces. The river shows distinct erosional cut banks and depositional banks within the project area. Locals cultivate alluvial terraces and colluvium cones or fans. The hilly slopes have colluvial deposits or old slide debris. However, along the Trishuli River, steep slopes are present on both banks.

5.1.4 Major Geological Structures around the project area

The project area lies between two tectonic boundaries, namely the Main Central Thrust (MCT) to the north and the Main Boundary Thrust (MBT) to the south. The rock formations in this area have undergone multiple tectonic events, including faulting, thrusting, and folding, resulting in the development of several lineaments within the rock mass. Here are some brief descriptions of the major tectonic elements in the project area.

- The Main Boundary Thrust (MBT), which separates the Lesser Himalaya from the Siwalik, is a low angle reverse fault known as a thrust that indicts compressive shortening of the crust. It is located approximately 4 km south of the proposed powerhouse at Gai Ghat and around 10 km from the barrage site. Due to the continued shear movement along the thrust, the rock mass associated with MBT is generally of poor to fair quality.
- The Main Central Thrust (MCT) is responsible for geological separation of rocks between the Lesser Himalaya and the Central Crystalline of the Higher Himalaya. The MCT lies approximately 50 km away from the project site and is currently considered to be relatively inactive.
- The Mahabharat Thrust (MT) is responsible for separating rocks of the Nuwakot Complex in the south (foot wall) from rocks of the Kathmandu Complex in the north (hanging wall). The Nuwakot Complex is composed of low-grade metamorphic rocks such as slate, phyllite, quartzite, and limestone, while the Kathmandu Complex consists of medium-grade metamorphic rocks like garnet-schist, marble, and mica-schist. The hanging wall of the MT features pure, simple, and complex shear senses in its rock sequences, and the same pattern is observed in the footwall, indicating the MT functions as a stretching fault. The activity level of this fault is uncertain. The MT is characterized by the abrupt appearance of the older Raduwa Formation over the younger Dunga Quartzite in a concordant relationship. It runs through several villages in the study area, including kothalitar, Puranagau, and Chhyas, before ending in Taubas village in the eastern part.

- Unconformity - An erosional unconformity exists between the Dhading Dolomite and Benighat Formation, which remains a subject of discussion and controversy. This unconformity, observed during surface mapping, is located less than 2.0 km from the dam site.
- Synclinorium/ Fold - A regional synclinorium axis trending in an E-W direction intersects with the proposed alignment of the headrace tunnel (HRT), with the axis plunging towards the north. Additionally, several minor small-scale folds are present on-site. A corresponding anticlinal fold is prominently developed on the northwestern portion of the area, with an E-W trend about 4.0km NW of the dam site. This fold is exposed along Mustya and SukauraKhola, as shown on the modified DMG map from 1996.
- Lineaments - The presence of linear topographic depressions suggests the existence of several linear weak zones or lineaments in the area. These lineaments may indicate fault, fold, and master joint sets. Additionally, indirect features such as the parallel alignment of streams/Kholsi, the occurrence of landslides in a series, and erosion along a linear pattern may also reflect lineaments. The table below describes the major geological structures that may impact the proposed dam site, along with their degree of severity.

Table 5. 1: Geological structures around the project area

SN	Structure	Distance from Project Site	Remark
1	HFT	>50.0km	Tectonic boundary between Siwalik & Gangetic plane. Located at a far distance to influence the area.
2	MBT	<10.0 km from the proposed Dam-1A& 4 Km from powerhouse location	Tectonic boundary between Lesser Himalaya & Siwalik. Will have the most severe influence
3	Regional Synclinorium	Intersects HRT	Passes across the head race tunnel & within the Project site. Will impose direct influence.
4	Local Folds	Approx. 4.0km NW of Dam site	Left bank of Seti (from surface mapping & literature). Will impose moderate influence.
5	Discontinuities	Majorly three sets observed all over	Will have direct/severe influence
6	Lineaments	Occasional Occurrence all over	Will have severe influence
7	Unconformity	1.0-3.0 km	Erosional unconformity between Benighat slate and Dhading Dolomite (?). Considered having less influence
8	MT (Mahabharat Thrust)	2.0km NW from D-1A	Between Robang and Raduwa Formation at Dubhung village. Considered imposing less influence.

9	MCT	>50.0 km	Project site not under influence

5.1.5 Soil Erosion and Slope Stability

The watershed conditions of the project area are moderate to fair. The agricultural lands being maintained by the farmers periodically do not pose problems of land erosion and land instability. The forest land and bush grasslands, however, are under pressure from cattle grazing, most of which are in degraded state. However, the forest conditions are gradually improving with the engagement of community forests. During the field survey the team had observed user groups members patrolling their territory routinely to discourage illegal harvesting. The forests are gradually improving with better undergrowth and forest stock.

The project area has terrain of the hilly landscape with varying degree of slope, the steeper section with thin to moderately thick colluvial soil cover has a potential to failure during heavy monsoon outpour. The old alluvial tars, particularly along the edge of the terrace breaks are also potential to block toppling and debris flow. Similarly, the tributary streams joining the Seti River in the north and south, have steep longitudinal profiles. These streams have a gully like morphology at the headwaters and have potential to expand laterally and headwards. Proximity of distribution line poles across such streams could be vulnerable to the risk of erosion and land instability.

Several active and old landslide debris and scars were observed in and around the project area, which are shown in the figure below.

Figure 32: Landslide (major) zones around the project area (Googel Earth Imagery)

5.1.6 Land use

The project area is dominated by the forest area followed by agriculture. The forest area is estimated to comprise nearly 68% of the land and agriculture around 30%, rest is made up of the other land use including riverine area, settlement, and barren lands. The general land use map of the project area is presented in the figure below.

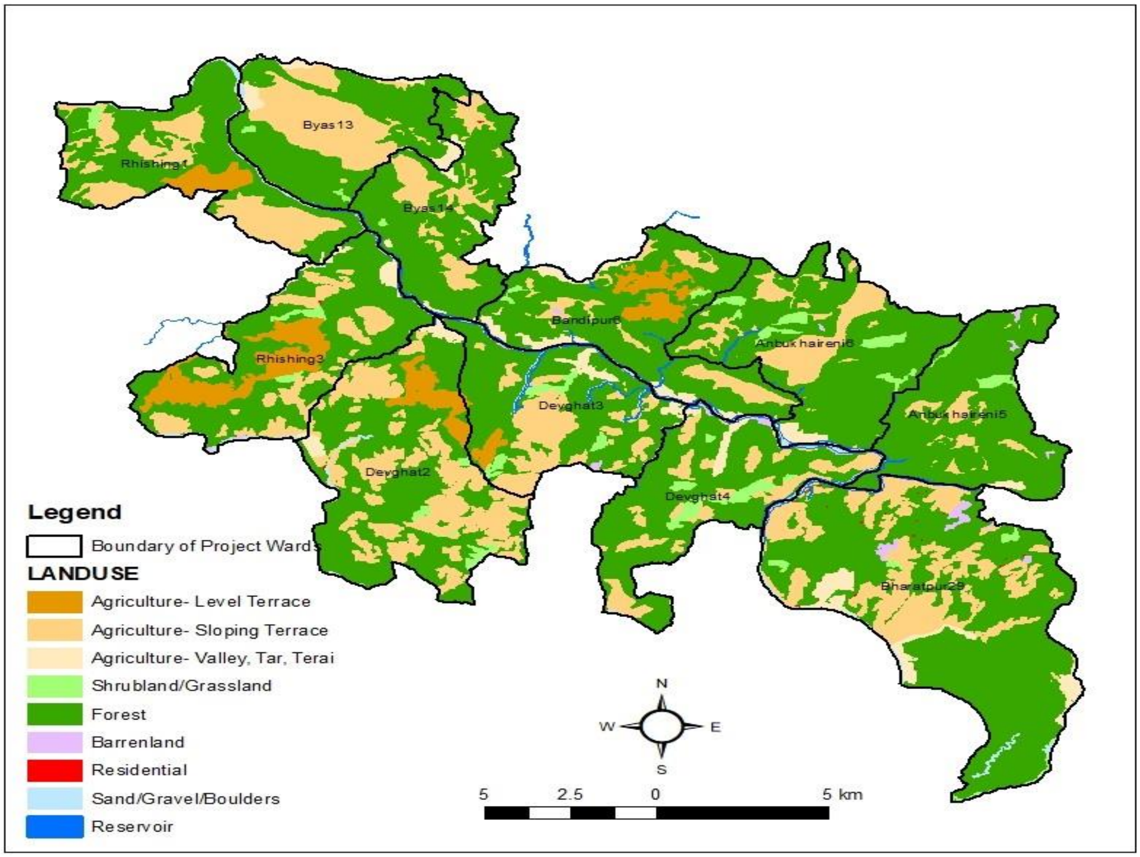


Figure 33: Land use distribution of the project affected wards

Table 5. 2: Land use of the project affected wards

Land use	**Area [ha]**	**Area [%]**
Agriculture- Level Terrace	1,407	3.83
Agriculture- Sloping Terrace	8,161	22.22
Agriculture- Valley, Tar, Terai	1,220	3.32
Barren Land	152	0.41
Forest	24,139	65.72
Residential	12	0.03
Sand/Gravel/Boulders	863	2.35
Shrubland/Grassland	774	2.11
Grand Total	36,728	100.00

5.1.7 Climate

The topographic variation from valley bottom to hill and mountain tops present a unique mixture of climatic conditions within the project area. Climate ranges from tropical at the river valley to temperate in the mountain tops.

In the tropical and subtropical areas, summers are very hot and humid, with temperatures soaring up to 40 degree C and above occasionally (May – June). In the winters (Dec – February) minimum temperature drops to less than 1 degree C and fluctuates between 3 degree C to 7-degree C. However, the midday temperatures are usually quite warm.
The temperatures in the Temperate Zones are quite comfortable. Day temperatures in summer vary between 20.0ºC to 30.0ºC and in the winters minimum temperatures in the morning drop below 0-degree C.

The climate of the project area is influenced by the monsoon. Western disturbances bring light rains in the months of January and February. Nearly 80% of the precipitation occurs in the monsoon period (June to September). In general, annual total precipitation varies from about 1900mm to 2500mm within the project area.

5.1.8 Water and watershed area

The Seti River is one of the major river systems of the Gandaki River Basin, intersecting with the Trishuli River, ultimately forming the Narayani River, which serves as the primary outflow of the Gandaki River. Regarding its catchment area, the Seti River basin encompasses approximately 14% of the total area of the Gandaki river basin, contributing around 11% of the overall run-off in the Gandaki river basin.

The proposed TSHPP covers a catchment area of 2,950 km^2, which includes a permanent snow-fed region of 114.5 km^2, within the Seti River in Nepal's Gandaki Province. The proposed barrange is located approximately 20 km downstream from the powerhouse site of the on-going Tanahu HPP. Furthermore, the junction of the Seti River and the Trishuli River is roughly 11 km downstream from the Barrage site. The catchment area map of TSHPP is presented in the figure below.

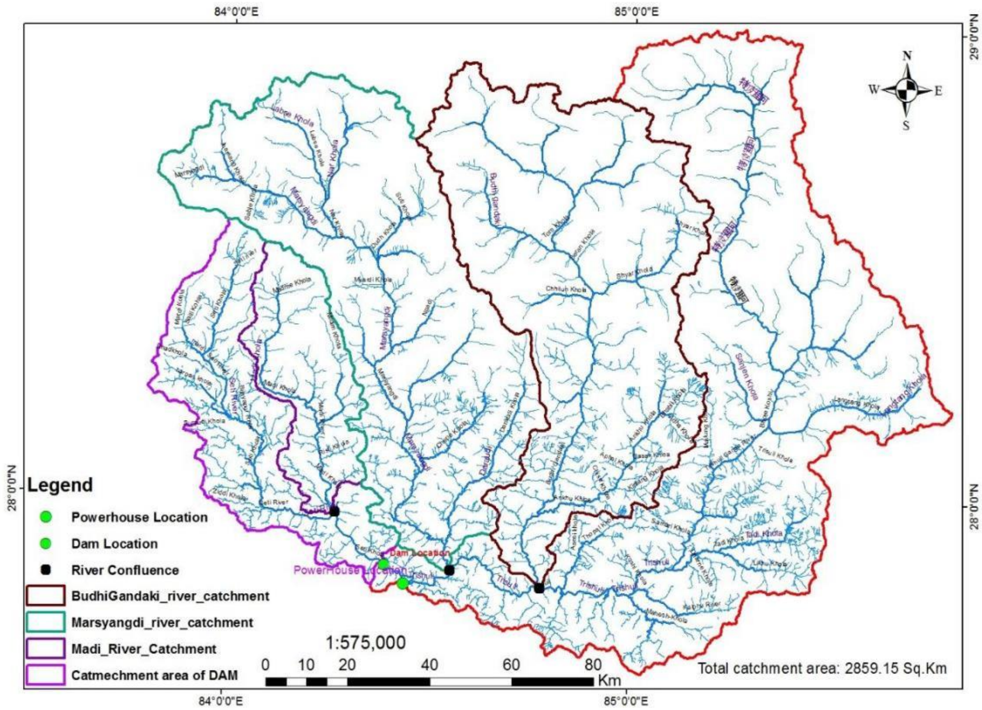


Figure 34: Catchment area of the TSHPP

Near to the project area, the Seti River merges with significant rivers such as Madi Khola. Additionally, the confluence of the Seti River and the Trishuli River occurs at Ghumaune, located about 4.20 km upstream of the powerhouse site at Gaighat. The Swti River flows a northwest-southeast direction within the project area; how3ever, at the point of convergence with the Trishuli River at Ghumaune Danda, it changes its course to a southwest direction.

Reservoir Elevation-Area-Capacity Curve

The Elevation-Area-Capacity curve of the Tallo Seti Hydropower Project is determined based on the recent survey map of reservoir area. The survey map was prepared from the DEM of 5 x 5 m resolution obtained from remote sensing technology. The surface area of the reservoir for each elevation was computed directly on AutoCAD based on the contour of the same level. The volume of the reservoir was calculated using the average area of two consecutive contours and multiplied by 5m (As each contour was plotted on 5 m interval). Then cumulative volume was calculated and plotted on graph with Elevation in Y axis and volume in X axis. The Elevation-Area curve is also plotted on same graph as shown in figure below:

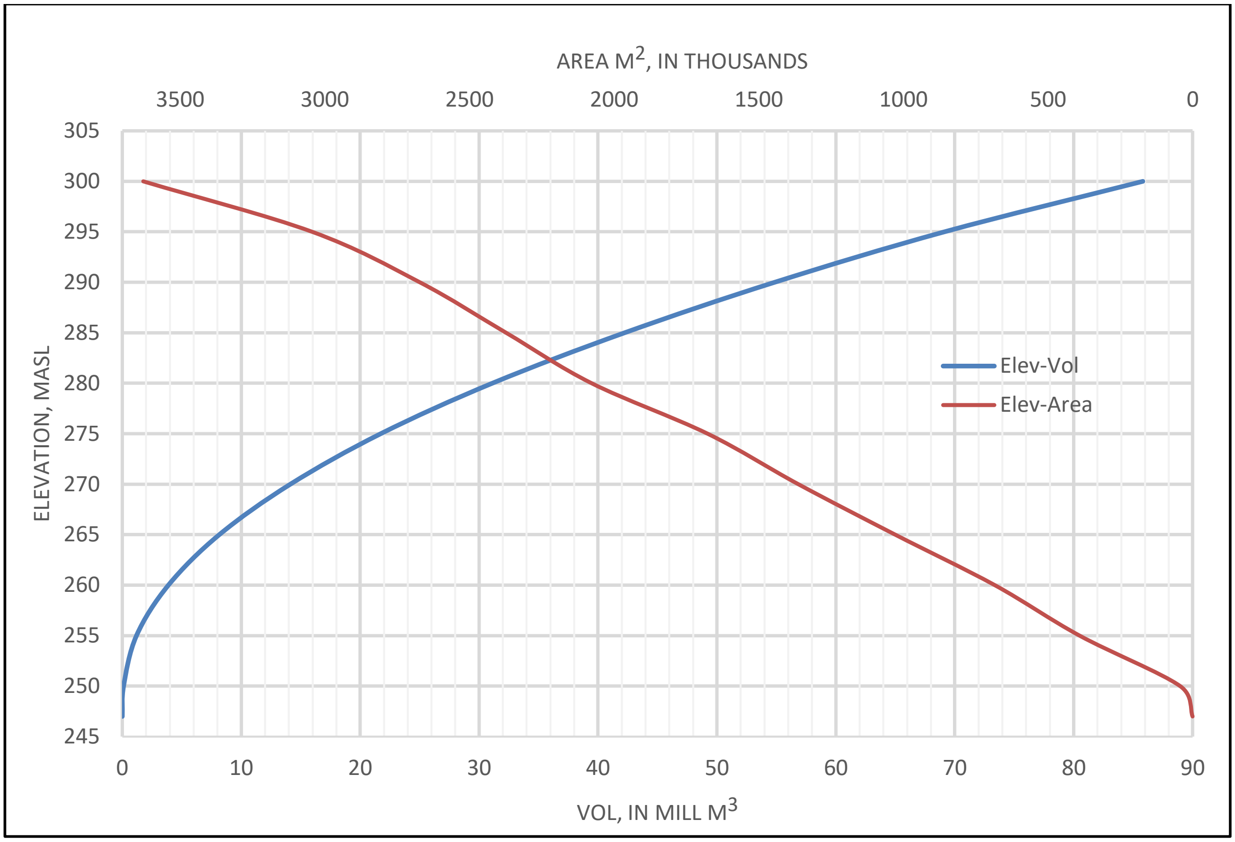


Figure 35: Reservoir Elevation-Area-Capacity Curve

The summary of the area and elevation values of TSHPP is presented in table below:

Table 5. 3: ***Reservoir Elevation-Area-Vol Values***

Elevation	Area	Volume	Cumulative Vol
ma.sl	**m^2**	**mm^3**	**mm^3**
247	0	0	0
250	42723.0734	0.106807684	0.106807684
255	390479.7302	1.083007009	1.189814693
260	683599.0873	2.685197044	3.875011736
265	1027797.448	4.278491338	8.153503075
270	1362889.397	5.976717113	14.13022019
275	1676486.361	7.598439395	21.72865958
280	2077553.384	9.385099363	31.11375894
285	2373318.504	11.12717972	42.24093867
290	2671503.602	12.61205527	54.85299393
295	3043868.349	14.28842988	69.14142381
300	3627503.699	16.67843012	85.81985393

Flow Duration Curve at the Tallo Seti Diversion Structure Site

The flow duration curve (FDC) for each month and the annual FDC has been developed usnig the daily flow data at stations 430.5 and 438 and transposing the result to the diversion structure site of the TSHPP using area weighted CAR (63% area in the St. 430.5 and 37% area in the St. 438). The processed data from 2000 to 2015 for the SL 430.5 and from 1975 to 2015 for St. No 438 have been considered. The daily flow from the Madi River (St. 438) and daily from the Seti River (St. 430.5) were used to generate the flow at the "balance area" which is the area located upstream of the diversion structure site and downstream of the DHM station. The "Natural" flow is estimated by ignoring the potential effect on the water availabilty due to the operaton schedule of the Upper Seti HPP. To estimate the actual water availability for the energy generation, the plant operation schedule of the Uppe Seti HPP is considered. Sudden drops in the discharge resulted from the changes in the scheduled plant operation of USHPP.

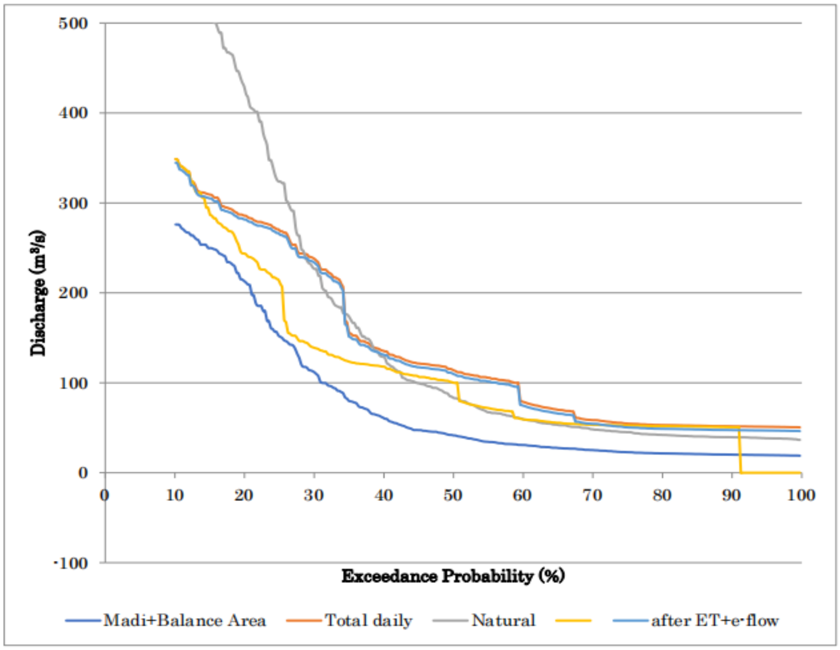


Figure 36: Flow Duration Curve at the diversion structure site of TSHPP under different scenario

Mean Monthly Inflow at Tallo Seti Diversion Structure site from RR model

The following table shows the mean monthly inflow at Tallo Seti diversion structure site from RR model.

Month	Date		Natural flow without USHPP (m^3/s)	USHPP and LSHPP operated in tandem (m^3/s)
	From	To	Case I	Case II
Baisakh	14-Apr	14-May	49.96	104.17
Jestha	15-May	14-Jun	107.60	125.62
Asadh	15-Jun	15-Jul	363.09	305.58

Month	Date		Natural flow without USHPP (m^3/s)	USHPP and LSHPP operated in tandem (m^3/s)
	From	To	Case I	Case II
Srawan	16-Jul	16-Aug	542.56	0.00
Bhadra	17-Aug	16-Sep	523.74	373.27
Aaswin	17-Sep	17-Oct	257.30	247.53
Kartik	18-Oct	16-Nov	120.99	132.60
Mangsir	17-Nov	15-Dec	69.76	72.63
Poush	16-Dec	14-Jan	50.48	57.07
Magh	15-Jan	12-Feb	41.77	52.46
Falgun	13-Feb	14-Mar	38.27	50.80
Chaitra	15-Mar	13-Apr	38.88	51.62

Long-term average hydrograph of Tallo Seti Hydropower Project Diversion Structure site

The following figure shows the long-term average hydrograph of Tallo Seti Hydropower Project diversion structure site.

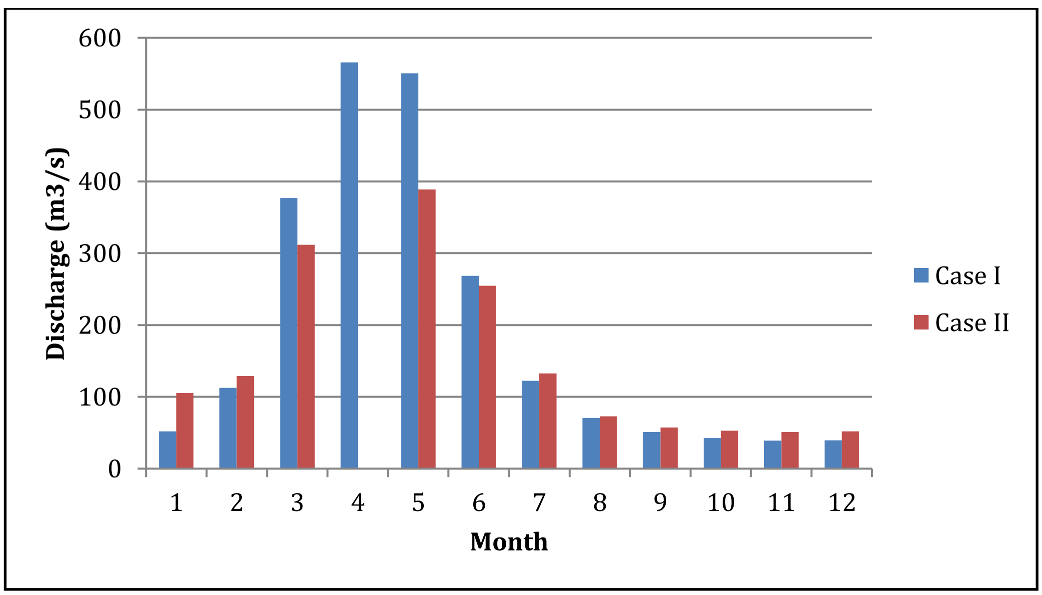


Figure 37:Long term average hydrograph

High Flood Studies

Studies for estimation of design flood have been carried out on rational and empirical formulae, frequency analysis using several distributions on observed peak flow data, SCS method, HEC-HMS and triangular unit hydrograph approach. All these methods due to adoption of different techniques, equations and data limitations etc have indicated slightly different peak values corresponding to return period flood as well as for PMF peak. The same have been compared/indicated in table below:

Table 5. 4: Estimated peak discharge at TSHPP the diversion structure site

S.No.	Return Period	Empirical Approach			Probabilistic Approach	Deterministic Approach		
		Dickens method	Rational method	Creger's Curve method	Frequency Analysis	Triangular UH method	SCS UH method	HEC-HMS model
1	2	-	5752	4580	1881	-	6241	4580
2	5	2633	6754	6220	3100	-	7325	6220
3	10	3308	7334	7270	4004	-	7997	7270
4	20	-	7904	8250	4855	-	8614	8250
5	25	4199	8094	8570	5137	-	8801	8570
6	50	4874	8601	9830	6007	-	9368	9830
7	100	5548	9107	10990	6900	-	9900	10990
8	200	7789	9550	12030	7821	-	10410	12030
9	1000	-	10563	14080	10096	-	11510	14080
10	10000	10030	11829	16050	14410	-	12890	16050
11	PMF	-	25568	40290	-	23585	27968	40290

The study indicates that the HEC-HMS and SCS models yield higher return period flood values as compared to traditional frequency analysis methods using Gumbel, LPT III and other distributions.

However, the decision to adopt design flood, i.e., PMF or any other return period flood are generally decided keeping design aspects in consideration and also in accordance with the standard guidelines of Nepal vis-à-vis Tallo Seti Diversion Structure duly factoring risk factors etc. during layout optimization and design studies.

Probable Maximum Flood (PMF)
A study based on studies carried out in India through a manual has been carried out again by development of a Synthetic Unit Hydrograph (SUH) to estimate the PMF at LSHPP site using Single Bell and Double Technique.

In Nepal, unfortunately, no such technique is available which could enable development of SUH for ungauged locations using Topographical and meteorological parameters of the catchment. The Central Water Commission (CWC) of India in association with Ministry of Surface Transport and Ministry of Railways carried out analysis of selected concurrent rainfall and floods for gauged catchments and derived UH parameters of one hour unit duration. The characteristics of the catchments and their UH made for several catchments in a sub-zone and then they have been correlated by regression analysis and subsequently the equations for SUH for those sub-zones developed. The loss rate and base flow were also estimated.

Accordingly, it is proposed to estimate the PMF using the equations proposed for a similar catchment (of India) as LSHPP as developed by CWC. In this regard the "Flood Estimation Report for North Brahmaputra Basin - Sub-zone 2 (a) is considered for development of SUH for LSHPP.

However since the Time Base of developed is more than 24 hours, so 2-Day Probable Maximum Precipitation (PMP) depth is considered in present study instead of 24 hour PMP depth. In addition, 1-Bell and 2-Bell method of analysis is considered for convolution and estimation of PMF. The results indicate a PMF peak of 20479 m3/s and 20109 m3/s respectively.
The decision to adopt design flood i.e. PMF is generally decided keeping design aspects in consideration and also in accordance with the standard guidelines of Nepal vis-à-vis Lower Seti diversion structure duly factoring risk factors etc. during design studies.

The PMF corresponding to 20479 m3/s based on Flood Estimation Report was recommended considering dam at TSHPP site. However, with the weak geology, a decision was taken subsequently to construct a barrage type diversion structure so that the scheme/project could work as peak run-of-river PRoR scheme. Accordingly design flood corresponding to 500 year return period flood of 9071 m3/s based on frequency approach has been approved and recommended tentatively for the proposed diversion structure at LSHPP site and shall be checked for 1000 year return period flood of 10096 m3/s.

5.1.9 Glacial Lake Outburst Flood (GLOF)

No vulnerable glaciers/water bodies have been reported from the Seti Basin, which can threaten the project in the Seti River stretch. The powerhouse is located on the right bank of the Trishuli River, about 5 km downstream from the S/T (Seti/Trishuli) confluence, which might be threatened by the Thulagi Glacial Lake.

The Thulagi Glacial Lake is vulnerable to Glacial Lake Outburst Flood (GLOF). This lake in fact is located in the Marsyangdi River. We have considered the threat of this lake as the Marsyangdi River meets the Trishuli River several km upstream from the powerhouse site. If it bursts, the powerhouse might be in the way of the flood. This lake is currently about 2 km long, which started as a small supra-glacial lake about 50 years ago. A comparison between topographical maps of the Survey of India from 1958 and the 1995 WECS field results indicated that the lake area had increased in size from 0.22 to 0.76 sq.km and in length from 0.6 to 1.97 km, but that there was not much change in width (WECS 1995c). The field investigations showed that from 1995 to 2009, the length of Thulagi Lake had again increased from 1.97 to 2.54 km, and the area from 0.76 to 0.94 sq.km. The development of the lake since 1990 was calculated using topographic maps, satellite images, and the results of the present and previous field investigations. The lake is expanding into the glacier terminus, causing it to retreat and calve.

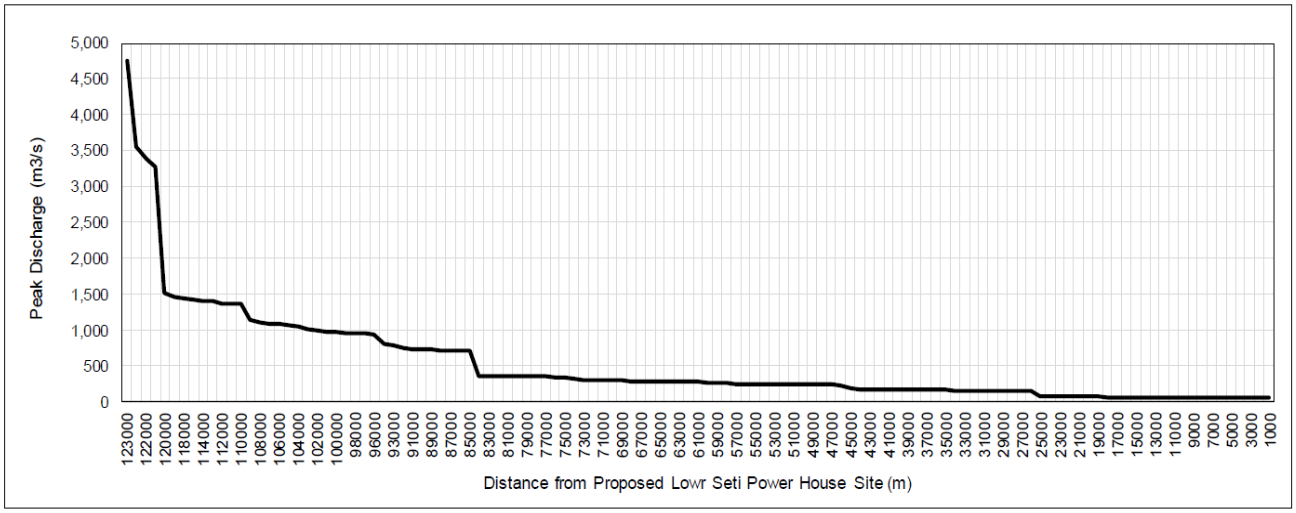


Figure 38: Flood peak discharge by dam breach of Thulagi lake (Design Report, 2021)

This lake is about 123 km upstream from the proposed powerhouse site. The study carried out on GLOF potential as a part of the feasibility study revealed that in case of the burst, the peak flood of about 4752 cubm/s will be released, however, this flood will be contained within the river channel and significantly subside until it reaches the powerhouse site. Thus, no damage is expected from the GLOF event in the Thulagi Glacial Lake.

5.1.10 River discharge and sediment content

The Seti River's water availability for TSHPP will be subjected to the THP which is currently under construction upstream. As a result, the flow received by the TSHPP will be altered by the THP's releases. Access to the natural flow for the TSHPP can only be attained if the THP's powerhouse is shut down and the reservoir is at the full capacity. Otherwise, the water from the Seti River will be half in the THP's reservoir. Additionally, during the rainy season, the THP's reservoir will retain water to be released during the dry season. The THP's power discharge will also be released back to the Seti River upstream of the TSHPP. Although excess water in the reservoir will spill over into the river during the wet season, this will not happen during the dry season.

To evaluate the water availability for the proposed TSHPP, a streamflow series covering approximately 25 to 30 years was computed. The Rainfall Runoff (RR) model was employed to estimate discharge for the TSHPP, which is a widely used yet simple method that develops a model for discharge measurement site based on observed data of the respective site, considering concurrent catchment rainfall and runoff. Monthly rainfall data for the monsoon period from 2000 to 2018 was utilized to develop the Rainfall Runoff (RR) model for DHM's station # 430.5, located at the Seti River at Damauli, using Thiessen polygons/weights and observed monthly rainfall data and observed monthly discharge for the monsoon period. The Station # 430.5 was selected as it exhibits similar characteristics and was situated with the catchment of TSHPP, in addition to being within the same hydro-meteorological region (with average catchment rainfall for concurrent periods at Station # 430.5 and TSHPP being 3206 mm and 3040 mm, respectively). Monthly flows during the non-monsoon periods were assessed by computing the average percentage runoff for each month relative to the total monsoon runoff for the observed period. A comparison was made between monsoon rainfall and runoff, which indicated a good correlation and trend, whereas correlation and trend during January and March (non-monsoon season) were slightly poor.

Table 5. 5: Details of stream gauging station # 430.5 [source: DHM]

Station #	River name	Location	Latitude	Longitude	Elevation [m]	Catchment [km^2]	Data available from
430.5	Seti Gandaki	Damauli	28^o 50' 00''	84^o 15' 00"	290	1350	Jan 2000
438	Madi River	Shisa Ghat	28^o 06' 00''	84^o 14' 00"	457	858	Jan 1975

The model's estimated monthly monsoon runoff has been divided into daily flows based on the percentage of daily runoff to monthly runoff determined during the observed runoff period data (data available between 2000 and 2015). Consequently, the daily flows for the period between 1957 and 2018 were evaluated daily.

Based on the rainfall-runoff model developed and validated at the Tallo Seti diversion structure site, the results indicate that the average monthly flows exhibit identical values, indicating that the model results are accurate. Additionally, the tank model study also shows identical values, as discussed in the subsequent paragraphs.

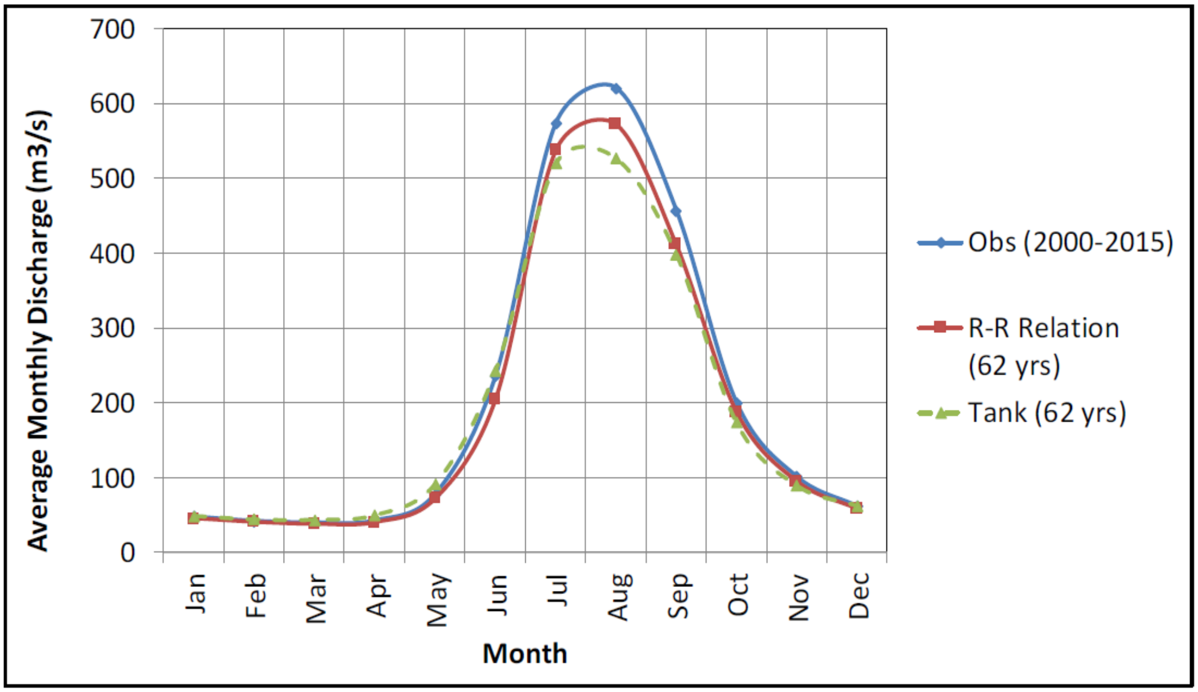


Figure 39: Long term monthly flow at TSHPP diversion barrage site by R-relation model (Design Report, 2021)

According to the model, the Seti River at the barrage site receives approximately 50 m^3/sec of discharge during the dry season, which spans from the end of October until the end of May. During the monsoon season, a significant amount of water is added to the system from rainfall, leading to an increase in discharge. The peak discharge of approximately 600 m^3/sec occurs in July and August, after which it gradually decreases.

A sediment content analysis was conducted in the river using the data of the Station # 430.5 and Station # 438. Furthermore, additional data at the Seti River was also collected beginning from 20 July 2019. It indicated that the sediment content is erratic and does not correspond to the discharge. This suggests that there are areas in the catchment that contribute more silt to the river. The type of sediment generated by rainfall varies depending on the location. The table below shows that the sediment content is higher at lower discharges and lower at higher discharges.

Table 5. 6: Correlation between discharge and suspended sediment concentration at TSHPP sampling site [Seti River] in 2019

SN	Month	Date	Suspended sediment concentration [ppm]	Discharge [cubm/s]
1	July	20	1,336	291.82
2		21	10,892	460.56

SN	Month	Date	Suspended sediment concentration [ppm]	Discharge [cubm/s]
3		24	9,994	458.19
4		30	3,236	417.14
5	August	1	1,650	492.40
6		3	3,329.96	587.29
7		13	2,187	374.66
8		17	11,666	492.61
9		21	1,686	398.19
10	September	29	1686	398.19

Furthermore, the THP data showed that the silt content can be higher during the March and October, which is presented in the table below:

Table 5. 7: THP sediment data

Month	Date	Suspended sediment concentration [ppm]
April - 1974	19	3260
	20	3070
	21	3310
June 1975	5	3390
	21	4000
April 1976	22	6960
	29	5410
May 1976	14-31	3610 to 12,000
June 1976		3960 to 60,800
July 1976		3110 to 17,100
Aug 1976		3170 to 3780

March 1978	6	11,800
September 2000	2	5496
	7	4212
	8	3986
	19	9993

The sediment load received by TSHPP will also be affected by the operation of THP. The reservoir of THP is designed to trap sediment, and clear water will flow info the intake of TSHPP. However, only silt from the Madi River and immediate catchment will reach TSHPP. Additionally, most of these sediments are expected to settlement in the 12.7 km long TSHPP reservoir, resulting in clear water entering it intake.

5.1.11 Spring sources

We have identified and located 18 spring sources during our field works, which are currently being used by the locals for drinking water. The below displays the location of these sources.

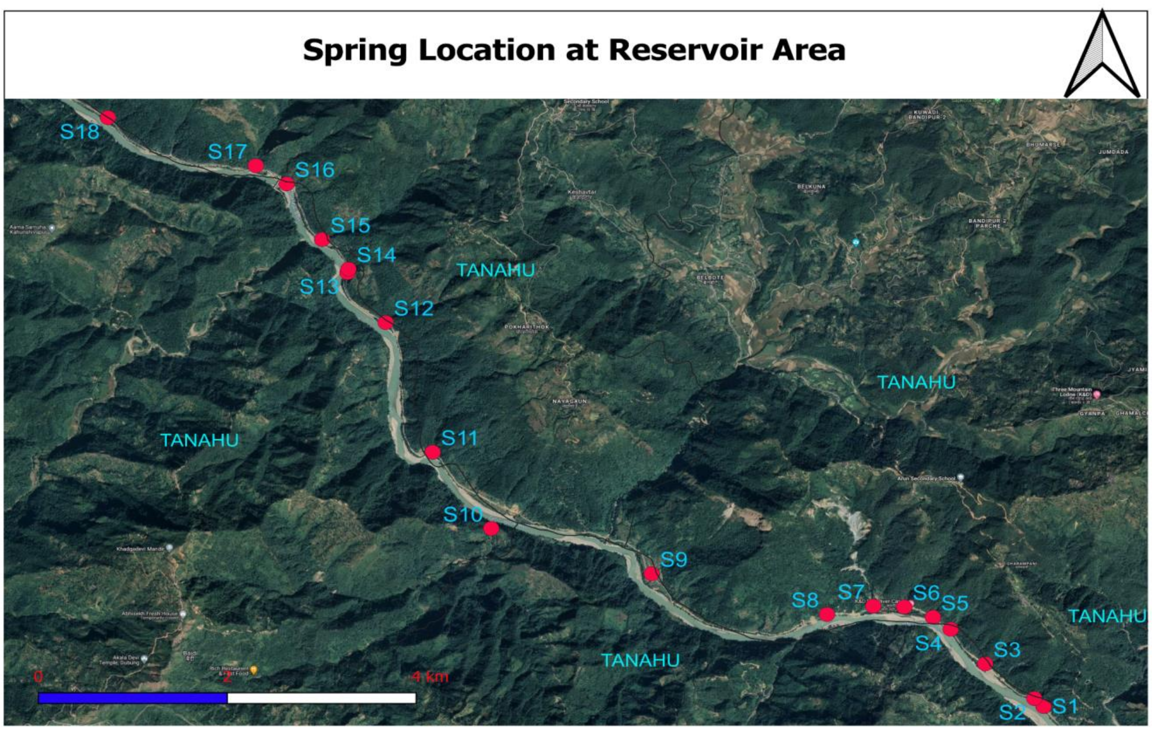


Figure 40: Spring Locations (Baseline Survey, EIA Study)

The discharge of springs was measured for one season and the discharge data is provided in table below:

Table 5. 8: Discharge data of springs

Spring Code	Location		Discharge (L/min)
	Longitude	Latitude	
S1	27°51'40.81"N	84°23'35.69"E	6.34
S2	27°51'44.16"N	84°23'32.05"E	6.88
S3	27°51'51.78"N	84°23'17.27"E	7.07
S4	27°52'7.35"N	84°23'1.14"E	7.37
S5	27°52'12.96"N	84°22'55.97"E	7.9
S6	27°52'14.93"N	84°22'40.74"E	9.839
S7	27°52'16.55"N	84°22'27.69"E	8
S8	27°52'12.95"N	84°22'8.82"E	6.12
S9	27°52'22.84"N	84°21'7.78"E	6.87
S10	27°52'48.10"N	84°19'59.96"E	4.59
S11	27°53'14.47"N	84°19'35.03"E	7.43
S12	27°54'3.40"N	84°19'22.42"E	8.12
S13	27°54'23.40"N	84°19'5.70"E	7.1
S14	27°54'21.72"N	84°19'6.20"E	7.89
S15	27°54'35.57"N	84°18'56.11"E	10.62
S16	27°54'57.70"N	84°18'44.25"E	7.44
S17	27°55'3.09"N	84°18'32.05"E	8.91
S18	27°55'21.02"N	84°17'35.74"E	5.01

5.1.12 Air and Noise Quality

The ambient air quality data sampled using the "Air Visual Pro sensor" by IQAir which provides real-time measurements of fine (PM2.5) and coarse (PM10) particles. The device also demonstrates the data of the Air Quality Index and CO_2. The results are presented below:

Table 5. 9: Air quality report of the sample locations in the project area (Source: Baseline Survey, 2023)

Sampling station	AQI			PM2.5(μg/m^3)			CO2(ppm)
	min	**max**	**avg**	**min**	**max**	**avg**	**avg**
Koidim Ghat	148	325	240	300	425	350	48
Masdi Ghat	150	290	220	275	425	350	48
Khahare	149	220	185	250	410	330	48
Naldi	150	250	200	250	410	330	49
Sarang Ghat	155	240	200	255	410	332	48
Gai Ghat	140	200	170	310	400	355	45

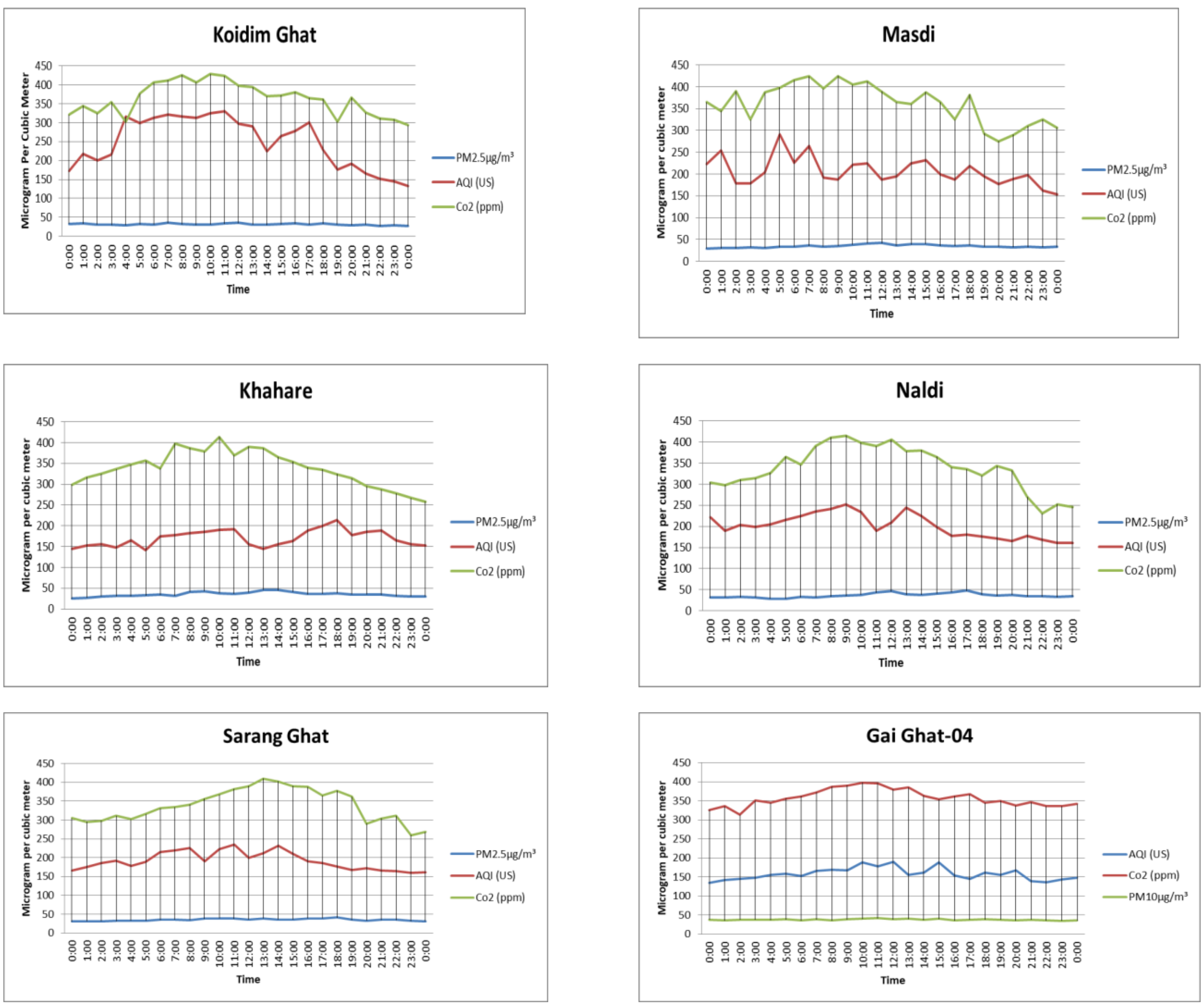


Figure 41: Distribution of air quality parameters (Source: Baseline Survey, 2023, EIA Study)

The Air Quality Index (AQI) is a metric used to indicate the extent of air pollution in a given location. It typically depends on the levels of major air pollutants such as PM2.5, PM10, Ozone (O3), nitrogen dioxide (NO2), sulfur dioxide (SO2), and carbon monoxide (CO). The AQI standard norms may vary across different countries and regions, but generally range from 0 to 500. Specifically, in the Indian context, the AQI standard norms are categorized as follows: good (0-50), satisfactory (51-100), moderate (101-200), poor (201-300), very poor (301-400), and severe (401-500).

The project area showed AQI values ranging from 148 to 240, indicating moderate to poor air quality. Generally, lower AQI values were recorded during the night in most sample locations, with values increasing and reaching their peak during midday. Except for Masdi Ghat where several peaks and drops in AQI values were observed. Furthermore, Carbon dioxide levels were positive correlated with AQI values in all locations, while PM2.5 value remains consistent through out the sampling period in most locations. This suggests that air quality is mainly impacted by vehicular exhaust rather than dust.

5.1.13 Noise Level

In a similar manner, we collected noise data from the project area and identified the locations on the map. Our recordings showed noise levels of up to 83 dB, with an average daytime range of 50-80 dB, which can be considered noisy for a rural setting. However, the noise level dropped to an acceptable range of 40 dB and below during the nighttime. The main sources of noise in the project area were vehicles and their horns, as well as ongoing construction work.

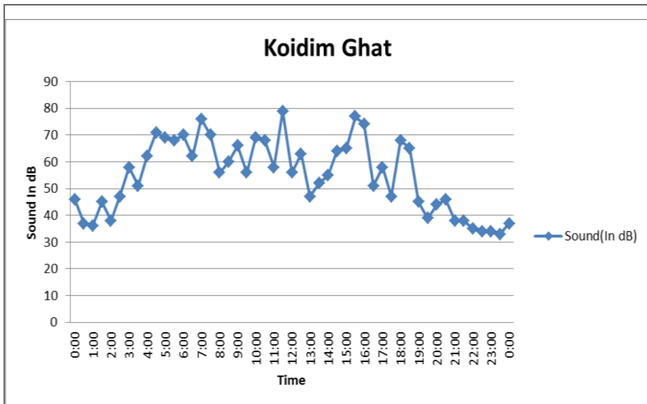
Table 5. 10: Noise levels recorded in the project area (source: Baseline Survey 2023, EIA Study)

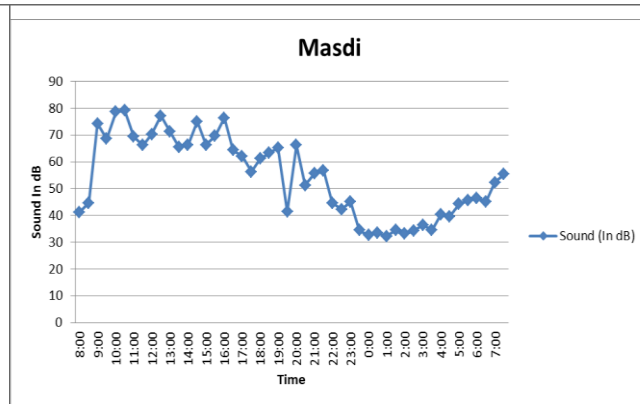
SN	Sample location	Low [dB]	High [dB]	Avg [dB]
1	Koidim Ghat	30	80	55
2	Masdi Ghat	30	80	55
3	Khahare	30	81	56
4	Naldi	35	82	59
5	Sarang Ghat	30	80	55
6	Gaighat	30	75	52

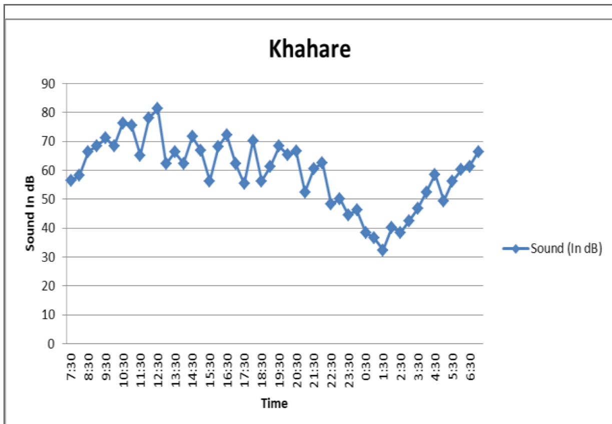
Table 5. 11: Average Day-time and Night-time noise levels

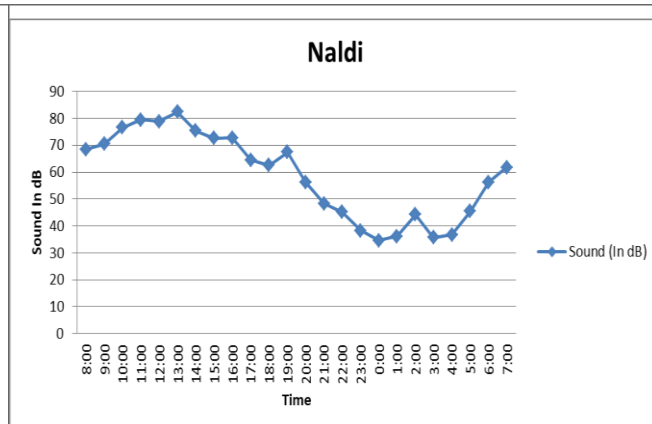
Location	Duration	Average Noise Level (dB)
Koidim Ghat	Night	46
	Day	69.33
Masdi	Night	46.25
	Day	64.75
Khahare	Night	54.14
	Day	67.8

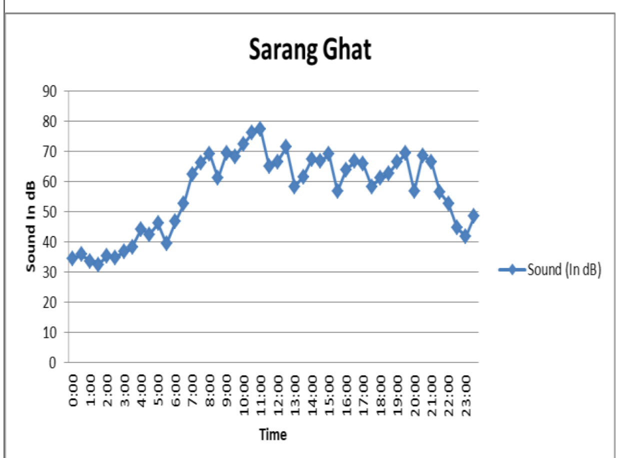
	Night	50.85
Naldi	Day	72.3
	Night	49.5
Saranghat	Day	68.2
	Night	41.85
Gaighat	Day	64.3











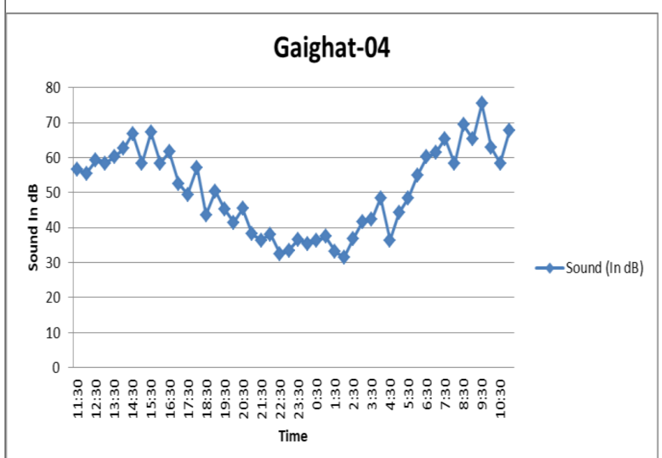


Figure 42: Noise level distribution in the project area (source: Baseline Survey 2023, EIA Study)

5.1.14 Water quality

Water quality monitoring was conducted for the portion of the Seti River within the project area. Water samples were collected from various locations, including the starting point of the hydropower, upstream of the dam, the barrage area, dewater zone, adit 4, spring sources, and mixing zone. The detailed lab results of the water quality assessment can be found in Annex L.

Table 5. 12: Summary of Water Quality Results

S.N.	Parameter	Standard Value		Dewater Zone	Upstream	Spring Source	Mixing Zone	Barrage Area	Adit-4	Starting point of Reservoir
		WHO (2017)	NDWQS (2079)							
1	pH	6.5-8.5	6.5-8.5	7.28	6.61	7.32	6.63	7.13	6.88	7.01
2	TDS (mg/L)	-	1000	280	328	540	392	336	316	120
3	Temperature ºC	-	-	24.5	24.4	24.3	24.6	24.7	24.8	24.9
4	DO (mg/L)	-	-	5.53	5.13	6.31	5.53	5.13	5.92	5.92
5	BOD (mg/L)	-	-	55.4	55.2	47.4	47.4	47.4	63.2	63.2
6	Sulphate (mg/L)	-	250	4.46	6.53	9.63	5.84	5.49	7.04	6.09
7	TSS (mg/L)	-	-	25	13	4	7	44	4	11
8	Total Coliform (MPN/100)	0	0 in 95% samples	36	37	26	31	35	70	32
9	Fecal Coliform (MPN/100)	0	0	17	20	9	11	21	45	20
10	Conductivity (µmHOS/cm	-	1500	293	243	563	240	325	255	308
11	Turbidity (NTU)	5	5	19.6	14.2	2.23	10.3	48.4	2.19	17.5
12	Ammonia (mg/L)	-	1.5	0.24	0.21	0.53	0.19	0.27	0.32	0.31
13	Nitrate (mg/L)	3	50	0.55	2.19	0.83	0.72	0.90	0.39	1.84
14	Nitrite (mg/l)			ND	ND	ND	ND	ND	ND	ND
15	Phosphate (mg/L)	-	-	0.05	0.07	0.11	0.05	0.16	0.13	0.16
16	Total Nitrogen (mg/l)	50	-	2.4	2.87	1.62	2.60	2.7	2.1	1.8
17	Oil and Grease (mg/L)	-	<10	0.30	ND	0.80	0.41	ND	2	ND
18	COD (mg/L)	-	-	5	4	6	3	5	6	4

The pH, TDS, temperature, BOD, sulphate, TSS, conductivity, ammonia, nitrate, nitrite, total nitrogen, and COD values are within acceptable limits for all locations and fall within the WHO and NDWQS range.

The Dissolved Oxygen values appear to be acceptable, although there are minor variations among the sampling points.

The values for Total Coliform and Fecal Coliform are well above the recommended value. It is essential to note that fecal coliform is considered a more specific indicator of fecal contamination and potential pathogenic organisms in water. The presence of fecal coliform in drinking water is a cause for concern as it indicates possible contamination with human or animal waste, which can lead to waterborne diseases.

Turbidity values vary among the sampling points, and turbidity values exceed the WHO standard value of 5 NTU in tip of the reservoir, upstream of barrage, barrage area, dewatered zone, and mixing zone.

We have observed three primary sources of pollution.

a) Agricultural chemical may enter the river from the cultivated land. The alluvial deposits along the river valley are used for farming, and as a result, water draining from these cultivated lands could carry the agricultural chemicals applied in these fields.
b) There are several settlements located along the banks of the river. These settlements have been discharging domestic effluents into the river, which could lead to biological contamination of the river's water.
c) The on-going construction works of the Tanahu Hydropower have been contributing to an increase in the sedimentation level of the river.

5.1.15 Dam Break Analysis

Dam Break Analysis was carried out during the design stage of the project. Two models for Sunny Day Failure Modelling (SDF) and Rainy-Day Failure (RDF) were analysed. The flood inundation at downstream reach, peak flood hydrographs, maximum water surface levels, arrival time and maximum velocities along the downsteam reach were checked.

Sunny Day Failure (SDF) Result

The 2D flood mapping resulting from a dam break was simulated for 22 km downstream river stretch of the dam axis. The water depths along the river channel, velocities, arrival time periods, peak hydrographs at different locations of the Seti River are generated in HEC-RAS. The peak flood during sunny day dam break from the diversion structure of Lower Seti arrives at tailrace of the powerhouse in 1 hour and 4 minutes. The maximum water level at the tail race is EL 210.63 m. The flood hazard map due to sunny day dam break is given in the Figure below:

Figure 43: Flood Hazard map of SDF along 22 km downstream

Rainy Day Failure (RDF) Results

The 2D flood resulting from a dam break was simulated for a 22 km river stretch downstream of the dam axis. The water depths along the river channel, velocities, arrival time periods, peak hydrographs at different locations of the Seti River are generated in HEC-RAS. The flood of rainy-day dam break arrives at tailrace of the powerhouse in 51 minutes. The maximum corresponding water level at the tail race is EL 214.48 m. The flood hazard map due to rainy-day dam break is given in the figure below:

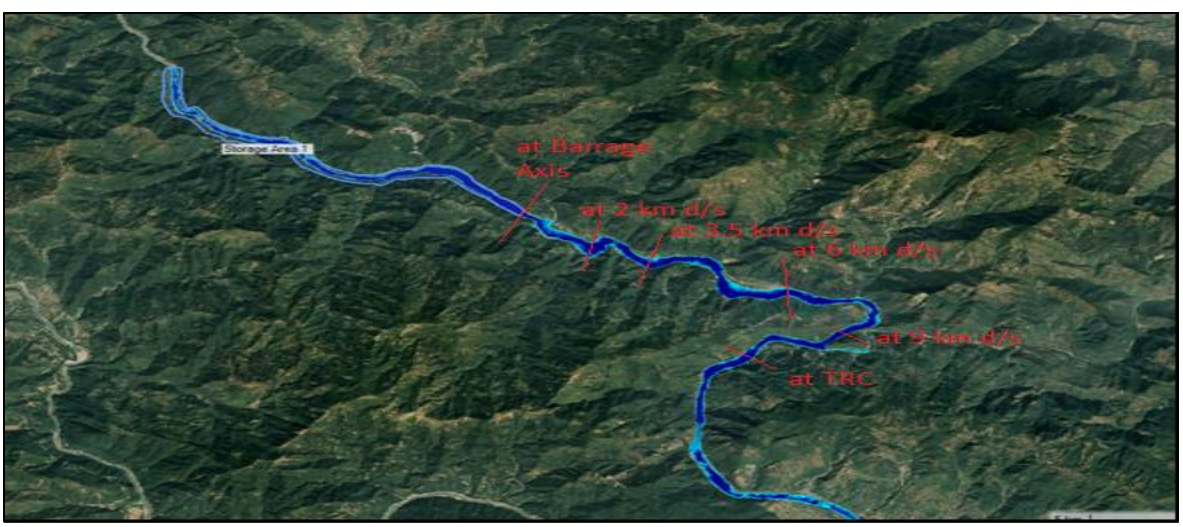


Figure 44: Flood Hazard map of RDF along 22 km downstream

5.2 Biological environment

5.2.1 Forest and Vegetation

The project area lies outside the protected areas declared by the Department of Wildlife Conservation and National Parks of the GoN.

5.2.1.1 Forest and Vegetation in National Context

Nepal is situated at the heart of the main Himalayan range, which stretches over 2400 km (Polunin & Stainton, Flowers of the Himalaya, 1984). Floristically, Nepal is divided into three botanical provinces. The eastern Nepal province (east of 86º30') is dominated by East Himalayan Floristic Elements, which are highly diversified and humid, while the western Himalayan province (west of 83ºE) is dried and has less diversified flora. The project area is in the Central Botanical Province between east of 83ºE and west of 86º30', where floral elements are intermixed and overlapping, and the flora is moderately rich. However, the project site, situated close to the Pokhara Valley, is more humid and floristically rich.

Dobremez (1976) identified six bio-climatic zones in Nepal that span from the Tropical to Nival zone and are further divided into elevation sub zones. The project area is a part of Tropical Bioclimatic region according to Dobremez. Stainton (1972) identified 35 forest types in Nepal, largely based om Champion's (1936) work, as state in the FRA publication (TISC Doc No. 135, 2002). These 35 types are often categorized into 10 major groups by the MFSC (2014):

- Tropical
- Subtropical broadleaved
- Lower temperate mixed broadleaved
- Upper temperate broadleaved
- Upper temperate mixed broadleaved
- Temperate coniferous
- Sub-alpine
- Alpine scrub.

5.2.1.2 Forest types and forest management practices in Tanahu District

The Tanahu District is in Gandaki Province of western Nepal. The land area covers 1569 km2 which is 1.05% of the country. The altitude varies from 187m (Devghat) to 2325m (Chhimkeswari Lekh), providing an important factor for establishment of various forest and vegetation types. The climate of the project area is typically tropical, subtropical, and lower temperate. Being one of the representative districts of the Mid-Hill region of Nepal, the Tanahun District has successfully implemented the Community Forest Development Program to restore the degraded forests.

The Tanahu District encompasses a total land area of 156,902 ha, with 82,549 ha (52.61%) covered by forests, and the remaining area primarily utilized for agricultural purposes, occupying 74,353 ha (47.39%). Recently, Tripathi et al (2020) conducted a study that provided the first detailed analysis of the spatial and temporal patterns of forest cover change in Tanahu district. The study revealed that the forest cover in the district had rapidly declined during the period of 1976-1991, with significant deforestation in various areas. However, after 1991, the forest cover had gradually increased, and there was a significant decrease in deforestation and conversion of forests into other land use classes until 2015.

There are three main types of climatic zones distributed in the district: tropical (up to 1000m), subtropical (1000 – 17000m), and lower temperate (1700 - 2300m). The vegetation found in these zones is like that found in other regions of the Central Nepal that share similar bioclimatic conditions.

The distribution of forest area in the district, according to the municipality is presented in the table below:

Table 5. 13: Forested land of the project affected municipality (Source: District Profile, 2022).

SN	RM/M	Total land area [sq km]	Forest area [sq km]	Forest area [%]
1	Aanbu Khaireni Rural Municipality	127.72	77.49	60.67
2	Bandipur Rural Municipality	101.34	46.48	45.86
3	Vyas Municipality	247.28	124.80	50.05
4	Devghat Rural Municipality	159.13	116.84	73.42
5	Rising Rural Municipality	214.69	123.25	57.41
	Total	850.16	488.86	57,50

Likewise, the forest holdings of different forest categories in the district are shown below.

Table 5. 14: Forest area under different management system in the project municipalities

SN	Municipality	CF	Area of CF [ha]	LF	Area of LF [ha]	RF	Area of RF [ha]	Remaining NF Land area [ha]
1	Aanbu Khaireni Rural Municipality	35	4149.28	57	240.61	0	0	3359.11
2	Bandipur Rural Municipality	37	3551.52	44	154.20	2	7.7	934.58
3	Vyas Municipality	107	9163.48	84	283.13	1	4.47	3028.92
4	Devghat Rural Municipality	39	5647.02	47	250.94	2	4.47	5781.57

5	Rising Rural Municipality	65	8024.96	93	517.90	0	0	3782.14
	Total	283	30,5336. 26	32 5	1446.78	5	16.64	16,886.32

Note: Number of registered private forests is 84 covering 46.56 ha.
Source: Website of Division Forest Office, Tanahu. (https://dfotanhun.gov.np)
RM=Rural Municipality, UM=Urban Municipality
CF=Community Forest, LF=Leasehold Forest, RF=Religious Forest, NF=National Forest

5.2.1.3 Forest management practices in the project development area

Most of the forested area in and around the project site are being managed by the community, either as a Community Forest or as a Leasehold Forests, which are presented in the table below.

Table 5. 15: Community forests affected by the project. (source: Baseline Survey 2023, EIA Study)

SN	Project component	Total land requirement for the project component [ha]	Forest area required for the project component [ha]	Project Municipality	Forest management (CF/ NF)	Remarks
1	Reservoir	157.45	30.29	Bandipur – 6	Siddhartha CF Bakhar Khola CF – Sarang Ghat	Left bank
				Byas 14	Rumsi CF Harkapur CF Bhayar CF – Masdi Ghat Todke CF	Left bank
				Byas 13	Benikot CF – Koidium Ghat Pokhari Chhap – Kharaasdi Khola	Left bank
				Devghat 3	Sirchuli CF – Naldighat	Right bank
				Devghat 2	Chiuri Bhanjyang CF	Right bank
				Rishing 3	Solang CF	Right bank
				Rishing 1	Koidium CF	Right bank
2	Intake	8.63	3.19	Bandipur - 6	Siddhartha CF Bakhar Khola CF – Sarang Ghat	Left bank

				Devghat 3	Sirchuli CF	Right bank
3	Adit 2	0.09	0.09	Devghat 3	Sirchuli CF	
4	Adit 3	0.07		Devghat 4	Janahit CF	
5	Adit 4	0.17		Devghat 4	Ghusitol Leasehold Forest Gotheri Leasehold Forest	
6	Dumping area HW	6.88	NA	Devghat - 4	Sirchuli CF Ghusitol Leasehold Forest Gotheri Leasehold Forest	

The project study team has collected most of the information on the forest and its management through field observation and consultation with the local communities and member for CFUGs.

5.2.1.4 Vegetation and Forest Resources in the Project Area

The flora and vegetation in the project area are typical of the lower tropical areas found in similar bioclimatic zones of central Nepal. However, the local habitat condition and physical settings of the surrounding area have a significant influence on the vegetation.

Due to its proximity to the Pokhara Valley, one of the wettest regions in the country, the flora and vegetation in the project area are more representative of wet climatic conditions. The high amount of rainfall in the surrounding areas generally supports tall and dense vegetation. However, due to steep topography and rocky physical setting, the project sites, particularly on the right bank of the river, have moderate vegetation density with fewer trees and bushy vegetation. On the left bank of the river, the vegetation is affected by road construction and settlements, resulting in visible degradation of the forest due to human interferences.

5.2.1.5 Vegetation in the project construction site

5.2.1.5.1 Forests in the Dam /Barrage and Reservoir area

The LS reservoir area is predominantly covered by forested vegetation on both sides of the Seti River, except for areas under cultivation, thin settlements, and bushlands. However, on the left side of the river, the vegetation has been significantly modified due to road construction. On the other hand, the right side of the river has steep slopes and is difficult to access, resulting in less disturbed vegetation. The riverbanks are known for their high biodiversity due to the unique habitat conditions created by the riverine environment.

Principal tree species of this site were:

Dhale Katus *Castanopsis indica*	Bot Dhaiyaro (*Lagestroemia parviflora*)	Saandan (*Desmodium oojeinense*)
Chilaune *Schima wallichii*	Sindure (*Mallotus philippensis)*	Tinju (*Diospyrus sp*.)
Bhelor (*Trewia nudiflora*)	Sal (*Shorea robusta*)	Bohori (*Cordia dichotoma*)
Khirro (*Falconeria insignis*)	Karam (*Haldina cordifolia*)	Kyamuna (*Syzygium nervosum*)
Simal (*Bombax ceiba*)	Bel (*Aegle marmelos*)	Dumri (*Ficus racemosa*)
Saaj (*Terminalia elliptica*)	Chhativan (*Alstonia scholaris*)	Taadee (*Pandanus furcatus*)
Bhorla (*Phanera vahlii*)		

	
Lower part of reservoir area	Middle part of the reservoir area

Figure 45: Vegetation in the surrounding of the reservoir area (Source: Field work for EIA Study, 2023)

Likewise, prominent shrubs and herbs of this site were:

Asuro (*Justicia adhatoda*)	Dhursul (*Colebrookia oppositifolia*)	Dhaiyaro (*Woodfordia fruiticosa*)
Curry Patta (*Murraya koenigii*)	Simali (*Vitex negundo*)	Baghmukhe (*Caryopteris bicolor*)
Sajiban (*Jatropa curcas*)	Bhati (*Clerodendron viscosum*)	Bayar (*Zizyphus mauritiana*)
Sisno (*Urtica dioca*)	Datiwan (*Achyranthus aspera*)	Siru (*Imperata cylindrica*)
Amriso (*Thysanolaena maxima*)	Babiyo (*Eulaliopsis binata*)	Kurilo (*Asparagus racemosus*)
Banmara (*Chromolaena odorata*)	Niuro (*Diplazium esculentum*)	Titepaati (*Artemisia indica*)
Gandhe (*Ageratum conyzoides*)	Kaans (*Saccharum spontaneum*)	Kaali Niuro (*Tectaria coadunata*)
Mauro (*Pteris biaurita*)	Lajjawati (*Mimosa pudica*)	

5.2.1.5.2 Powerhouse Complex

There is no significant tree vegetation in the powerhouse site. However, there are some scattered tree species around this site which include.

Simal (*Bombax ceiba*)	Bakaino (*Melia azadiractah*)	Kabhro (*Ficus lacor*)
Dabdabe (*Garuga pinnata*)	Chaap (*Magnolia champaca*)	Gineri (*Premna barbata*)
Taki (*Bauhinia purpurea*)	Aanp (*Mangifera indica*)	Litchi (*Litchi chinensis*).

Close to this site some bamboo clumps (*Dendrocalamus sp*.) were also recorded.

5.2.1.5.3 Adit 1

Tree species observed and Sal (*Shorea robusta*), Saaj (*Terminalia elliptica*), Bot Dhaiyaro (*Lagestroemia parviflora*), Kyamuna (*Syzygium nervosum*), etc. and some ground flora recorded in this site are Dhursul (*Colebrookia oppositifolia*), Dhaiyaro (*Woodfordia fruiticosa*), Angeri (*Osbekia nepalensis*), Kharighans (*Pogonantherum crinitum*), Rudilo (*Pogostemon benghalensis*), etc.

5.2.1.5.4 Adit 2

Principal tree components of this site are Sal (*Shorea robusta*), Saaj (*Terminalia elliptica*), Kyamuna (*Syzygium nervosum*), Chilaune (*Schima wallichii*), Guelo (*Callicarpa arborea*), Khayar (*Senegalia catechu*), Tanki (*Bauhinia purpurea*), *etc*., and some shrubs and herb species are Dhursul (*Colebrookia oppositifolia*), Bilaune (*Maesa chisia*), Rudilo (*Pogostemon benghalensis*), Kharighans (*Pogonantherum crinitum*), Paani Amala (*Nephrolepis codifolia*), Niuro (*Diplazium esculentum*), *etc*.

5.2.1.5.5 Adit 3

This site is almost devoid of tree vegetation. However, some tree species recorded at the surrounding area are Bot Dhaiyaro (*Lagestroemia parviflora*), Khirro (*Falconeria insignis*), Guelo (*Callicarpa arborea*), Harro (*Terminalia chebula*), Barro (*Terminalia bellirica*), Sal (*Shorea robusta*), Karam (*Haldina cordifolia*), *etc*.

5.2.1.5.6 Adit 4 in Powerhouse Complex

There is no significant tree vegetation in the powerhouse site. However, there are some scattered tree species around this area. They include Simal (*Bombax ceiba*), Bakaino (*Melia azadirac*), Kabhro (*Ficus lacor*), Gineri (*Premna barbata*), Taki (*Bauhinia purpurea*), Dabdabe (*Garuga pinnata*), *etc*., along with some bamboo clumps (*Dendrocalamus sp*.).

5.2.1.5.7 Camp sites

Both the camp sites (near headworks and powerhouse) are in the agricultural fields, which are devoid of tree vegetation. Common plants found in this locality are Lunde Kanda (*Amaranthus spinosus*), Titepaaati (*Artemisia indica*), Kalo Kuro (*Bidens pilosa*), Sano Taapre (*Cassia tora*), Bethe (*Chenopodium album*), Salaha Jhar (*Conyza sp*.), Baakhre Ghans (*Crassocephalum crepidioides*), Chitlange Ghans (*Galinsoga parviflora*), Seto Gandhe Jhar (*Ageratum conyzoides*), Nilo Gandhe Jhar (*Ageratum houstonianum*), Seto Banmara (*Chromolaena odorata*), Bhede Kuro (*Xanthium strumarium*), Boki Jhar (*Gnaphalium leutoalbum* subsp. affine), Ratnyaulo Jhar (*Persicaria capitata*), *etc*.

5.2.1.5.8 Project access road to Adit and Adit portals

Project access road to Adit and Adit portals passes from cultivated land and some forest area consisting of sparsely distributed tree species. Some of the tree species of this locality are Khirro (*Falconeria insignis*), Karam (*Haldina cordifolia*), Simal (*Bombax ceiba*), Bakaino (*Melia azadiractah*), Kabhro (*Ficus lacor*), Dabdabe (*Garuga pinnata*) Chaap (*Magnolia champaca*), Gineri (*Premna barbata*), Taki (*Bauhinia purpurea*), Kyamuna (*Syzygium nervosum*), Chilaune (*Schima wallichii*), Sal (*Shorea robusta*), Saaj (*Terminalia elliptica*), Bot Dhaiyaro (*Lagestroemia parviflora*), *etc*.

Common shrubs and herbs are Dhursul (*Colebrookia oppositifolia*), Dhaiyaro (*Woodfordia fruiticosa*), Angeri (*Osbekia nepalensis*), Bilaune (*Maesa chisia*), Rudilo (*Pogostemon benghalensis*), Kharighans (*Pogonantherum crinitum*), Paani Amala (*Nephrolepis codifolia*), Niuro (*Diplazium esculentum*), etc. along with some bamboo clumps (*Dendrocalamus sp*.).

5.2.1.5.9 Project access road from powerhouse to headworks and surge tank

The project access road consists mainly of cultivated field and very few standing trees. Plant species found in this alignment are Baghmukhe (*Caryopteris odorata*), Dhaiyaro (*Woodfordia fruiticosa*), Batulipate (*Rotala rotundifolia*), Andir (*Ricinus communis*), Asuro (*Justicia adhatoda*), Painleti (*Cipadessa baccifera*), Bhuin Amala (*Phyllanthus urinaria*), Datiwan (*Achyranthes aspera*), Dhursul (*Colebrookia oppositifolia*), Bihi (*Solanum torvum*), Curry Patta (*Muraya coenigi*), Kharighans (*Pogonantherum crinitum*), Babiyo (*Eulaliopsis binata*), Amriso (*Thysanolaena maxima*), Kaans (*Saccharum spontaneum*), Titepati (*Artemisia indica*), Rudilo (*Pogostemon benghalensis*), *etc*.

Significant tree species include Sindure (*Mallotus philippensis*), Padke Siris (*Albizzia odoratissima*), Khanayo (*Ficus cunia*), Chiuri, Bakaino (*Melia azadirach*), Simal (*Bombax ceiba*), Tinju (*Diospyrus melanoxylon*), Chhatiwan (*Alstonia scholaris*), Harro (*Terminalia chebula*), Barro (*T. bellirica*), Kainjal (*Bischofia polycarpa*), etc.

5.2.1.5.10 Muck disposal sites

Both the muck disposal sites (near headworks and powerhouse) are located partly in the vegetated area.

Principal tree species of the disposal site near headworks area are Simal (*Bombax ceiba*), Saaj (*Terminalia elliptica*), Bot Dhaiyaro (*Lagestroemia parviflora*), Tinju (*Diospyrus sp*.), Sindure (*Mallotus philippensis*), Karam (*Haldina cordifolia*), Bel (*Aegle marmelos*), Bohori (*Cordia dichotoma*), *etc*. Prominent shrubs and herbs of this site are Dhaiyaro (*Woodfordia fruiticosa*), Simali (*Vitex negundo*), Baghmukhe (*Caryopteris bicolor*), Bhati (*Clerodendron viscosum*), Sisno (*Urtica dioca*), Kurilo (*Asparagus racemosus*), Seto Banmara (*Chromolaena odorata*), Titanate (*Artemisia indica*), Gandhe (*Ageratum conyzoides*), Kaans (*Saccharum spontaneum*), *etc*.

Principal tree components of disposal site near powerhouse area are Saaj (*Terminalia elliptica*), Kyamuna (*Syzygium nervosum*), Bot Dhaiyaro (*Lagestroemia parviflora*), Guelo (*Callicarpa arborea*), Khayar (*Senegalia catechu*), Tanki (*Bauhinia purpurea*), *etc*. Ground flora recorded in this site are Dhursul (*Colebrookia oppositifolia*), Dhaiyaro (*Woodfordia fruiticosa*), Kharighans (*Pogonantherum crinitum*), Rudilo (*Pogostemon benghalensis*), Niuro (*Diplazium esculentum*), Paani Amala (*Nephrolepis codifolia*), *etc*.

5.2.1.5.11 Dewatered zone

Principal tree components of the of this site are Khayar (*Senegalia catechu*), Sal (*Shorea robusta*), Harro (*Terminalia chebula*), Barro (*T. bellirica*), Saaj (*T. elliptica*), Kainjal (*Bischofia polycarpa*), Bot Dhaiyaro (*Lagestroemia parviflora*), Sindure (*Mallotus philippensis*), Padke Siris (*Albizzia odoratissima*), Khanayo (*Ficus cunia*), Chiuri (*Diploknema butyracea*), Bakaino (*Melia azadirach*), Simal (*Bombax ceiba*), Tinju (*Diospyrus melanoxylon*), Dabdabe (*Garuga pinnata*), Chhatiwan (*Alstonia scholaris*), Bhorla (*Phanera vahlii*), Taadee (*Pandanus furcatus*), Saandan (*Desmodium oojeinense*), *etc*.

Prominent shrubs and herbs are Asuro (*Justicia adhatoda*), Painleti (*Cipadessa baccifera*) Dhursul (*Colebrookia oppositifolia*), Baghmukhe (*Caryopteris odorata*), Dhaiyaro (*Woodfordia fruiticosa*), Ank (*Calotropis gigantea*), Bihi (*Solanum torvum*), Curry Patta (*Muraya coenigi*), Kharighans (*Pogonantherum crinitum*), *Lindenbergia grandiflora*, Babiyo (*Eulaliopsis binata*), Amriso (*Thysanolaena maxima*), Kuro (*Bidens pilosa*), Rani Sinka (*Aleuritopteris bicolor*), Titepati (Art*emisia indica*), Rudilo (*Pogostemon benghalensis*), Datiwan (*Achyranthes aspera*), Kholi Niuro (*Dryopteris cochleata*), etc.

5.2.1.6 Plant Diversity

The project site and its surrounding areas host a diverse range of plant species. The plants recorded and observed in and around the project site are categorized by their life-forms and distribution pattern, which are listed below.

Table 5. 16: Plant species recorded in the project area

SN	Scientific Name	Local name	Life-form	Distribution pattern
1	*Achyranthes aspera*	Datiban	Herb	Common
2	*Adiantum capillus-veneris*	Unyu	Herb	Common
3	*Aegle marmelos*	Bel	Tree	Occasional
4	*Agerarum conyzoides*	Gandhe	Herb	Common
5	*Agerarum houstonianum*	Nilo Gandhe	Herb	Common
6	*Albizia lucidior*	Padke Siris	Tree	Common
7	*Albizia chinensis*	Siris	Tree	Common
8	*Aleuriopteris bicplor*	Rani Sinka	Herb	Common
9	*Alstonia scholaris*	Chhatiwan	Tree	Sparse
10	*Amaranthus spinosus*	Lunde	Herb	common
11	*Artemisia indica*	Titepati	Herb	Common
12	*Artocarpus lakoocha*	Badahar	Tree	Occasional
13	*Asparagus racemosus*	Kurilo	Herb	Occasional
14	*Azadiractah indica*	Neem	Tree	Rare

15	*Bauhinia variegata*	Koiralo	Tree	Sparse
16	*Bauhnia purpurea*	Tanki	Tree	Occasional
17	*Bidens pilosa*	Kuro	Herb	Common
18	*Bischofia polycarpa*	Kainjal	Tree	Rare
19	*Brassiopsis hainla*	Bhuletro	Tree	Rare
20	*Bridelia retusa*	Gayo	Tree	Rare
21	*Boehmeria rugulosa*	Daar	Tree	Sparse
22	*Bombex ceiba*	Simal	Tree	Occasional
23	*Bambusa nepalensis*	Choya Baans	Tall grass	Rare
24	*Butea minor*	Bhuletro	Climber	Rare
25	*Callicarpa arborea*	Gunyelo	Tree	Sparse
26	*Callicarpa macrocarpa*	Sano Gunyelo	Shrub	Sparse
27	*Calopogonium mucunoides*	Gahate Jhar	Creeping herb	Rare
28	*Calotropis gigantea*	Aank	Shrub	Sparse
29	*Cannabis sativa*	Ganja	Shrub	Sparse
30	*Castanopsis indica*	Dhale Katus	Tree	Sparse
31	*Carex sp.*	Ghaans	Herb	Sparse
32	*Caryopteris odorata*	Baghmukhe	Shrub	Occasional
33	*Cassia fistula*	Rajbriksha	Tree	Occasional
34	*Cassia tora*	Taapre	Shrub	Common
35	*Casearia graveolens*	Badkaulo	Shrub	Common
36	*Centella asiatica*	Ghodtaapre	Herb	Common
37	*Chenopodium album*	Bethe	Herb	Common
38	*Chromolaena odorata*	Seto Banmara	Herb	Common
39	*Cipadessa baccifera*	Paileti	Shrub	Occasional
40	*Cissampelos pareira*	Batulpaate	Herb	Occasional

41	*Clerodendron indicum*	Bhati	Shrub	Common
42	*Clerodendron japonicum*	**	Shrub	Common
43	*Coccinia grandis*	Golkankri	Climber	Rare
44	*Colebrookia oppositifolia*	Dhursul	Shrub	Common
45	*Cordia dichotoma*	Bohori	Tree	Rare
46	*Crasssocephalum crepidioides*	**	Herb	Common
47	*Crateva unilocularis*	Sipligham	Tree	Rare
48	*Curculigo orchioides*	Kalo Musali	Herb	Sparse
49	*Cyanotis cristata*	…...	Herb	Occasional
50	*Cynoglossum zeylanicum*	Kuro	Herb	Occasional
51	*Cynodon dactylon*	Dubo	Herb	Common
52	*Cyperus rotundus*	Mothe	Herb	Occasional
53	*Cymbidium aloifolium*	Sunakhari	Herb	Occasional
54	*Cymbopogon*	Kaagati Ghaans	Herb	Rare
55	*Cynoglossum zeylanicum*	Kuro	Herb	Occasional
56	*Dalbergia sissoo*	Sisau	Tree	Abundant
57	*Dalbergia latifolia*	Satisal	Tree	Rare
58	*Datura metel*	Dhaturo	Shrub	Occasional
59	*Delonix regia*	Gul Mohar	Tree	Rare
60	*Datura stramonium*	Dhaturo	Shrub	Occasional
61	*Dendrocalamus spp.*	Bans	Tall grass	Sparse
62	*Dendrocalamus strictus*	Bans	Tall grass	Sparse
63	*Dendrocalamus hamiltoni*	Tama Bans	Tall grass	Sparse
64	*Desmodium confertum*	Bhatamase	Shrub	Occasional
65	*Digitaria sp.*	Banso	Herb	Common
66	*Diploknema butyracea*	Chyuri	Tree	Occasional

67	*Dioscorea deltoidea*	Vhyakur	Climber	Rare
68	*Dioscorea bulbifera*	Gittha	Climber	Occasional
69	*Dioscorea sp.*	Kukur Tarul	Climber	Occasional
70	*Diospyrus malabarica*	Tmju	Tree	Occasional
71	*Diplazium esculentus*	Kali Niuro	Herb	Occasional
72	*Drynaria diandra*	Abijalo	Herb	Occasional
73	*Dryopteris cochleata*	Kholi Niuro	Herb	Occasional
74	*Dryopteris filix-mas*	Uniu	Herb	Common
75	*Dryopteris biaurita*	Mauro	Herb	Occasional
76	*Duabanga grandiflora*	Laampate	Tree	Sparse
77	*Elephantopus scaber*	Sahashrajari	Herb	Occasional
78	*Emblica officinalis*	Amala	Tree	Occasional
79	*Equisetum diffusum*	Ankhlejhar	Herb	Occasional
80	*Eragrostis tenella*	Ghans	Herb	Occasional
81	*Erythrina stricta*	Faledo	Tree	Sparse
82	*Eulaliopsis binata*	Babiyo	Herb	Common
83	*Euphorbia hirta*	Dudhe jhar	Herb	Common
84	*Euphorbia pulcherrima*	Lalupate	Shrub	Occasional
85	*Euphorbia royleana*	Sinundi	Shrub	Sparse
86	*Falconeria insignis*	Khirro	Tree	Sparse
87	*Ficus cunia*	Khaniyo	Tree	Occasional
88	*Ficus racemosa*	Dumri	Tree	Occasional
89	*Ficus religiosa*	Peepal	Tree	Rare
90	*Ficus sarmentosa*	Bedulo	Tree	Occasional
91	*Ficus hispida*	Khasreto	Tree	Rare
92	*Ficus lacor*	Kaabhro	Tree	Common

93	*Ficus raceamosa*	Dumri	Treee	Rare
94	*Ficus benghalensis*	Bar	Tree	Sparse
95	*Galinsoga parviflora*	**	Herb	Common
96	*Garuga pinnata*	Dabdabe	Tree	Occasional
97	*Gnaphalium sp*	**	Herb	occasional
98	*Girardinia diversifolia*	Allo	Shrub	Rare
99	*Haldina cordifolia*	Karam	Tree	occasional
100	*Hedera nepalensis*	**	Climber	Common
101	*Hedychium ellipticum*	**	Herb	Occasional
102	*Heteropogon contortus*	Khar	herb	Common
103	*Pogonantherum crinitum.*	Kharuki	Herb	Abundant
104	*Holerrhena pubescens*	Indra Jau/Sano Khirro	Shrub	Occasional
105	*Imperata cylindrica*	Siru	Herb	Sparse
106	*Inula cappa*	Gai Tihare	Shrub	Sparse
107	*Jatropa curcus*	Sajiban	Shrub	Sparse
108	*Justicia adhatoda*	Asuro	Shrub	Occasional
109	*Lagestroemia parviflora*	Budhdhaiyaro	Tree	Common
110	*Lantana camara*	Banfaanda	Shrub	Sparse
111	*Litchi chinensis*	Litchi	Tree	Occasional
112	*Lecus cephalotes*	Dronapushpi	Herb	Occasional
113	*Leea aspera, L. macrophylla*	Galeni	Herb	Common
114	*Lindenbergia grandiflora*	**	Herb	Occasional
115	*Litsea monopetala*	Kutmiro	Tree	Occasional
116	*Lygodium flexosum*	Kukrjhar	Herb	Occasional
117	*Mangifera indica*	Aanp	Tree	Occasional
118	*Maesa chisia*	Bilaune	Shrub	Rare

119	*Masa macrophylla*	Jangali Bhotate	Shrub	Occasional
120	*Magnolia champaca*	Chaanp	Tree	Rare
121	*Mallotus philippinensis*	Sindure	Tree	Occasional
122	*Melia azadiractah*	Bakenu	Tree	Occasional
123	*Momordica dioica*	Ban Karela	Climber	Rare
124	*Mimosa rubicaulis*	Areli	Shrub	Sparse
125	*Mimosa pudica*	Lajjawati	Herb	Occasional
126	*Morus alba*	Kimbu	Tree	Rare
127	*Murraya koenigii*	Karipatta	Shrub	Common
128	*Nephrolepis cordifolia*	Pani Amala	Herb	Occasional
129	*Nyctanthus arbo-tristis*	Paarijat	Tree	Sparse
130	*Onychium japonicum*	Unyu	Herb	Sparse
131	*Desmodium oogeinenssis*	Sandan	Small tree	Occasional
132	*Oroxylon indicum*	Tatelo	Tree	Tare
133	*Oxalis corniculata*	Chariamilo	Herb	Occasional
134	*Pandanus furcatus*	Tadee	Tree	Common
135	*Parthenium hysterophorus*		Herb	Common
136	*Phanera vahlii*	Bhorla	Large Climber	Occasional
137	*Phoenix sp.*	Thakal	Shrub	Occasional
138	*Phyllanthus emblica*	Amala	Tree	Occasional
139	*Phyllanthus parviflora*	Khareto	Shrub	Common
140	*Pilea glabberima*	**	Herb	Occasional
141	*Pilea weightii*	**	Herb	Occasional
142	*Piper longum*	Pipla	Climber	Rare
143	*Pogonantherum crinitum.*	Karighans	Herb	Common
144	*Pogostemon benghalensis*	Rudilo	Herb	Occasional

145	*Premna barbata*	Gineri	Tree	Rare
146	*Pteris vittata*	Unyu	Herb	Sparse
147	*Pteris biaurita*	Mauro	Herb	Sparse
148	*Ricinus communis*	Ader	Shrub	Sparse
149	*Saccharum spontaneum*	Kaans	Herb	Sparse
150	*Saccharum sp.*	Dhaddi	Herb	Sparse
151	*Sapindus mukorossii*	Rittha	Tree	Sparse
152	*Phanera vahlii*	Bhorla	Large climber	Sparse
153	*Sapium buccatum*	Ban peepal	Tree	Rare
154	*Scheichera oleosa*	Kusum	Tree	Sparse
155	*Schima wallichii*	Chilaune	Tree	Sparse
156	*Semecarpus anacardium*	Bhalayo	Tree	Occasional
157	*Senegalia catechu*	Khayar	Tree	Common
158	*Shorea robusta*	Sal	Tree	Occasional
159	*Sida cordifolia*	**	Shrub	Occasional
160	*Sida rhombifolia*	**	Shrub	Occasional
161	*Smilax ovalifolia*	Kurkurdaino	Thorny climber	Occasional
162	*Solanum nigrum*	Kaligedi		Common
163	*Solanum torvum*	Bihi	Shrub	Rare
164	*Solanum xanthocarpum, S. surattense*	Kantakaari	Herb	Sparse
165	*Spondias pinnata*	Amaro	Tree	Rare
166	*Strobilanthes angustifrons*	**	Herb	Common
167	*Syzyzium nervosum*	Kyamun	Tree	Occasional
168	*Terminalia elliptica*	Saaj	Tree	Common
169	*Terminalia bellirica*	Barro	Tree	Rare

170	*Terminalia chebula*	Harro	Tree	Rare
171	*Themeda arundinacea*	Dhaddi	Herb	Common
172	*Themeda triandra*	Khar	Herb	Common
173	*Thespesia lampas*	Van Kapas	Shrub	Occasional
174	*Thysanolaena maxima*	Amriso	Herb	Sparse
175	*Tinospora cordifolia*	Gurjo	Climber	Sparse
176	*Trachelospermum sp.*	Dudhe Lahara	Climber	Sparse
177	*Trewia nudiflora*	Ramriththa/vel lor	Tree	Common
178	*Urena lobata*	**	Shrub	Occasional
179	*Urtica dioca*	Sisno	Herb	Common
180	*Vanda sp.*	Sunakhari	Herb	Rare
181	*Vitex negundo*	Simali	Shrub	Sparse
182	*Viscum album*	Hadchur	Parasite	Rare
183	*Woodfordia fruticosa*	Dhainyaro	Shrub	Common
184	*Zizyphus mauritiana*	Bayar	Spreading shrub	Occasional

Source: Field Survey, 2022

5.2.1.6.1 Endangered/Threatened and Endemic Plants

After conducting a scoping visit and holding discussions with local communities, officials, Division Forest Office, and Community Forest User Groups, several plant species have been identified in the project area that are classified as Protected, Endangered/Threatened according to various standard publications (such as Nepal Rajpatra, Section 51, No. 36, 2058.9.16 B.S. and Nepal Rajpatra, Section 53, No. 31, 2060.8.1 B.S. and its amendment DPR, MOFE 2012). The veracity of these classifications has been confirmed through sources such as http://www.iucnredlist.org and http://www.cites.org. No endemic plants were found or reported in the project study area (Rajbhandari et al. 2017).

Please refer to the table below for a list of plants falling under different protection categories.

Table 5. 17: List of plants falling under different protected categories

S.N	Nepali Name	Scientific Name	Threat Category			Type of Protection	Remarks
			GoN	IUCN	CITES		
1	Sal	*Shorea rubusta*	Protected			Banned for felling, transport, and export	Project Site
2	Satisal	*Dalbergia latifolia*	Protected	Vu		Banned for felling, transport, and export	Project area
3	Vyaakur	*Dioscorea deltoides*		T	II		Project area
4	Sunakhari	*Cymbidium aloifolium*			II		Project site
5	Sunakhari	*Vanda sp.*			II		Project site

Source: Baseline EIA Study of Tallo Seti HEP, 2022

5.2.1.6.2 Non-timber Forest Products and Plants of Ethno-botanical uses

Based on the preliminary survey of the traditional and ethno-botanical uses of plants found in and around the project alignments, it was discovered that the local population partially relies on non-timber forest products (NTFPs) and forest-based resources. Most individuals utilize forest-based resources solely to meet their daily needs, such as collection firewood, wild fruits, and vegetables for personal consumption. Nevertheless, a few locals generate extra income by selling these resources in the local market (note that local markets are relatively small catering services to few HHs - 10 to 100). Furthermore, numerous plant species are recorded from the area, which has been used by locals, and have ethnobotanical importance, which are presented in the table below:

Table 5. 18: Ethnobotanical use of the plants recorded from the project area (Source: Baseline survey, 2022)

SN	Ethno-botanical uses	Species	Remarks
1	Medical use	Titepati (*Artemisia sp.*)	Treating wounds and skin allergy
		Bhogate (*Phanera vahli*)	Treating urinary tract issues

		Sinka (*Aleuritopteris bicolor*)	It is a fern species. Its leaves are used in treatment of respiratory problems such as asthma, bronchitis, and coughs. Its stems are used for ear piercing.
		Ghodtapre (*Centella asiatica*)	Brain tonic, treatment of gout, uric acid, fever and other.
		Harro (*Terminalia chebula*)	Treatment of cold and cough
		Khayar (*Acacia catechu*)	Khaya tree bark are used in traditional medicine as an astringent and antiseptic.
		Lajjawati (*Mimosa pudica*)	It has several medicinal uses – root and leaves are used to prepare decoction to treat epilepsy, paralysis, as well as treat urinary tract infection and other inflammatory conditions. The plant's extract has been shown to have antibacterial and antifungal quality as well.
		Amala (*Phyllanthus emblica*)	The fruit of Amala is rich in Vitamin C and is used to boost immunity and promote overall health.
		Batupaate (Cissampelos sp.)	The plant is known to have anti-inflammatory and analgesic properties. The roots and leaves of the plant is boild in water to make a decoction, which is used to treat diarrhea, dysentery, and stomach aches.
		Sisno (*Urtica dioca*)	The plant is known to have anti-inflammatory properties and is used to treat conditions such as arthritis and joint pain.
2	Religious use	Peepal (*Ficus religiosa*)	Sacred tree in Hinduism and Buddhism.
		Dubo (*Cynodon dactylon*)	Duba is commonly used in religious ceremonies. Sometime used to prepare garlands and often used to decorate temples.
		Dumri (*Ficus racemosa*)	Dumri tree are commonly known as Fig Tree or Gular Tree. The tree is considered sacred and often planted near temples. The leaves are used as offerings in traditional religious ceremonies.
		Bel (*Aegle marmelos*)	The Bel tree is considered sacred and often planted near temples. The leaves and fruits are used in traditional religious ceremonies.
3	Agriculture implements	Chilaune (*Schima wallichii*)	Its timber is used to make various farm implements such as plows, yokes, and carts. It is also used to construct farmhouses, barns, fences, and storage sheds.

			Its leaves are also used as traditional herbal medicine to treat various ailments of animals.
4	Economic	Simal (*Bombax ceiba*)	The soft fibers that surround its seeds are used for stuffing pillows, mattresses. Simal wood is also used for making furniture, boat, and in construction.
		Allo (*Girardinia diversifolia*)	Making of clothes
		Bhorla (*Phanera vahii*)	Making of rope, and local use its leaves as umbrella.
		Babiyo (*Eulaliopsis binata*)	Making of ropes and broom
		Amriso (*Thysanolaena crinitum*)	The leaves of the Amriso plant are used for making rope, basket, mats, and other handicrafts. The leaves of the Amriso plant are used for mulching in agriculture to retain soil moisture and prevent erosion.
		Laampate (*Duabanga grandiflora*)	The wood of the Laampate tree is highly valued for its durability and is used for making furniture, agricultural tools, and construction materials.
		Simal (*Bombax ceiba*)	Simlar tree is used as timber for furniture, construction, and boar-making. The wood is strong, usable and resistant to decay.
		Dendracalamum sp.	It is a genus of bamboo. It is used as building materials for construction, including houses, bridges and other structures. The bamboo is strong, lightweight, and flexible, making it ideal for construction.
5	Food	Vyakur (*Dioscorea deltoidea*)	It is also known as Ban Tarul or Wild Yam. It is used as a culinary ingredient in traditional Nepali cuisine as a vegetable.
		Sisno (*Urtica dioca*)	Besides medicinal property, Sisno is also used as a culinary ingredient in traditional Nepali cuisine as a vegetable.
		Gittha (*Sioscorea bulbifera*)	Gittha, its aerial tubers are cooked and consumed as a vegetable in Nepal.
		Kalo nihuro (*Diplazium exculentus*)	Kalo Nihuro is a popular wild edible vegetable that is consumed as a delicacy. The young fronds of fern are harvested and cooked as a vegetable, often in combination with other wild greens.
6	Fodder	Khanayo (*Ficus cunia*)	The leaves are used as a fodder for livestock. In some parts of Nepal, it is also grown as a food crop.

		Badahar (*Atrocarpus lakoocha*)	Fodder
		Muse Kharuki (*Pogonantherum crinitum*)	Also known as Sano Chyante used as fodder
		Karyo (*Ficus lacor*)	The leaves of the Karyo tree are used as fodder for livestock.

Sunakhari (*Cymbidium aloifolium*) -1, an epiphytic orchid, at the bank of Seti river

Sunakhari (*Vanda sp.*) – 2, an epiphytic orchid, at the bank of Seti River

Kaligedi (*Solanum nigrum*)

Unyu (*Pteris vitta*)

	
Unyu (*Adiantum capillus-veneris*)	*Lindenbergia grandiflora*
	
Dhursul (*Colebrookia oppositifolia*)	Kainjal (*Bischofia polycarpa*) tree with fruits
	
EIA study team	Consultations with local community

Figure 46: Common plants recorded from the project area (Baseline field work, 2022)

5.2.1.6.3 Agro-diversity

The study area contains a significant expanse of land suitable for agricultural activities, which is primarily utilized for traditional farming practices. This agricultural system features an integrated crop-livestock production system that serves as a means of subsistence for the local households. The farmers cultivate crops in small, concentrated areas, with a focus on cereal crops such as paddy, maize, millets, wheat, pulses, mustard, and vegetables. Additionally, they cultivate some perennial crops such as fruits, fodder, and timber, primarily for household consumption.

The major crops being cultivated in the project area are presented in the table below:

Table 5. 19: Major crops of the project area (Baseline study, 2023)

SN	Crops	Species
1	Cereals	Paddy (*Oryza sativa*), Local varieties: Raam, Sabitri, Ekledhan, Sukkha2,3; Makawanpure; Maize (*Zea mays*), Local varieties: yellow, white, and red; Gahun (*Triticum aestivum*); Kodo (*Eleusine coracana*)
2	Pseudo-cereal	Phapar (Fagopyrum esculentum)
3	Pulses	Bean (*Phaseolus mungo*), Chickpea (*Cicer arietinum*), Bodi (*Vigna sinensis*), Gahat (*Dolichus biflorus*), Simi (*Phaseolus vulgaris*), Masuro (*Lens culinaris*)
4	Vegetables	Mustard (*Brassica oleracia var. botrytis*), Potato (*Solanum tuberosum*), Mula (*Raphnus sativus*), Ghiraula (*Luffa cylindriccal*), Chichindo (*Trichosanthes dioca*), Bhanta (*Solanum melongena*), Dhaniya (*Coriandrum sativum*), Golbheda (*Lycopersicon esculentum*), Carrot (*Daucus carota*), Kakro (*Cucumis sativum*), Tite Karela (*Momordica charantia*), Pharsi (*Cucurbita pepo*), Pindalu (*Colocasia* sp.), Rayo ko Sag (*Brassica juncea*), Banda (*Brassica olaracea var. capitata*), Lauka (*Lagenaria ciseraria*), Kauli (*Brassica olaracea var. botrytes*)
5	Cash crops	Ukhu (*Saccharum officinaram*), Adhuwa (*Zinziber officinale*), Lasun (*Allium sativum*), Pyaaj (*Allium cepa*), Khursani (*Capsicum frutescens*), Besar (*Curcuma domestica*)
6	Fruits:	Litchi (*Litchi chinensis*), Banana (*Musa paradisiaca*), Aanp (*Mangifera indica*), Papaya (*Carica papaya*), Ammba (*Psidium guahava*), Aru (*Prunus domestica*), Kagati (*Citrus acida*), Nibuwa (*Citrus limon),* Bhuikatahar (*Ananas cosmosus*), Katahar (*Atrocarpus heterophyllus*)

5.2.2 Wildlife

Human interference and encroachment have significantly degraded the project area's habitat. The locals extensively practice cattle grazing and extract forest resources, exacerbating the habitat degradation. Anthropogenic disturbances and the area's proximity to settlements have led to a decrease in the diversity and abundance of wildlife, particularly mammalian species. Additionally, reports of accidental as well as intentional forest fires have emerged. The baseline study has revealed a limited presence of wildlife in the area, potentially due to the fragmented and degraded habitat.

5.2.2.1 Herpetofauna of the project area

The project area has confirmed the occurrence of 38 herpetofauna species (see Annex L-3). Among the recorded species, 10 are amphibians, 13 are lizards, at least two are turtles, and 13 are snakes (eight nonvenomous and five venomous).

The recorded herpetofauna included species with IUCN Red List Status ranging from Least Concern (LC) to Critically Endangered (CR), listed in CITES I and II Appendices, and included in the protected priority list of Nepal government's National Parks and Wildlife Conservation Act, 1973 (2029 BS). The Critically Endangered (CR) Elongated turtle - *Indotestudo elongata*, occurs in the mixed broadleaved forest of Khode (586m) and Symchyang (714m) villages. However, occasional occurrence of crocodiles has been reported from the area, whereas occurrence of terrestrial and aquatic turtle species reported to be scarce.

According to locals, crocodiles and turtles are found in the Seti River, and occasionally 4-5 kg turtles were caught in the gill nets. Crocodiles, both young and adults, are observed basking or swimming in deep pools. Turtles (both hard shell and soft-shell spp.) are occasionally found up to the Dhap area (Mr. Nim Bahadur Thapa and Mr. Ash Bahadur Gurung, Pers. comm.). The lowest elevation for the Kashmir rock agama, *Laudakia tuberculata*, in Nepal is recorded at 187m in Labdi (27 50,1NL, 84, 27, 51EL), which was earlier at 790m (Shah and Tiwari, 2004).

Last year, a crocodile was seen basking below Labdi by Debendra Jung Gurung of Amdanda village, Debghat Municipality, ward no. 4. In 2021, an adult python and crocodile were seen below Gaighat bridge (Mr. Durga Man Gurung, Acting ward chairman, Debghat Municipality, ward no. 4. Pers Comm., 2022). In April 2022, two combating male king cobras were observed in Saranghat by Mr. Milan Kumar Gurung, a hotelier, and some locals also made videos of the incident.

5.2.2.1.1 Conservation status of the herpetofauna

The herpetofauna in the project area comprised of 14 species classified as Least Concern (LC) in the IUCN Red Data Book of Threatened Species, with three species listed in CITES[2]

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), is a multilateral treaty established to safeguard listed species of plants and animals from overexploitation due to international trade and ensure that such trade does not threaten their survival. Its genesis can be traced back to a resolution passed in 1963 during a meeting of members of the IUCN (The World Conservation Union) aimed at controlling the trade of threatened species. The draft was eventually adopted in Washington, D.C., USA, on March 3, 1973, by representatives of 80 countries, and it came into force on July 1, 1975.

The regulation of the trade in wild animals and plants requires international cooperation to protect certain species from over-exploitation, as it crosses borders between countries. Thus, CITES was established to foster such cooperation. Nepal became a signatory on June 18, 1975,

Appendix I and six in Appendix II (see Annex L-3). Additionally, two species are included in the protected priority list of Nepal's National Parks and Wildlife Conservation Act, 1973 (2029 BS), while one species, the Elongated tortoise (*Indotestudo elongata*), is classified as Critically Endangered (CR) and three species as Vulnerable (VU) in the IUCN Red Data Book.

No endemic, migratory or invasive species of herpetofauna were recorded in the project area.

5.2.2.2 Mammals

The project area has confirmed occurrence of 29 mammal species (see Annex L-4). While some locals believe the presence of Clouded leopard (*Neofelis nebulosa*) and Fishing cat (*Felis viverrina*), their existence could not be ascertained without strong evidence. Respondents were also found to confuse between three wild cat species: leopard, leopard cat, and clouded leopard, as they use a common Nepali term "nigaale baagh". However, the first two species are known to occur in the area.

The recorded mammal species have global and national status ranging from Least Concern (LC) to Vulnerable (VU), are listed in CITES I and II Appendices, and are included in the protected priority list of Nepal's National Parks and Wildlife Conservation Act, 1973 (2029 BS).

The Malayan porcupine has been recorded in Aamdanda village (250m), Debghat municipality, ward no. 4, which is the lowest elevation record for this species in Nepal. Previously, it was believed that this species only occurred in the mid-hill mountains of Nepal (Baral and Shah, 2008). Both species of porcupine, Malayan porcupine (*Hystrix brachura*) and Indian crested porcupine (*Hystrix indica*), are sympatric in Naldighat, Dhap, and Khaharetal areas.

No endemic, migratory, or invasive mammal species were recorded in the project area.

5.2.2.2.1 Conservation status of the mammals

Of the recorded mammal species, four are listed in CITES Appendix I, six in Appendix II, and two are included as protected priority species under the National Parks and Wildlife Conservation Act, 1973 (2029 BS). Additionally, 2 species are classified as Vulnerable (VU), 6 as Data Deficient (DD), and 17 as Least Concern (LC) in the IUCN Red Data Book of Threatened Species. One species is classified as Endangered (EN), 5 as Vulnerable (VU), 3 as Data Deficient (DD), and 13 as Least Concern (LC) in the National Red Data Book of Threatened Species.

5.2.2.3 Human wildlife (with reference to Herpetofauna and Mammals) conflict

According to all the respondents, a moderate level of human-wildlife conflict occurring in the project area. Certain animals, including rats, mice, hares, porcupines, barking deer, and all three species of monkeys, are considered agricultural pests (as listed in Table 34), as they cause damage to various types of crops and stored grains in fields and houses. Additionally, some wildlife is known to prey on the livestock. The following recent incidents of livestock depredation by wildlife have been recorded from the area.

- In Labdi (187m 27 50,1NL, 84, 27, 51EL), a leopard took away a goat around February 2022 (Mr. Jeet Bahadur Gurung pers comm.). A goat was killed in Aamdanda (Mr. Ganga Bahadur Gurung pers comm.) by the leopard.
- In May and June 2022 alone, a yellow-throated marten had killed 22 chickens, in Gaighat.
- Yellow-throated martens are serious pests for beehives in Simchyang and Kafaldanda villages.
- Turtles accidentally caught in fishnets are often killed for their meat and shells, which are used for medicinal purposes.
- Although snakebites are not common in the area, they do occur periodically. Among venomous snakebites, the green pit viper is the most frequent. In the event of a snakebite, the wound is washed with potash water and then treated with chanting mantras, which cannot cure venomous bites. Some local elders know the chants to treat snakebites. Occasionally, snakebite victims are taken to Bharatpur, Narayanghat for treatment. In 2020, a villager in Aamdanda was bitten by a green pit viper and was hospitalized for five days.

Local wildlife is often subjected to conflicts instigated by the local people, who engage in activities such as

- Encroaching their habitats through expansion of agricultural lands and infrastructure development.
- Wildlife is illegally killed for meat, economic gain, medicine, and fur. For instance, just a few days ago (around May 5-6, 2022), a porcupine was killed in Aamdanda village by hitting its abdomen with sticks while it was cornered by dogs.
- The selling of porcupine meat is a common practice in the area (Mr. Ram Prashad Bote, Pers. comm.).
- Livestock grazing in prime wildlife habitats also adds to the conflict, as well as simply creating disturbances due to human presence in those areas.

Table 5. 20: Crops and livestock depredating by wildlife (Baseline study, 2022)

SN	Wildlife species	Damaged crops and livestock
1	Hare	Hares are often considered agricultural pests and are considered a nuisance by farmers. They cause damage to crop such as maize, wheat, and grains. They are also known to cause damage to vegetable crops and young trees
2	All three species of monkey	Monkeys are opportunistic feeders and will consume a wide variety of plants, including fruits, vegetables, grains, insects, and small vertebrates. This makes them serious pest in agricultural areas.
3	Civets (common and masked)	Civets are particularly become a nuisance where their habitat overlaps with human settlements. They are known to raid chicken

SN	Wildlife species	Damaged crops and livestock
		coops and steal eggs and may attack small livestock such as chickens and ducks. They also damage fruits such as banana, guava, litchi, mango.
4	Large Indian palm civet	The Large Indian Palm Civet, also known as the Malabar Civet, is a species that can cause human-wildlife conflict in Nepal. These civets are known to raid chicken coops and feed on poultry, causing damage and economic loss to farmers. They may also cause damage to crop such as bananas and guava, and occasionally enter human settlements and cause disturbance. Additionally, Large Indian Palm Civets have been known to attack and kill domestic cats, causing distress to pet owners.
5	Jackal	Human-wildlife conflict involving jackals is mainly related to predation on livestock, such as goats and sheep, and damage to crops. Jackals may attack and kill livestock, causing significant economic losses to farmers. They also damage crops by feeding on fruits and vegetables. In some cases, jackals may attack humans, especially if they feel threatened or cornered.
6	Porcupine	Porcupines are a common agricultural pest in Nepal, causing damage to various crops such as maize, wheat, paddy, and millet. They are known to destroy crops by chewing on the stem, leaves, and fruits. In addition to crop damage, they are also known to damage infrastructure such as water pipelines, electric wires, and wooden houses.
7	Wild boar	Wild boars are known to cause damage to crop, including maize, rice, wheat, and sugarcane, by rooting up the soil and eating the newly planted seedlings. They also damage irrigation systems and water sources by digging and wallowing in them. In addition to agricultural damage, wild boars are also known to cause physical harm to humans and their livestock. They can attack humans if they feel threatened or cornered and have been known to cause serious injuries. They also prey on small domestic animals like goats, sheep, and poultry, causing economic losses to farmers.
8	Ghoral	Ghoral, also known as Himalayan Thar, is a species of ungulate found in the Himalayan region of Nepal. Human-wildlife conflict with Ghoral typically occurs when they raid crops and plantations, especially during the winter season when food is scarce in their natural habitat. Ghoral are known to damage crops such as maize, wheat, and potato. They can also cause damage to fruit orchards

SN	Wildlife species	Damaged crops and livestock
		and timber plantations. In addition, Ghoral can transmit diseases to livestock, posing a risk to the livelihoods of local communities.
9	Mongoose	Mongoose are known to raid poultry farms or other small livestock enclosures. They may also raid damage crops, leading to conflict with farmers. In some cases, mongoose may also be considered a threat to public health as they are known carriers of rabies and may bite humans or domestic animals.
10	Yellow throated marten	Yellow-throated marten is known to raid beehives, causing losses to beekeepers, and can also prey on poultry, causing losses to farmers. They may also enter human settlements in search of food, causing damage to property and sometimes attacking pets.
11	Bengal fox	The Bengal fox (Vulpes bengalensis), like other carnivores, can come into conflict with humans over issues such as predation on livestock and pets, as well as scavenging in human settlements for food.
12	Leopard	Leopards are known to cause human-wildlife conflict. Leopards can attack livestock and, in rare cases, pose a threat to humans.

Economic, Religious and Cultural Importance (Ethnozoology) of the Herpetofauna and Mammals

Despite some mammals and reptiles being responsible for crop and livestock damage, as well as causing harm to humans as discussed above, they also hold cultural, religious, and traditional significance, such as:

- the frogs of *Nanorana spp*., locally known as "Paahaa," are collected from the Seti River and its tributaries and are used for food and medicinal purposes. These frogs are typically collected in September and October.
- The shells of turtles are kept in homes as a means of warding off lightning strikes.
- Wall lizard's tails and urine are considered poisonous, and if they meet naked skin, they may cause blisters and wounds.
- Local Chepang, Bhujel/Bote communities residing in the Gai Ghat area consume bat meat.

5.2.2.4 Habitat condition

The major habitats in the project area include forests (including Riverine forests), agricultural lands, wetlands, and settlements. Unfortunately, the forest habitats, which are highly important for wildlife, appear to be significantly degraded due to overexploitation of natural resources, as well as the construction of roads, bridges, and other linear infrastructure projects, leading to soil erosion. However, some steep forest habitats along the Seti River remain intact due to their inaccessibility.

In particular, the Elongated turtle (*Indotestudo elongate*), which is a Critically Endangered (CR) species, occurred in the mixed broadleaved forest of Khode (586m) and Symchyang (714m) villages. Additionally, several globally and nationally Endangered (EN) and Vulnerable (VU) species of herpetofauna and mammals also inhabit the project area. Therefore, the occurrence of these critically endangered, endangered, and vulnerable species highlights the importance of local habitats meeting the criteria for Critical Habitats (CH).

5.2.2.5 Significant Local Habitats

The area comprises of forests (sub-tropical broadleaf), agricultural lands, wetlands (including small ponds, streams, and rivers), and human settlements. These habitats are extensively used by local villagers for livestock grazing, as well as for collecting forest products and other resources. Unfortunately, most of these habitats have been significantly degraded due to various anthropogenic activities, such as livestock grazing, overexploitation of natural resources, and forest fires.

5.2.3 Avifauna

The Tallo Seti (Tanahun) hydropower project adopts a Peaking Run of the River (PRoR) design, utilizing an underground tunnel to redirect water from the barrage site to the powerhouse and creating a dewatered area downstream of the barrage. The water impoundment is projected to extend approximately 12.7 km upstream from the barrage to a location known as Sundhe, situated in ward no. 13 of Byas Urban Municipality. To convey the water, a Head Race Tunnel with a length of around 6.763 km passes through wards no. 3 and 4 of Devghat Municipality.

The Tallo Seti (Tanahun) Hydropower project is situated on a hill and is surrounded by five Important Bird and Biodiversity Areas (IBAs) in the vicinity, making it a strategically important location for bird and biodiversity conservation (Figure below). The Chitwan IBA/ Chitwan National Park to the south is the closest IBA to the designated Powerhouse site, located approximately 19 km from the hydropower site. The Annapurna IBA/Annapurna Conservation Area is situated to the north, at about 36 km from the edge of the reservoir area. Additionally, the Rampur IBA is about 40 km on west, Panchase IBA is about 55 km on northwest, and Manaslu IBA is 64 km north. These IBAs provide a sanctuary for a wide variety of birds. In addition to these, the Seti River corridor serves as a migratory route for raptors, particularly vultures and waterfowl, connecting their movement between lowlands of Terai and mountainous regions (see the Figure below).

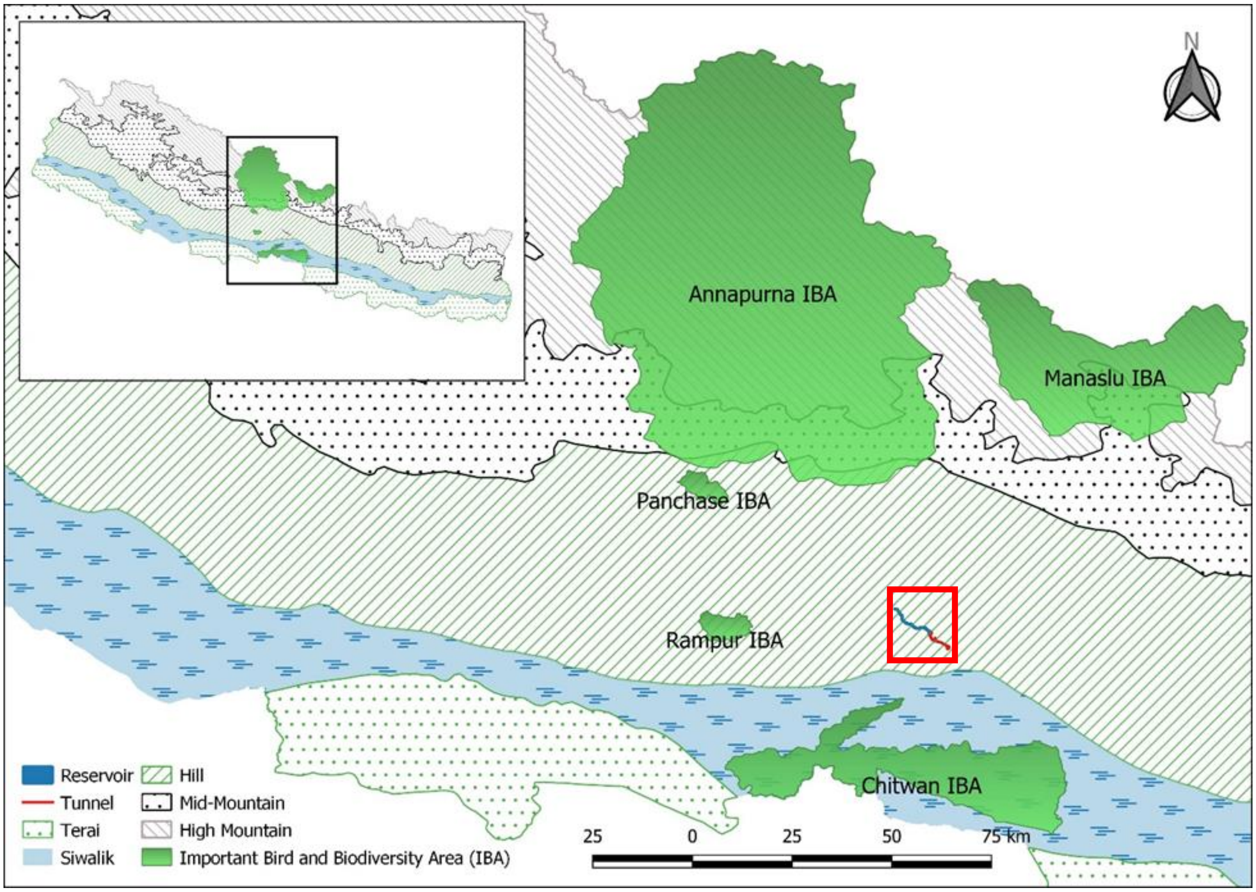


Figure 47: Tallo Seti (Tanahun) Hydropower Project Area and IBAs at the proximity

The project area comprised of diverse environment, including river riparian areas, farmland, forests, and settlements, which provide habitat for a varied assemblage of avifauna. During two study visits to the project area, a total of 594 individuals of 83 bird species were recorded. The forest birds were the most abundant recorded up to 45 species, following by 13 species of raptor, 10 species of riparian birds, 8 species of urban birds and 7 species of farmland birds. The most observed bird species were the Himalayan Bulbul (*Pycnonotus leucogenys*), Red-vented Bulbul (*Pycnonotus cafer*), and Oriental Magpie Robin (*Copsychus saularis*), which were recorded in almost 88% of the sampling transects. Additionally, the Barn Swallow (*Hirundo rustica*), Blue-whistling Thrush (*Myophonus caeruleus*), Common Myna (*Acridotheres tristis*), Indian White-eye (*Zosterops palpebrosus*), and Western Spotted Dove (*Spilopelia suratensis*) were commonly encountered in 82% of the sampling transects.

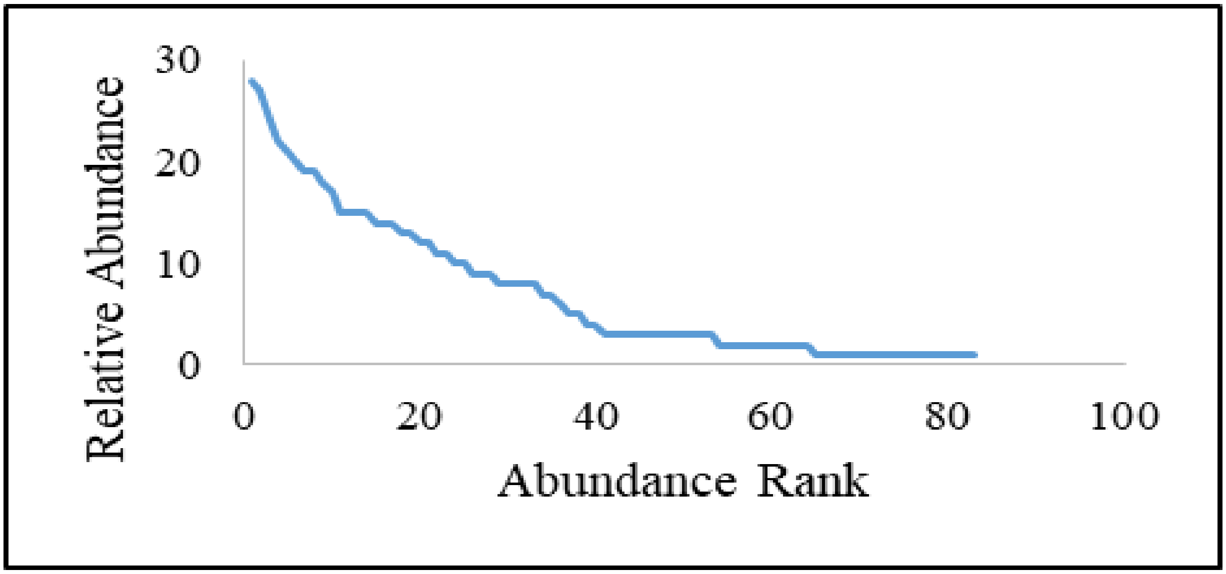


Figure 48: Rank abundance curve

The Shannon-Wienner Diversity (H') Index of 3.98 waw obtained for bird diversity, which indicated that the project area is rich in bird diversity, with species evenness value of 0.9. suggesting that the species reported in the project area are almost evenly distributed. However, the rank abundance curve displayed a steep slope, indicating low evenness.

Table 5. 21: Avifauna diversity and encounter status in the TSHPP area

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																		
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
1	Asian Barred Owlet	*Glaucidium cuculoides*	डुन्डुल	√	√				+					+								
2	Ashy Drongo	*Dicrurus leucophaeus*	ध्वाँसे चिबे	√	√	+	+	+		+			+		+	+		+				+
3	Ashy Woodswallow	*Artamus fuscus*	मिथुन		√																+	+
4	Banded Bay Cuckoo	*Cacomantis sonneratii*	धर्के खैरो कोइली	√																	+	
5	Barn Swallow	*Hirundo rustica*	घर गौथली	√	√			+	+	+	+	+		+	+	+	+	+	+	+	+	+
6	Besra	*Accipiter virgatus*	बेसरा		√								+									
7	Black Drongo	*Dicrurus macrocercus*	कालो चिबे	√	√	+	+	+	+				+			+	+			+	+	+
8	Black Francolin	*Francolinus francolinus*	कालो तित्रा		√			+	+				+			+	+	+	+			+

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
9	Black-chinned Babbler	*Cyanoderma pyrrhops*	कालोचिउँडे वनभ्याकुर		√								+									
10	Blue-fronted Redstart	*Phoenicurus frontalis*	नीलटाउके खञ्जरी	√		+	+	+	+			+			+		+	+				
11	Blue whistling-thrush	*Myophonus caeruleus*	कल्चौंड	√	√	+	+	+	+	+	+	+	+	+			+	+		+	+	+
12	Blue-throated Barbet	*Psilopogon asiaticus*	कुथुर्के	√	√								+									
13	Cattle egret	*Bubulcus ibis*	वस्तु बकुल्ला	√	√	+	+	+	+					+	+	+	+					
14	Chestnut-headed Bee-eater	*Merops leschenaulti*	कटुसटाउके मुरलीचरा		√		+	+	+					+	+	+						
15	Chestnut-tailed Starling	*Sturnia sinensis*	फुस्रोटाउके सारौँ		√																	+
16	Collared Falconet	*Mucrohierax caerulescens*	पौरी बाज		√						+		+									

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																		
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
17	Collared Scops-owl	*Otus lettia*	चित्री उलूक		√									+								
18	Common Iora	*Aegithina tiphia*	सुसेलीचरी	√		+																
19	Common Kingfisher	*Alcedo atthis*	सानो माटीकोरे		√							+	+									
20	Common Kestrel	*Falco tinnunculus*	बौँडाइ		√								+									
21	Common Myna	*Acridotheres tristis*	डाङ्ग्रे रुपी	√	√				+	+	+	+	+	+	+	+	+	+	+	+	+	+
22	Common Tailorbird	*Orthotomus sutorius*	पातसिउने फिस्टो	√	√	+	+	+	+	+				+	+	+	+	+		+		
23	Crested Bunting	*Emberiza lathami*	जुरे बगेडी		√														+			
24	Crested Serpent Eagle	*Spilornis cheela*	काकाकुल	√	√				+										+			
25	Crimson Sunbird	*Aethppyga siparaja*	सिपराजा बुङ्गेचरा	√	√														+	+		

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
26	Dark-sided Thrush	*Zooghera marginata*	लामोठूँडे सानो चाँचर		√															+		
27	Egyptian Vulture	*Neophron percnopterus*	सेतो गिद्ध	√	√	+	+	+									+					
28	Eurasian Tree Sparrow	*Passer montanus*	रुख भँगेरा	√	√				+			+	+	+	+		+		+	+		
29	Fulvous-breasted Woodpecker	*Dendrocopos macei*	काष्ठकूट	√	√														+	+		
30	Golden Eagle	*Aquila chrysaetos*	सुपर्ण महाचील	√															+			
31	Great Barbet	*Psilopogon virens*	न्याउली	√	√									+	+				+	+		
32	Great Tit	*Parus major*	चिचिल्कोटे	√	√	+	+	+	+										+	+	+	
33	Greater Yellownape	*Chrysophlegma flavinucha*	ठूलो सुनजुरे काठफोर		√									+			+					
34	Greater Coucal	*Centropus sinensis*	ढोडे गोकुल	√	√										+	+			+			

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
35	Green-billed Malkoha	*Phaenicophaeus tristis*	हरित मालकौवा		√												+				+	
36	Grey-breasted Prinia	*Prinia hodgsonii*	फुस्रोछाती घाँसे फिस्टो		√									+			+					
37	Grey Treepie	*Dendrocitta formosae*	पहाडी कोकले	√	√			+	+	+				+			+					
38	Grey-capped Emerald Dove	*Chalcophaps indica*	हरिल ढुकुर	√	√			+							+							
39	Indian Pygmy Woodpecker	*Picoides nanus*	पुन्टे काष्ठकूट	√	√				+												+	
40	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	चञ्चले अर्जुनक	√		+	+	+	+													
41	Grey-headed Woodpecker	*Picoides canicapillus*	फुस्रोटाउके काष्ठकूट		√									+								
42	Grey-hooded Warbler	*Phylloscopus xanthoschistos*	तुमुलकारी फिस्टो	√	√	+	+	+					+								+	+

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	**May**	**RT1**	**RT2**	**RT3**	**RT4**	**RT5**	**RT6**	**BT**	**A2T**	**DT1**	**DT2**	**DT3**	**DT4**	**DT5**	**HT1**	**HT2**	**HT3**	**HT4**
43	Hair-crested drongo	*Dicrurus hottentottus*	केशराज चिबे	√	√			+	+	+						+	+	+	+			
44	Himalayan Black-lored Tit	*Machlolophus xanthogenys*	पाण्डु चिचिल्कोटे	√	√								+					+		+		
45	Himalayan Bulbul	*Pycnonotus leucogenys*	जुल्फे जुरेली	√	√	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
46	Himalayan Griffon	*Gyps himalayensis*	हिमाली गिद्ध	√		+	+	+	+													
47	House Sparrow	*Passer domesticus*	घर भँगेरा	√	√				+	+	+	+	+	+	+		+				+	+
48	House Swift	*Apus nipalensis*	फिरफिरे घरगौँथली		√				+	+				+	+	+						
49	Hume's leaf Warbler	*Phylloscopus humei*	चञ्चले फिस्टो	√		+	+															+
50	Indian Golden Oriole	*Oriolus kundoo*	गाजले सुनचरी		√																+	+

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
51	Jungle Myna	*Acridotheres fuscus*	वन रुपी		√								+									
52	Indian Cuckooshrike	*Coracina macei*	लटुशक विरहीचरी		√								+									
53	Little Egret	*Egretta garzetta*	सानो सेतोबकुल्ला	√	√	+	+	+	+	+												
54	Long-tailed Shrike	*Lanius schach*	भद्राई	√	√	+	+	+		+					+	+						+
55	Orange-bellied Leafbird	*Chloropsis hardwickii*	स्वर्णोदर हरितचरी		√																+	
56	Oriental Honey-Buzzard	*Pernis ptilorhynchus*	मधुहा		√																+	
57	Oriental Magpie Robin	*Copsychus saularis*	धोबिनी चरा	√	√		+	+	+	+	+	+	+		+	+	+	+	+	+	+	+
58	Indian White-eye	*Zosterops palpebrosus*	कांकीर	√	√	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	**May**	**RT1**	**RT2**	**RT3**	**RT4**	**RT5**	**RT6**	**BT**	**A2T**	**DT1**	**DT2**	**DT3**	**DT4**	**DT5**	**HT1**	**HT2**	**HT3**	**HT4**
59	Paddyfield Pipit	*Anthus rufulus*	आली चुइयाँ	√												+	+					
60	Pied Bushchat	*Saxicola caprata*	काले भ्याप्सी	√	√								+	+	+	+						
61	Plumbeous Water-Redstart	*Phoenicurus fuliginosus*	नीलाम्बर जलखञ्जरी	√			+	+	+							+	+					
62	Purple Sunbird	*Cinnyris asiaticus*	कालो बुङ्गेचरा	√	√																+	+
63	Red Junglefowl	*Gallus gallus*	लुइँचे		√		+	+	+	+	+	+								+	+	+
64	Red-headed Vulture	*Sarcogyps calvus*	सुन गिद्ध	√		+				+		+										
65	Red-rumped Swallow	*Cecropis daurica*	गेरुकटी गौँथली		√									+			+					
66	Red-vented Bulbul	*Pycnonotus cafer*	जुरेली	√	√	+	+	+	+	+	+	+	+	+	+	+	+				+	+
67	River Lapwing	*Vanellus duvaucelii*	खोले हुटिट्याउ	√	√						+	+										

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																
				Jan	May	RT1	RT2	RT3	RT4	RT5	RT6	BT	A2T	DT1	DT2	DT3	DT4	DT5	HT1	HT2	HT3	HT4
68	Rock Dove	Columba livia	मलेवा	√	√									+		+					+	
69	Ruddy Shelduck	Tadorna ferruginea	चखेवाचखेवी	√								+						+				
70	Rusty-cheeked Scimitar Babbler	Erythrogenys erythrogenys	पाल्कोटे		√								+									
71	Sirkeer Malkoha	Taccocua leschenaultii	न्याउरी मालकौवा		√												+					
72	Slaty-backed Forktail	Enicurus schistaceus	फुस्रोढाडे खोले धोबिनी	√	√	+							+									
73	Spotted Owlet	Athene brama	कोचलगाँडे लाटोकोसेरो		√									+							+	
74	Striated Prinia	Prinia crinigera	सुया घाँसेफिस्टो		√																+	
75	Wallcreeper	Tichodroma muraria	मुरारी पुतलीचरा	√			+															

SN	Bird Species	Scientific Name	Nepali Name	Time		Study Transect																		
				Jan	**May**	**RT1**	**RT2**	**RT3**	**RT4**	**RT5**	**RT6**	**BT**	**A2T**	**DT1**	**DT2**	**DT3**	**DT4**	**DT5**	**HT1**	**HT2**	**HT3**	**HT4**
76	Western Spotted Dove	Spilopelia suratensis	कुर्ले ढुकुर	√	√	+	+		+		+	+	+	+	+	+	+	+	+	+	+	
77	White-browed Wagtail	Motacilla maderaspatensis	खोले टिकटिके	√	√	+	+				+	+					+				+	+
78	White-capped Water-Redstart	Phoenicurus leucocephalus	सेतोटाउके जलखञ्जरी	√			+	+		+						+	+					+
79	White-crested Laughingthrush	Garrulax leucolophus	हिउँजुरे तोरीगाँडा		√								+									
80	White-rumped Munia	Lonchura striata	सेतोढाडे मुनियाँ		√									+							+	
81	White-rumped Vulture	Gyps bengalensis	डंगर गिद्ध	√		+	+				+											

SN	**Bird Species**	**Scientific Name**	**Nepali Name**	**Time**		**Study Transect**																
				Jan	**May**	**RT1**	**RT2**	**RT3**	**RT4**	**RT5**	**RT6**	**BT**	**A2T**	**DT1**	**DT2**	**DT3**	**DT4**	**DT5**	**HT1**	**HT2**	**HT3**	**HT4**
82	White-breasted Kingfisher	Halcyon smyrnesis	सेतोकण्ठे माटीकोर		√	+	+	+	+	+	+	+	+		+	+						+
83	Yellow-bellied Fairy Fantail	Chelidorhynx hypoxanthus	पहेँलो मारुनीचरी	√		+																

Species occurred in 88% of the study transect

Species occurred in 82% of the study transects

R-Reservoir Area; B-Barrage Site; A: Adit; D: Dewater Zone; H: Head race Tunnel Area

5.2.3.1 Migratory status of Avifauna

Out of the 83 bird species recorded in the project area, 48 species are entirely resident to the area and do not migrate, while 30 species are resident of Nepal but show some form of migration. Among these 30 species, 18 are full migrant residents and 10 species exhibit altitudinal migration, which depends on the weather condition, seasons, food availability and habitat condition, and thus their sighting requires regular field work. Only a few species observed in the project area are full migrants, and their sighting are mostly limited to winter or summer seasons.

Ruddy Shelduck (*Tadorna ferruginea*) and Wallcreeper (*Tichodroma muraria*) are recorded as winter visitors, while Banded Bay Cuckoo (*Cacomantis sonneratii*), Chestnut-headed Bee-eater (*Merops leschenaultia*) and Indian Golden Oriole (*Oriolus kundoo*) are summer visitors recorded in the project site. Common Kestrel (Falco tinnunculus) and Oriental Honey-buzzard (*Pernis ptilorhynchus*) recorded as full migrants with varied migratory nature, reported as resident as well as passage migrant. Oriental Honey-buzzard is a summer visitor to Nepal.

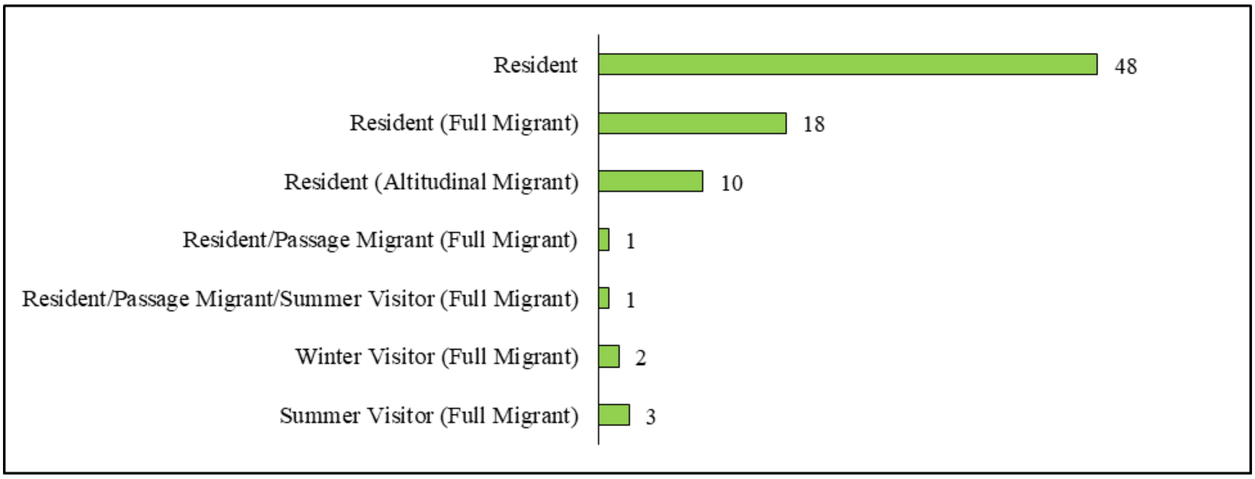


Figure 49: Migratory status of Avifauna recorded in TSHPP area

Figure 50: Winter visitor birds recorded in the TSHPP area (A) Wallcreeper and (B) Ruddy Shelduck

Figure 51: Summer visitor birds recorded in the TSHPP area (A) Banded-bay Cuckoo, (B) Chestnut-headed Bee-eater and (C) Indian Golden Oriole

Figure 52: Resident/Passsage migrant Common Kestrel (A) and Resident/Passage migrant/summer visitor Oriental Honey-buzzard (B)

Table 5. 22: Migratory status of avifauna recorded in the TSHPP area

SN	Bird Species	Scientific Name	Nepali Name	Migratory Status (Migration Pattern)
1	Asian Barred Owlet	*Glaucidium cuculoides*	डुन्डुल	R (AM)
2	Ashy Drongo	*Dicrurus leucophaeus*	ध्वाँसे चिबे	R (FM)
3	Ashy Woodswallow	*Artamus fuscus*	मिथुन	R (FM)
4	Banded Bay Cuckoo	*Cacomantis sonneratii*	धर्के खैरो कोइली	SV (FM)
5	Barn Swallow	*Hirundo rustica*	घर गौथली	R (FM)
6	Besra	*Accipiter virgatus*	बेसरा	R (AM)
7	Black Drongo	*Dicrurus macrocercus*	कालो चिबे	R (FM)
8	Black Francolin	*Francolinus francolinus*	कालो तित्रा	R
9	Black-chinned Babbler	*Cyanoderma pyrrhops*	कालोचिउँडे वनभ्याकुर	R
10	Blue-fronted Redstart	*Phoenicurus frontalis*	नीलटाउके खञ्जरी	R (AM)
11	Blue whistling-thrush	*Myophonus caeruleus*	कल्चौंड	R (FM)
12	Blue-throated Barbet	*Psilopogon asiaticus*	कुथुर्के	R
13	Cattle egret	*Bubulcus ibis*	वस्तु बकुल्ला	R (FM)
14	Chestnut-headed Bee-eater	*Merops leschenaulti*	कटुसटाउके मुरलीचरा	SV (FM)
15	Chestnut-tailed Starling	*Sturnia sinensis*	फुस्रोटाउके सारौं	R
16	Collared Falconet	*Mucrohierax caerulescens*	पौरी बाज	R
17	Collared Scops-owl	*Otus lettia*	चित्री उलूक	R (AM)
18	Common Iora	*Aegithina tiphia*	सुसेलीचरी	R
19	Common Kingfisher	*Alcedo atthis*	सानो माटीकोरे	R (FM)

SN	Bird Species	Scientific Name	Nepali Name	Migratory Status (Migration Pattern)
20	Common Kestrel	*Falco tinnunculus*	बौँडाइ	R/PM/SV (FM)
21	Common Myna	*Acridotheres tristis*	डाङ्ग्रे रुपी	R
22	Common Tailorbird	*Orthotomus sutorius*	पातसिउने फिस्टो	R
23	Crested Bunting	*Emberiza lathami*	जुरे बगेडी	R (AM)
24	Crested Serpent Eagle	*Spilornis cheela*	काकाकुल	R
25	Crimson Sunbird	*Aethppyga siparaja*	सिपराजा बुङ्गेचरा	R
26	Dark-sided Thrush	*Zooghera marginata*	लामोठूँडे सानो चाँचर	R
27	Egyptian Vulture	*Neophron percnopterus*	सेतो गिद्ध	R (FM)
28	Eurasian Tree Sparrow	*Passer montanus*	रुख भँगेरा	R
29	Fulvous-breasted Woodpecker	*Dendrocopos macei*	काष्ठकूट	R
30	Golden Eagle	*Aquila chrysaetos*	सुपर्ण महाचील	R (FM)
31	Great Barbet	*Psilopogon virens*	न्याउली	R (AM)
32	Great Tit	*Parus major*	चिचिल्कोटे	R
33	Greater Yellownape	*Chrysophlegma flavinucha*	ठूलो सुनजुरे काठफोर	R
34	Greater Coucal	*Centropus sinensis*	ढोडे गोकुल	R
35	Green-billed Malkoha	*Phaenicophaeus tristis*	हरित मालकौवा	R
36	Grey-breasted Prinia	*Prinia hodgsonii*	फुस्रोछाती घाँसे फिस्टो	R
37	Grey Treepie	*Dendrocitta formosae*	पहाडी कोकले	R
38	Grey-capped Emerald Dove	*Chalcophaps indica*	हरिल ढुकुर	R
39	Indian Pygmy Woodpecker	*Picoides nanus*	पुन्टे काष्ठकूट	R
40	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	चञ्चले अर्जुनक	R

SN	Bird Species	Scientific Name	Nepali Name	Migratory Status (Migration Pattern)
41	Grey-headed Woodpecker	*Picoides canicapillus*	फुस्रोटाउके काष्ठकूट	R
42	Grey-hooded Warbler	*Phylloscopus xanthoschistos*	तुमुलकारी फिस्टो	R
43	Hair-crested drongo	*Dicrurus hottentottus*	केशराज चिबे	R (FM)
44	Himalayan Black-lored Tit	*Machlolophus xanthogenys*	पाण्डु चिचिल्कोटे	R (AM)
45	Himalayan Bulbul	*Pycnonotus leucogenys*	जुल्फे जुरेली	R (FM)
46	Himalayan Griffon	*Gyps himalayensis*	हिमाली गिद्ध	R (FM)
47	House Sparrow	*Passer domesticus*	घर भँगेरा	R
48	House Swift	*Apus nipalensis*	फिरफिरे घरगौंथली	R
49	Hume's leaf Warbler	*Phylloscopus humei*	चञ्चले फिस्टो	R (FM)
50	Indian Golden Oriole	*Oriolus kundoo*	गाजले सुनचरी	SV (FM)
51	Jungle Myna	*Acridotheres fuscus*	वन रुपी	R
52	Indian Cuckooshrike	*Coracina macei*	लटुशक विरहीचरी	R
53	Little Egret	Egretta garzetta	सानो सेतोबकुल्ला	R (FM)
54	Long-tailed Shrike	Lanius schach	भद्राई	R (FM)
55	Orange-bellied Leafbird	Chloropsis hardwickii	स्वर्णोदर हरितचरी	R
56	Oriental Honey-Buzzard	Pernis ptilorhynchus	मधुहा	R/PM (FM)
57	Oriental Magpie Robin	copsychus saularis	धोबिनी चरा	R
58	Indian White-eye	Zosterops palpebrosus	कांकीर	R
59	Paddyfield Pipit	Anthus rufulus	आली चुइयाँ	R
60	Pied Bushchat	Saxicola caprata	काले भ्याप्सी	R (FM)
61	Plumbeous Water-Redstart	Phoenicurus fuliginosus	नीलाम्बर जलखञ्जरी	R

SN	Bird Species	Scientific Name	Nepali Name	Migratory Status (Migration Pattern)
62	Purple Sunbird	Cinnyris asiaticus	कालो बुङ्गेचरा	R
63	Red Junglefowl	Gallus gallus	लुइँचे	R
64	Red-headed Vulture	Sarcogyps calvus	सुन गिद्ध	R
65	Red-rumped Swallow	Cecropis daurica	गेरुकटी गौँथली	R (FM)
66	Red-vented Bulbul	Pycnonotus cafer	जुरेली	R
67	River Lapwing	Vanellus duvaucelii	खोले हुटिट्याउ	R
68	Rock Dove	Columba livia	मलेवा	R
69	Ruddy Shelduck	Tadorna ferruginea	चखेवाचखेवी	WV (FM)
70	Rusty-cheeked Scimitar Babbler	Erythrogenys erythrogenys	पाल्कोटे	R
71	Sirkeer Malkoha	Taccocua leschenaultii	न्याउरी मालकौवा	R
72	Slaty-backed Forktail	Enicurus schistaceus	फुस्रोढाडे खोले धोबिनी	R
73	Spotted Owlet	Athene brama	कोचलगाँडे लाटोकोसेरो	R
74	Striated Prinia	Prinia crinigera	सुया घाँसेफिस्टो	R (AM)
75	Wallcreeper	Tichodroma muraria	मुरारी पुतलीचरा	WV (FM)
76	Western Spotted Dove	Spilopelia suratensis	कुर्ले ढुकुर	R (FM)
77	White-browed Wagtail	Motacilla maderaspatensis	खोले टिकटिके	R
78	White-capped Water-Redstart	Phoenicurus leucocephalus	सेतोटाउके जलखञ्जरी	R (AM)
79	White-crested Laughingthrush	Garrulax leucolophus	हिउँजुरे तोरीगाँडा	R
80	White-rumped Munia	Lonchura striata	सेतोढाडे मुनियाँ	R
81	White-rumped Vulture	Gyps bengalensis	डंगर गिद्ध	R
82	White-breasted Kingfisher	Halcyon smyrnesis	सेतोकण्ठे माटीकोर	R

SN	Bird Species	Scientific Name	Nepali Name	Migratory Status (Migration Pattern)
83	Yellow-bellied Fairy Fantail	Chelidorhynx hypoxanthus	पहेँलो मारुनीचरी	R (AM)

R-Resident; SV- Summer Visitor; WV-Winter Visitor; PM- Passage Migrant; AM-Altitudinal Migrant; FM-Full Migrant

5.2.3.2 Congregatory Status of Avifauna

8 species of bird recorded in the project area exhibited congregatory behavior, as listed in the table below. These species were observed roosting on the riverbank in small groups or as individuals. Vultures were observed perching in various locations during the day and roosting on the riverbank, but were not seen at dusk, indicating that the Seti River corridor is used by vultures as a migratory route between feeding and roosting sites. Some vultures were observed feeding on carcasses at the riverbank. A congregation of vultures was observed at an abandoned cow rescue center located 20 km north of the project site. Cattle Egrets and Little Egrets were seen foraging along the river corridor during the daytime. Two Ruddy Shelducks were recorded roosting at the barrage site and at the confluence of the Seti River and the Trishuli River on different days during the field survey. River Lapwings were observed until dusk at the barrage site and at a resort on the bank of the Seti River, suggesting that they may use the riverbank as a shelter. Based on the sighting evidence and activities of congregatory birds, it appears that the project area is primarily used as a feeding site or migratory route by the congregatory birds rather than for congregation or roosting.

Table 5. 23: Species recorded in project area that show Congregatory behavior (Baseline Study, 2022)

SN	Bird Species	Scientific Name	Nepal Name	Congregatory
1	Barn swallow	*Hirundo rustica*	घर गौथली	Congregator (and Dispersive)
2	Cattle egret	*Bubulcus ibis*	वस्तु बकुल्ला	Congregator (and Dispersive)
3	Common kestrel	*Falco tinnunculus*	बौँडाइ	Congregatory (and Dispersive)
4	Egyptian vulture	*Neophron percnopterus*	सेतो गिद्ध	Congregatory (and Dispersive)
5	Little egret	*Egretta garzetta*	सानो सेतोबकुल्ला	Congregatory (and Dispersive)
6	River lapwing	*Vanellus duvaucelii*	खोले हुटिट्याउ	Congregatory (and Dispersive)
7	Ruddy shelduck	*Tadorna ferruginea*	चखेवाचखेवी	Congregatory (and Dispersive)
8	White-rumped vulture	*Gyps bengalensis*	डंगर गिद्ध	Congregatory (and Dispersive)

Figure 53: Roosting vultures observed at varied location in the TSHPP area

Figure 54: Red-headed Vulture (A) and Himalayan Griffon (B) feeding on same carcass left at the bank

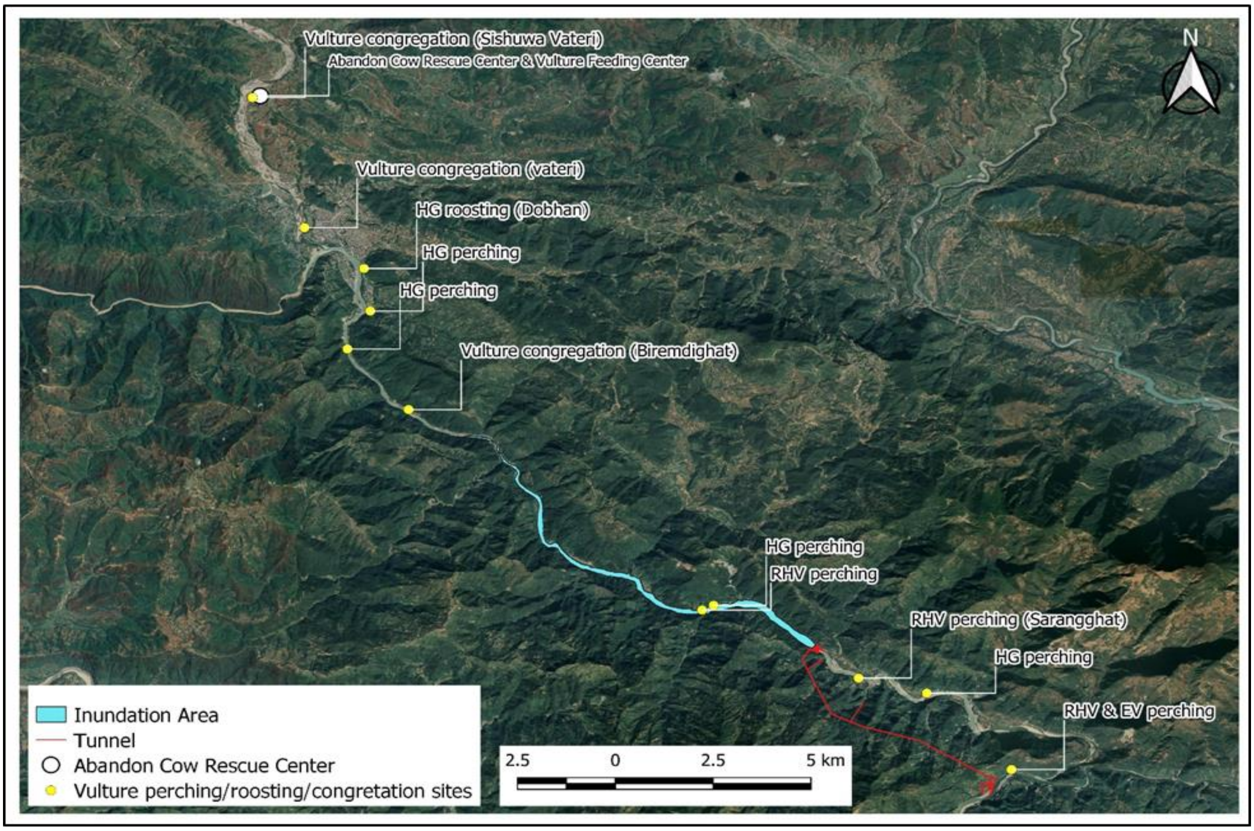


Figure 55: Vulture perching and congregation sites along the Seti River

Figure 56: Ruddy Shelduck (A) and River Lapwing (B) roosting at the Seti riverbank

5.2.3.3 Conservation Significant Avifauna

Among the bird species recorded in the project area, the majority (54%) are forest birds, followed by raptors (16%), wetland birds (12%), urban birds (10%), and farmland birds (8%). Most of the recorded bird species in the project area are of Least Concern (LC) in the global as well as national red list of birds. However, several birds recorded have conservation significance, which are illustrated below.

- 16 bird species, including vultures, owls, eagles, and buzzards, are of conservation significance, with 13 being raptors, 2 being wetland birds, and 1 being a forest bird.

- 4 bird species recorded in the project area are globally significant for conservation. The Red-headed vulture (*Sarcogyps calvus*) and White-rumped vulture (*Gyps bengalensis*) are critically endangered globally, the Egyptian vulture (*Neophron percnopterus*) is endangered globally, and the Himalayan Griffon (*Gyps himalayensis*) is Near Threatened globally.
- Although relatively fewer species are globally significant, more bird species recorded in the project area are nationally significant. The White-rumped vulture and Red-headed vulture are nationally critically endangered and endangered, respectively. The Himalayan Griffon, Golden eagle (*Aquila chrysaetos*), Egyptian vulture (*Neophron percnopterus*), and Dark-sided thrush (*Zooghera marginata*) are nationally vulnerable among the recorded bird species in the project area. The Collared falconet (*Mucrohierax caerulescens*), River lapwing (*Vanellus duvaucelii*), and Ruddy Shelduck (*Tadorna ferruginea*) are nationally Near Threatened bird species.
- Furthermore, all 13 raptor species recorded in the project area are listed in Appendix-II of the Convention on International Trade in Endangered Species (CITES) of wild fauna and flora.

None of the bird species recorded in the hydropower project area is regulated by the National Park and Wildlife Conservation (NPWC) Act.

Table 5. 24: Conservation significant avifauna in the project area (Source: Baseline study, 2022)

SN	Bird Species	Scientific Name	Nepali Name	Conservation Status			CITES
				Global	National	NPWC	
1	Asian Barred Owlet	*Glaucidium cuculoides*	डुन्डुल				II
2	Besra	*Accipiter virgatus*	बेसरा				II
3	Collared Falconet	*Mucrohierax caerulescens*	पौरी बाज		NT		II
4	Collared Scops-owl	*Otus lettia*	चित्री उलूक				II
5	Common Kestrel	*Falco tinnunculus*	बौँडाइ				II
6	Crested Serpent Eagle	*Spilornis cheela*	काकाकुल				II

7	Dark-sided Thrush	*Zooghera marginata*	लामोठूँडे सानो चाँचर		VU		
8	Egyptian Vulture	*Neophron percnopterus*	सेतो गिद्ध	EN	VU		II
9	Golden Eagle	*Aquila chrysaetos*	सुपर्ण महाचील		VU		II
10	Himalayan Griffon	*Gyps himalayensis*	हिमाली गिद्ध	NT	VU		II
11	Oriental Honey-Buzzard	*Pernis ptilorhynchus*	मधुहा				II
12	Red-headed Vulture	*Sarcogyps calvus*	सुन गिद्ध	CR	EN		II
13	River Lapwing	*Vanellus duvaucelii*	खोले हुटिट्याउ		NT		
14	Ruddy Shelduck	*Tadorna ferruginea*	चखेवाचखेवी		NT		
15	Spotted Owlet	*Athene brama*	कोचलगाँडे लाटोकोसेरो				II
16	White-rumped Vulture	*Gyps bengalensis*	डंगर गिद्ध	CR	CR		II

Note - NT-Near Threatened; VU-Vulnerable; EN-Endangered; CR-Critically Endangered

Asian-barred Owlet

Besra

	
Collared Falconet	Collared Scops-owl
	
Common Kestrel	Crested Serpent Eagle

	
Dark-sided Thrush	Egyptian Vulture

	
Golden Eagle	Himalayan Griffon
	
Oriental Honey-buzzard	Red-headed Vulture

	
River Lapwing	Ruddy Shelduck

	
Spotted Owlet	White-rumped Vulture

Figure 57: Conservation significant bird species recorded in TSHPP area.

5.2.4 Aquatic Ecology

Aquatic life samplings were conducted in specific river sections of the Seti and Trishuli Rivers within the project area. It covered five sampling stations with a total of 10 sites. These stations were strategically positioned along the river, encompassing different areas: (a) upstream of the reservoir, (b) within the reservoir, (c) in the reduced discharge stretch, (d) upstream of the tailrace, and (e) downstream of the tailrace.

The selection of these sampling sites was based on well-defined criteria. Factors such as the anticipated impacts on habitats, representative reference habitat, potential breeding sites, migration range of key species, habitat variation, river gradient, and accessibility were considered. This thoughtful selection process ensured that the study achieved comprehensive coverage and collected accurate data.

Table 5. 25: Aquatic habitat of the project area (Baseline Survey, 2022)

Station	River Section	River Section	Dominant River habitat	Major Spawning Tributaries*	Species Occurrence*	Remarks
S-1	Seti River, upstream of the reservoir	Seti River	Runs	Madi River	*Opsarius bendelisis, Neolissochilus hexagonolepis, Paracanthocobitis botia*	
S-2	Reservoir, upstream of the dam	Seti River and Dhand Khola Confluence	Runs	Dihul Khola, Masdi Khola, Dhand Khola,	*Opsarius bendelisis, Neolissochilus hexagonolepis, Paracanthocobitis botia, Danio rerio, Garra*	

Station	River Section	River Section	Dominant River habitat	Major Spawning Tributaries*	Species Occurrence*	Remarks
					gotyla, Pethia conchonius	
S-3	Reservoir, upstream of dam	Seti	Runs	+		
S-4	Downstream of the dam, reduced water zone	Bagar Khola/ Seti River Confluence	Runs	Jaubari Khola, Baruwa Khola, Bar Khola, Bhut Khola, Labdi Khola,	*Opsarius bendelisis, Neolissochilus hexagonolepis, Paracanthocobitis botia, Danio rerio, Garra gotyla, Puntius*	
S-5	Reduced Water Zone	Seti River/ Bhut Khola Confluence	Runs			
S-6	Downstream of the dam – Reduced Water Zone	Labdi Khola/ Seti River Confluence	Runs			
T-1	Trishuli River, upstream of the S/T confluence	Seti River/ Trishuli River Confluence	Runs	Rigdi Khola	*Garra gotyla, Nemacheilus corica, Opsarius bendelisis*	
T-2	Upstream of the Tailrace Outlet	Trishuli River	Runs			
T-3	Downstream of the tailrace outlet	Trishuli River	Runs	Jugedi Khola	*Garra gotyla, Nemacheilus corica, Opsarius bendelisis,*	
T-4	Down stream of the tailrace outlet	Trishuli River	Runs			

Based on consultation and sampling survey

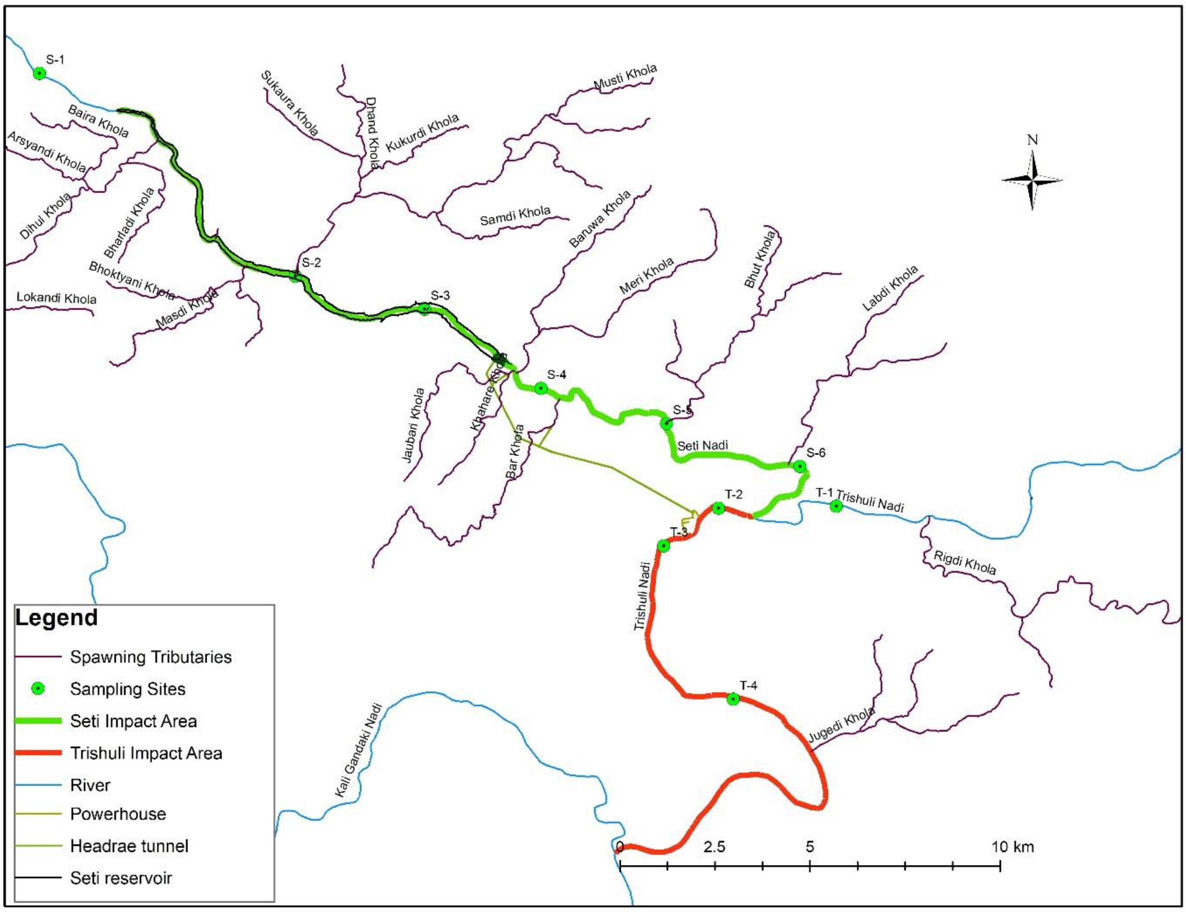


Figure 58: Major spawning tributaries of the project area (based on field survey and consultation with the locals)

Nepal's diverse forms of water bodies, including rivers, lakes, and wetlands, offer excellent habitats for numerous indigenous fish species, many of which hold significant economic value for local communities. The taxonomic status of fish in Nepal reveals a rich diversity, with a total of 252 fish species recorded in the country. This diverse range of fish species contributes to the ecological and economic significance of Nepal's aquatic ecosystems.

In addition to fish, the Biodiversity Strategy and Action Plan 2014-2020 highlights the remarkable biodiversity of phytoplankton and zooplankton in Nepalese wetlands. There are 102 species of phytoplankton and 109 species of zooplankton identified, demonstrating the importance of these microscopic organisms in supporting the food web and overall health of wetland ecosystems.

Within the specific area (Seti and Madi river) of the Tanahu Hydropower Project, Swar conducted a survey in 2017/18 and recorded the presence of 67 fish species. This information is crucial for understanding the fish diversity and population dynamics within the project's vicinity. By identifying the fish species present, researchers and conservationists can assess the potential impacts of the hydropower project on the local fish community and implement suitable measures for their protection.

During the surveys conducted in February 2022 and May 2022, a comprehensive study of the aquatic biodiversity was undertaken, focusing on 10 sampling sites within the project area. The surveys revealed a total of 34 fish species across these sampling sites, reflecting the rich diversity of fish in the region.

The distribution of fish species varied among the different sections of the project area. Upstream of the reservoir, 19 species were recorded, indicating a diverse assemblage of fish species in this section. Within the reservoir itself, 17 species were observed, suggesting a slightly lower species richness compared to the upstream area.

The Reduced water stretch of the Seti River exhibited the highest species richness, with 21 recorded species. This section of the river appears to support a particularly diverse fish community, potentially due to favorable habitat conditions and ecological factors.

Similarly, the Trishuli River upstream of the tailrace also hosted a notable diversity of fish, with 17 recorded species. Although slightly lower in comparison to the Reduced water stretch of the Seti, it still showcased a considerable variety of fish species.

Conversely, the Seti Reservoir and Trishuli River upstream of the Tailrace displayed the lowest species richness among the studied sections, with 17 and 19 recorded species, respectively.

The data presented in below provide valuable insights into the distribution of fish species within the project area. Understanding the spatial patterns of species richness helps in identifying areas of ecological significance and potential conservation hotspots. It can also aid in assessing the impact of the hydropower project on the local fish community and inform management strategies to preserve the diverse aquatic biodiversity in the region.

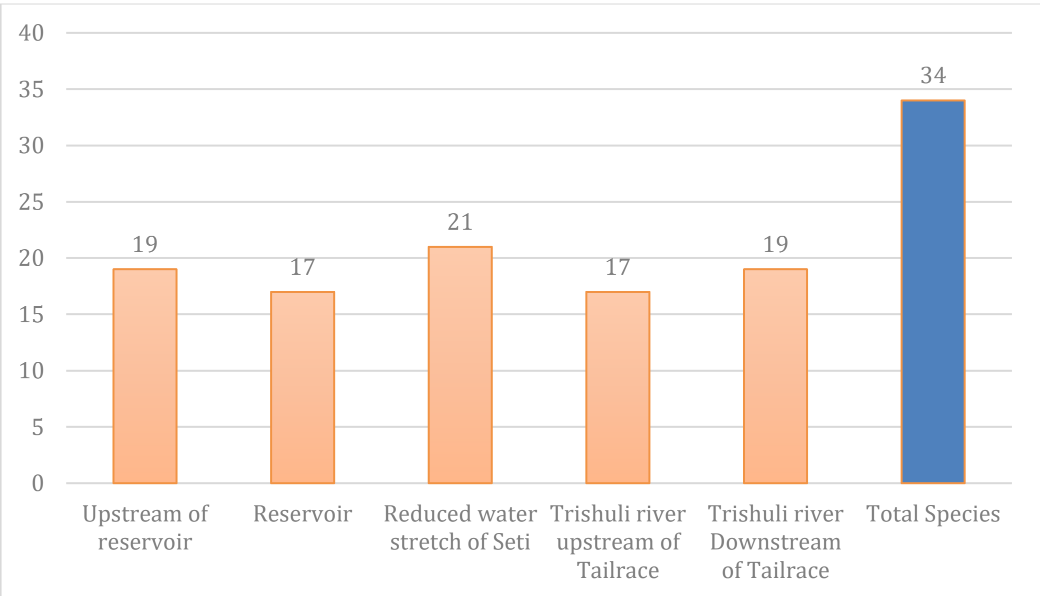


Figure 59: Species richness in sampling stations

During the survey, a total of 68 fish species were recorded, as presented in the annex L-8 in detail. Out of these 68 species, 26 were observed in February, and the number increased to

30 species in May. Additionally, two more species were observed in the catch of local fishermen during the survey.

The data collected during the survey provided valuable insights into the diversity of fish species in the study area. The variation in the number of recorded species between Feb and May might be attributed to seasonal changes or other factors that influence fish behavior and distribution.

The information gathered from the Tanahu HEP's records and the field survey was also essential in assessing the fish species' presence and abundance in the region. Understanding the fish diversity and their distribution helped in evaluating the potential impacts of the hydropower project on the aquatic ecosystem and designing appropriate conservation measure to protect the biodiversity in the area.

During the month of Feb, based on both the number of individuals and their biomass, 3 fish species, namely Sucker head (Garra gotyla), Mate Buduna (Tariqilabeo latius), and Faketa (Opsarius bendelisis), were found to be dominant in the project area. These species displayed a higher abundance and contributed significantly to the total biomass of fish recorded during the survey.

Figure 60: (a) Sucker head (Garra gotyla), (b) Mate Buduna (Tariqilabeo latius), and (c) Gurdere (Opsarius bendelisis),

In May, *Garra gotyla* once again exhibited high numbers and biomass, and it remained once of the dominant species during this month as well. Alongside, *Garra gotyla*, *Opsarius bendelisis* and *Labeo dero* were also observed to be dominant.

Overall, throughout both Feb and May, *Garra gotyla* consistently held a prominent position as the most abundant species. Its higher abundance and biomass compared to other species indicated its strong presence and importance in the local fish community.

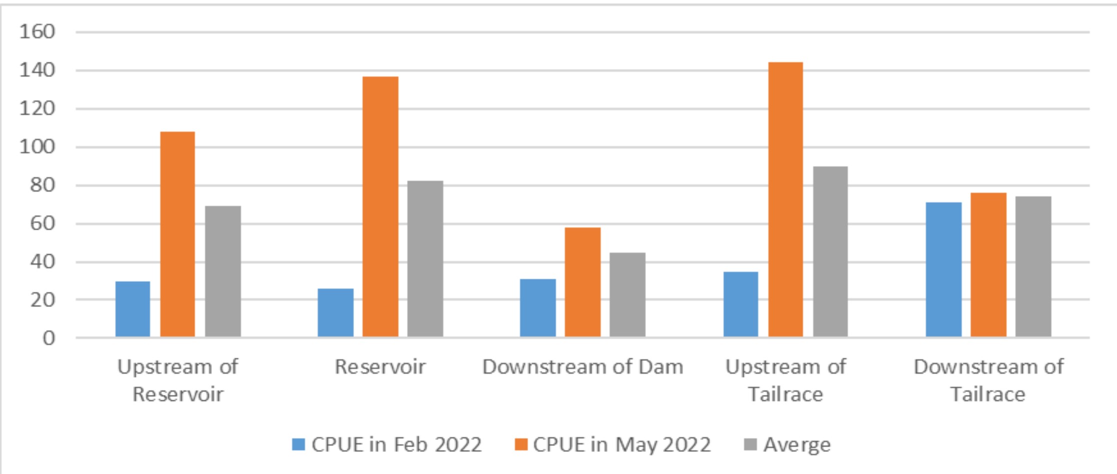


Figure 61: Catch Per Unit Effort (CPUE)

During the survey, the Catch Per Unit Effort (CPUE) was used as a measure to assess fish abundance and distribution in different sections of the project area. The CPUE is a valuable metric that indicates the number of fish caught per unit of effort, such as per hour of fishing or per net deployment.

The survey revealed that the CPUE was recorded to be higher in 2 specific locations: (a) the proposed reservoir area in the Seti River, and (b) The Trishuli River stretch upstream of the Tailrace. This suggests that the fish abundance in these areas are relatively higher compared to other sections of the project area. The reservoir area, being an area with a large expanse of water and potential for fish aggregation, likely to contribute to the higher CPUE observed there. Similarly, the Trishuli River stretch upstream of the tailrace might have favorable conditions and more accessible location for fish, leading to increased catch rates.

Table 5. 26: Catch Per Unit Effort (CPUE) During the Survey

Location	**Upstream of Reservoir**	**Reservoir**	**Downstream of Dam**	**Upstream of Tailrace**	**Downstream of Tailrace**
CPUE in Feb 2022	30	26	31	35	71
CPUE in May 2022	108	137	58	144	76
Average	69	82	45	90	74

Source: Field Surveys EIA Study

Out of the 68 species listed in Annex-L-8, 22 species are migratory in nature that included 15 recorded species (13 sampled species and 2 observed species) and 7 reported species.

Most of the migratory fish species are distributed both upstream and downstream of the dam. During the survey, it was observed that various tributaries of the Seti and Trishuli Rivers, including Dihul Khola, Masdi Khola, Dhand Khola, Jaubari Khola, Bar Khola, Baruwa Khola, Bhoot Khola, Labdi Khola, and Jugedi Khola, privide essential spawning habitats for the recorded fish species. Among these fish species, Raj Bam (*Anguilla bengalensis*) is a catadromous[3] fish that spans in the Bay of Bengal. Other long-distance migratory species identified during the survey included *Bagarius bagarius, Clupisoma sp., Tor putitora*, and *Tor tor.*

A total of 68 species of fishes were reported from the project area. Among these,

- ***5 species have listed as "Threatened species by the Global IUCN Red List"***, that means the species are at risk of extinction and require special conservation attention to ensure their survival. These were - Golden Mahseer *(Tor putitora)* (EN), Gaint Catfish or Goonch (*Bagarius bagarius)* (VU) and Snow Trout (*Schizothorax richardsonii)* (VU), Giant Snakehead Fish (*Channa orientalis)* (VU), and Sind Danio *(Cyprinion semiplotum)* (VU) are included in the Global IUCN Red List as Threatened species.
- ***2 species were considered endemic species*** to Nepal, which means that these species are found only in the specific geographic regions within Nepal and are not naturally found anywhere else in the world. These were False-Eye Catfish (*Psilorhynchus*

[3] Catadromous fish spend most of their lives in fresh water, then migrate to the seas to breed.

pseudecheneis) and Blyth's River Catfish (*Myersglanis blythii*) are endemic species to Nepal.

Table 5. 27: Migratory and Endemic Species Reported in the Project Area

SN	Nepali Name	English Name	Scientific Name	Migratory/Endemic Status
1	Raj Bam	Indian Mottled Eel	*Anguilla bengalensis*$*	Migratory
2	Goonch	Goonch	*Bagarius bagarius#*	Migratory
3	Gardi	Kalabans/River Rohu	*Bangana dero*	Migratory
4	Baghi/Sisne	Almorha Loach	*Botia almorhae*	Migratory
5	Chaguni/Khasree	Chaguni	*Chagunius chagunio**	Migratory
6	Hile/Bhoti	Dwarf Snake head	*Channa gachua*	Migratory
7	Jalkapoor	Garua Bachcha	*Clupisoma garua#*	Migratory
8	Jalkapoor	-	*Clupisoma montanum**	Migratory
9	Lohari Buduna	Annandale Garra	*Garra annandalei*	Migratory
10	Singhi	Singee	*Heteropneustes fossilis**	Migratory
11	Gardi	Brahmaputra Labeo	*Labeo dyocheilus**	Migratory
12	Kalaacha/ Termassa	Pangusia labeo	*Labeo pangusia*	Migratory
13	Chuche Bam	Spiny Eel	*Mastacembelus armatus*	Migratory
14	Rai gadero	Stone Loach	*Nemacheilus corica*	Migratory
15	Katle	Copper Mahseer	*Neolissochilus hexagonolepis*	Migratory
16	Faketa	Hamilton's Barila	*Opsarius bendelisis*	Migratory
17	Tite	Nepalese Minnow/Stone Carp	*Psilorhynchus pseudecheneis*	Migratory and Endemic
18	Asala	Snow Trout	*Schizothorax plagiostomus**	Migratory
19	Chuchhe Asala	Pointd-nosed Snowtrout	*Schizothorax progastus*	Migratory
20	Buchche Asala	Blunt-nosed Snowtrout	*Schizothorax richardsonii*	Migratory
21	Pahale Sahar	Golden Mahseer	*Tor putitora*	Migratory
22	Falame Sahar	Tor Mahseer	*Tor tor**	Migratory
23	Til-Kavre	Stone cat	*Myersglanis blythii**	Endemic

Note: * = Reported Species, # observed in local fishermen's catch, $=photographs of the species provided by local people

The baseline survey, conducted in February 2022 at 8 different sampling sites located in Seti and Trishuli rivers, reported the presence of 23 species of phytoplankton, 07 species of zooplankton, 20 families of benthic macroinvertebrates (ANNEX-L-10, L-11, L-12)

5.2.4.1 Impact Zone

The proposed project is a Peaking Run-of-the-River Project. It is expected to impound the water in the reservoir upstream of the Barrage for short-term to accumulate sufficient volume of water that can generate sufficient energy targeted by the project.

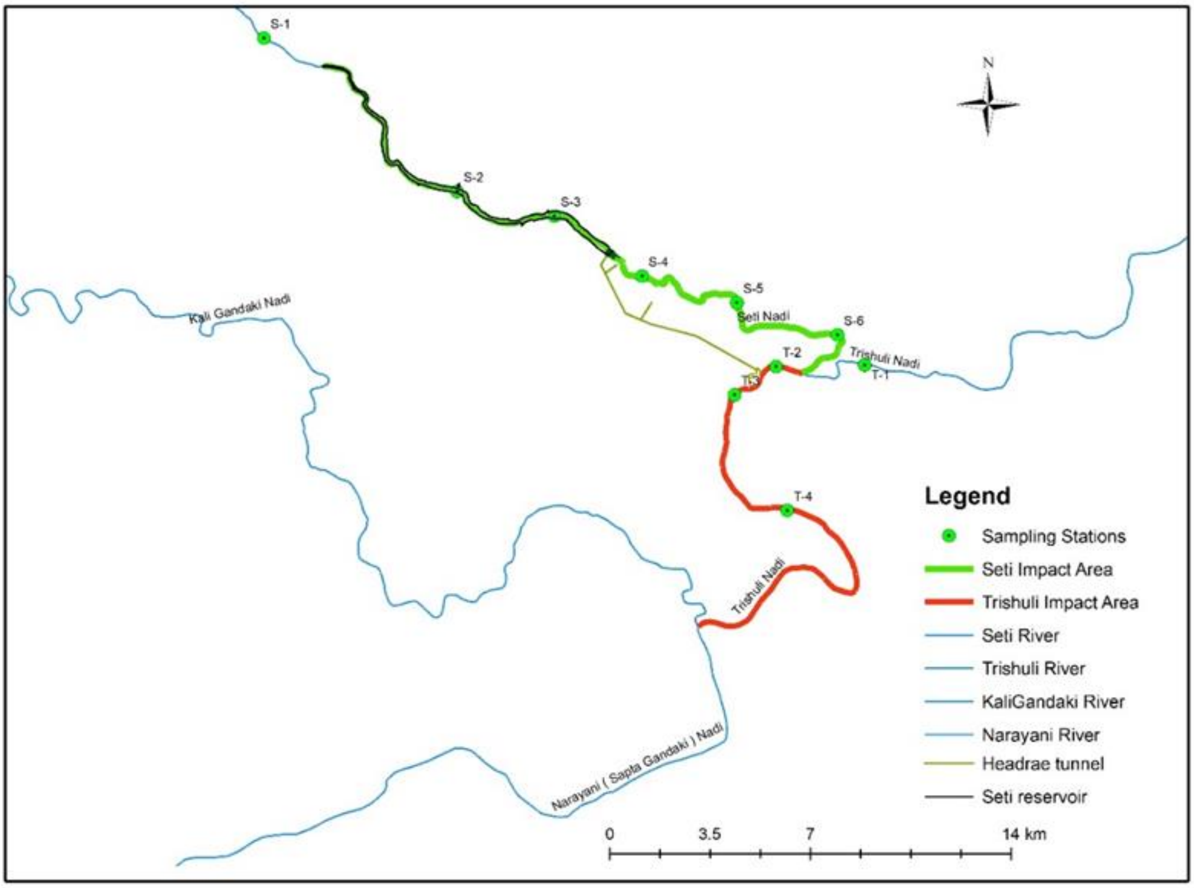


Figure 62: Impact zone of TSHPP

The impoundment process is expected to change the flow regime of the Seti and Trishuli Rivers, which can have direct and indirect impacts on the aquatic ecology of the project area.

The impact zone, where impacts will be most pronounced, stretches from the reservoir's upper end to the Trishuli River – namely Seti/Trishuli Confluence (S/T Confluence). The powerhouse is situated on the right bank of the Trishuli River, approximately 2 km from the S/T confluence. This stretch will have a relatively lower impact compared to the Seti River stretch upstream from the S/T confluence, as the Trishuli River, larger river than the Seti River, contributes a significant discharge. The delineated impact zone is vital for assessing potential impacts on the aquatic ecosystem and identifying areas requiring special conservation attention.

The changes in the flow regime can lead to several ecological impacts, such as:

(a) Habitat alteration – the altered flow patterns can impact the physical structure of the riverbed and the surrounding riparian habitat, affecting the availability of suitable breeding and feeding grounds for aquatic species.

(b) Water quality – Changes in flow patterns may influence water quality parameters, including temperature, dissolved oxygen levels, and nutrient concentrations. Altered water quality can have implications for the health and survival of aquatic organisms.
(c) Sediment transport – The changes in flow can impact sediment transport, leading to sediment accumulation or erosion in certain areas. This can influence the availability of spawning sites and affect the habitats of benthic organisms.
(d) Fish migration – Migratory fish species that rely on specific flow conditions for migration and spawning may face challenges in reaching their traditional breeding grounds, potentially affecting their reproductive success.

Seti River: The impact zone in the Seti River spans about 24 km, starting from the S/T confluence and extending to the upper end of the Reservoir in the Seti River. Out of this, 12 km comprise the reduced discharge stretch, while the remaining 12 km make up the reservoir.

Trishuli River: The impact zone in the Trishuli River covers 18 km, starting from the S/T confluence and ending at the Kaligandaki River Confluence. This includes 2 km upstream of the tailrace and 16 km downstream of the tailrace.

5.2.4.2 Economic Value of Fishes

Most of the fish species in the Seti and Trishuli Rivers have high to medium food value based on consultations with local people. All the fish species collected/reported during the field are edible and have considerable food value. These fishes can be grouped under three categories, High Food Value (H) which are large or moderate size fish with good taste. Medium food value (M) fishes are of medium size with inferior taste in comparison to high food value fish. Low food value (L) fish are generally small sized with inferior taste. The price of the fish varies according to the food value, i.e. higher the food value higher is the price.

In the project area, fishes are used mainly for food and economic generation by local fishermen. No aquarium, cultural and aesthetic values of fishes were reported. According to local, *Psilorhynchus pseudecheneis* has medicinal value against indigestion.

5.3 Socio-economic condition

This section of the report describes the socio-economic bassline conditions of the project area. It has primarily focused on social and economic aspects of the project area, which might be affected by the project implementation. These include changes that the project might cause in the livelihood condition, occupation and employment scenario, income level, access to resources of locals as well as overall well-being of the community.

5.3.1 Administration, Governance and Political Context

Nepal’s constitution has established a 3-tire governance system, consisting of Federal, Provincial and Local level governments.

The local level government comprises of two types of municipalities – Rural Municipality and Urban Municipality. These are the basic administrative units responsible for local governance and service delivery at the grassroot level. These local governments have elected representatives who are responsible for addressing the needs and concerns of the local communities.

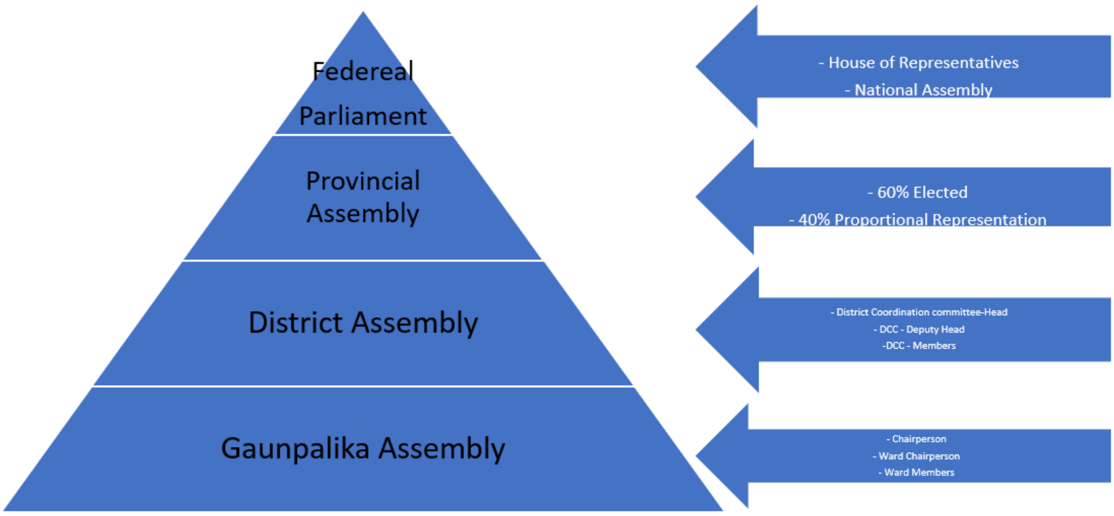


Figure 63: Governance and Political Hierarchy in Nepal

5.3.2 Demography and Ethnicity

As per the Census 2021 (NSO, 2021), the total population of Nepal has been reported to be 2,91,92,840 residing in 67,61,059 households. This reflects a 0.93% increase from the population recorded during the Census 2011. Additionally, the current sex ratio is 95.91, which according to the UN World Population Prospects 2019 (UN, 2019), is the lowest amongst SAARC countries.

According to the Census 2021 (NSO, 2021), the population of Tanahu District was recorded at 3,27,620. The sex ratio in the district is lower than the national average, with a value of 87.53. To compare the demographics of Tanahu District with national and provincial statistics, the following table provides relevant information.

Table 5. 28: National level, Province level and District level demographic comparison (Source – NSO, 2021)

Demographic Parameter	Tanahu	Gandaki Province	Nepal
Total Population	3,27,620	24,79,745	2,91,92,480
Male Population	1,52,921	11,80,460	1,42,91,311
Female Population	1,74,699	12,99,285	1,49,01,169
Sex Ratio	87.53	90.85	95.91
Average Household Size	3.52	3.66	4.32

Population Density [sq km]	212	116	198
Population Growth Rate	0.13	0.30	0.93

As depicted in the table above, despite having a lower sex ratio, household size, and population growth rate, Tanahu District has a higher population density than both the national and provincial statistics. This could be attributed to the district's relatively favorable geography, which includes a larger usable land area compared to other neighboring areas, thereby accommodating more people in a smaller area.

Administratively, the Tanahu District is divided into 8 municipalities, out of which 4 are urban municipalities while the remaining 6 are rural municipalities.

Table 5. 29: Local level population of Tanahu district (Source – NSO 2021)

Local Administrative Level	**Number of Wards**	**Population**	**Area [sq km]**
Vyas Municipality	14	80,944	248
Sukla Gandaki Municipality	12	55,620	165
Bhanu Municipality	13	42,794	184
Bhimad Municipality	9	29,248	129
Aanbukhaireni Rural Municipality	6	22,349	128
Rhising Rural Municipality	8	18,821	215
Myagde Rural Municipality	7	23,578	115
Bandipur Rural Municipality	6	19,403	102
Ghiring Rural Municipality	5	14,334	126
Devghat Rural Municipality	5	3,653	159
Total		310,774	1,571

The project area of TSHPP encompasses 8 wards of 4 rural municipalities, namely –Rishing, Devghat, Bandipur and Anbukhairani and 2 wards of Vyas Urban municipality of Tanahu district . In addition, ward number 29 of Bharatpur Metropolitan City of Chitwan District is also included as the project affected area due impacts associated in the Trishuli river to due discharges from the tailrace.

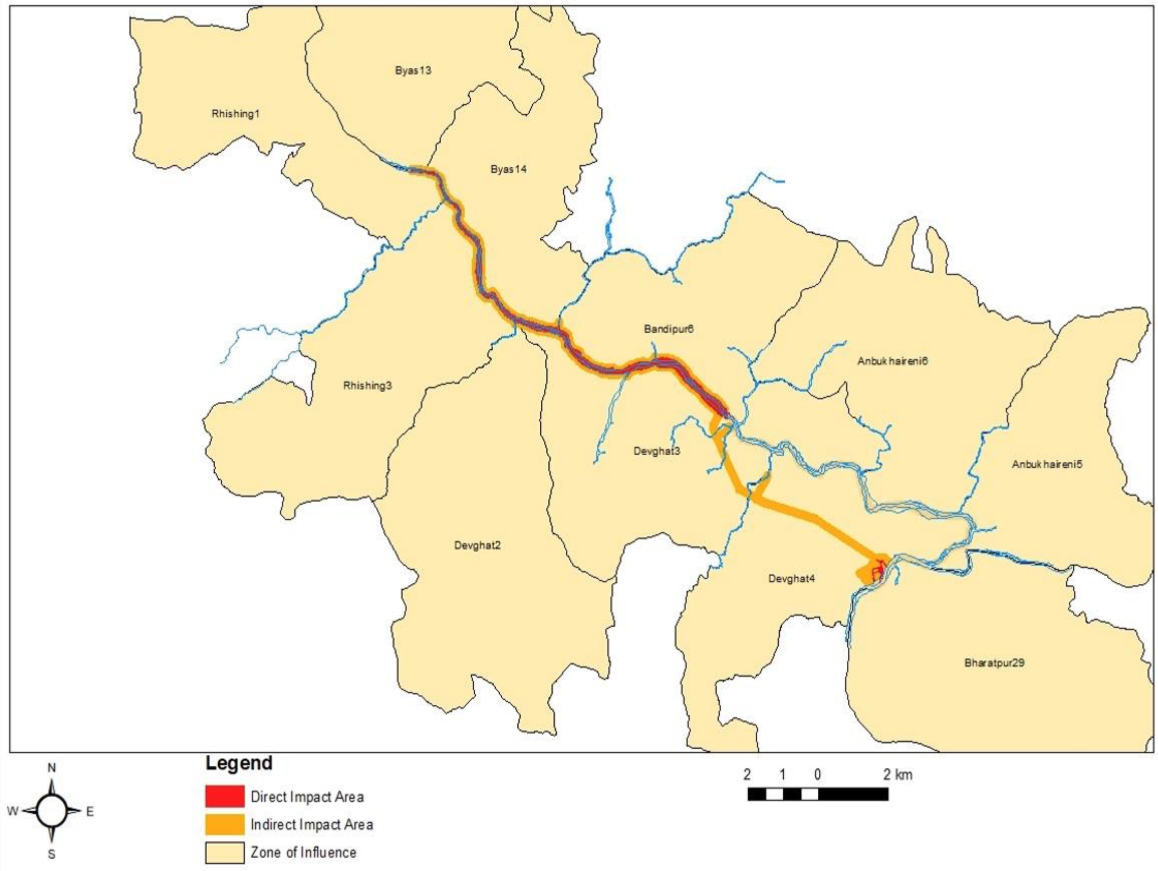


Figure 64: Project impact area of TSHPP

Table 5. 30: Project affected districts, municipalities, and their wards.

District	**Municipality - ward**
Tanahu	Rhising 1 & Rhising 3, Byas 13 & Byas 14, Devghat 2, Devghat 3 & Devghat 4, Bandipur 6, Anbu Khaireni 5, & Anbu Khaireni 6.
Chitwan	Bharatpur 29

Demographic status of affected municipalities of the Tanahu district is shown in the table below.

Table 5. 31: Demography of the affected municipalities of the Tanahu

Urban/ Rural Municipality	**HH**	**Population**			**Average HH Size**	**Area [sqkm]**	**Sex Ratio**	**Density [people/ sqkm]**
		Total	**Male**	**Female**				
Anbu Khaireni RM	4,758	22,349	10,791	11,558	4.69	128	93.36	174.60
Bandipur RM	4,712	19,403	9,251	10,152	4.11	102	91.12	190.22
Byas M	19,547	80,944	37,669	43,275	4.14	248	87.04	326.38
Devghat RM	3,653	14,941	7,115	7,826	4.91	159	90.91	93.96
Rhising RM	4,611	18,821	8,590	10,231	4.08	215	83.96	39.95
Total	37,281	156,458	73,416	83,042				

Source: NSO 2021

Table 5. 32: Demography of the affected municipality of Chitwan district

Urban/Rural Municipality	**HH**	**Population**			**Average HH Size**	**Area [sqkm]**	**Sex Ratio**	**Density [people/sqkm]**
		Total	**Male**	**Female**				
Bharatpur Metropolitan City	77,838	3,69,377	1,79,744	1,79,633	4.74	432.95	100.06	853.16

Source: NSO 2021

5.3.2.1 Project Affected Families and Severely Project Affected Families

The subsequent parts of the report have compiled precise data related to the project areas that have been directly affected. This information has been extracted from the socio-economic survey conducted as a part of this study.

This study has focused on assessing HHs residing within the project wards which are considered as the Project Affected Families (PAF). These HHs encompass all those impacted in some way by the project implementation.

Moreover, it has differentiated within this group to identify Severely Project Affected Families (SPAF). These HHs represent a subset facing more significant consequences directly attributed to the project, such as substantial impacts on their livelihoods or properties, or even displacement due to the project's implementation.

By distinguishing between PAF and SPAF, the study likely aims to prioritize assistance or interventions for those experiencing more severe hardships caused by the project. This differentiation helps in tailoring support measures and allocating resources more effectively based on the varying degrees of impact experienced by different HHs.

For this study, the cadastral survey carried out identified a total of 437 parcels to be affected by the implementation of the project. The ownership of these parcels was identified from the data available with the Land Revenue office of Tanahun. These parcels belonged to 285 households, Care & Downey resort, Nepal Electricity Authority, Public Lands and Government of Nepal. There were also certain parcels, the ownership of which could not be identified. A total of 16 parcels could not be identified.

Hence, for the survey, 269 HHs were identified as SPAFs along with the Care & Downey resort and a government school named Shree Seti Ganga Basic School. Among these HHs, 133 HHs were from Bandipur-6, 75 HHs were from Byas-14, 17 HHs were from Devghat-3, and 44 HHs were from Devghat-4.

However, during the survey work only 164 HHs of SPAFs could be interviewed. To understand the socio-economic status, 12 HHs from Anbu Khaireni was also included in the survey. Hence for this study, a total of 176 households (HHs) were selected from the Tanahu district. The households surveyed in Tanahu belonged to Aabu Khaireni RM, Bandipur RM, Devghat RM, and Vyas RM as the project activities are primarily focused on these municipalities.

The HH survey had a combined population of 979, with an average HH size of 5.40 individuals. It was also observed that 19.31% of the surveyed HHs, *i.e.*, 34 HHs were headed by women. Additionally, out of the total population affected, 54.44% were male, and 45.55wq% were female.

Table 5. 33: Surveyed households (Baseline Survey 2022)

Municipality	**Surveyed HHs**	**Total Male Population**	**Total female population**	**Total Population**	**Female/Male Ratio**	**Avg. HH Size**
Anbukhaireni	12	29	26	55	0.90	4.58
Bandipur	65	188	155	343	0.82	5.27
Devghat	51	152	131	283	0.86	5.55
Vyas	48	164	134	298	0.82	6.21
Total	176	533	446	979	0.85	5.40

Table 5. 34: Affected number of parcels and area in project components (Source: Baseline Survey, 2022)

SN	Project Component	Municipality/ Ward	Area [ha]	Land Type		No of Parcels	Acquisition Type
				Private	Public		
1	Explosive Store House/Barrack	Bandipur-6	0.41	0.41	0	7	Temporary
2	Access Road to Adit 2	Devghat-4	1.06		1.06		Temporary
3	Batching Plant and Laboratory A	Bandipur-6	0.52		0.52	2	Temporary
4	Batching Plant and Laboratory for Tunnel B	Devghat-3	1.10	0.54	0.56	8	Temporary
5	Clay Area Private Land	Byas-14	6.81		6.81	1	Temporary
6	Dumping Area-HW	Bandipur-6	6.88		6.88	-	Temporary
7	Additional Dumping Area at Intake	Devghat-3	2.91		2.91		Temporary
8	Dumping Area-PH	Devghat-4	2.52	0.22	2.3	4	Temporary
9	Temporary Labor Camp A	Bandipur-6	1.4	0.82	0.33	7	Temporary
10	Temporary Labor Camp B	Devghat-4	0.51		0.51	-	Temporary
11	Temporary Labor Camp C	Devghat-4	1.15	1.15		5	Temporary
12	Old Alluvial Deposits and Coarse Aggregate	Bandipur-6	2.79		2.79	-	Temporary
13	Intake Area	RB: Devghat-3, LB: Bandipur-6	8.63		8.63	-	Permanent
14	Reservoir FSL 275m	LB: Bandipur-6, Byas-14, Byas-13 RB: Devghat 2, 3; Rhising 1, 3	157.45	14.23	143.22	128	Permanent

SN	Project Component	Municipality/ Ward	Area [ha]	Land Type		No of Parcels	Acquisition Type
				Private	Public		
15	Reservoir Buffer 278m	LB: Bandipur-6, Byas-14, Byas-13 RB: Devghat 2, 3; Rhising 1, 3	23.95		23.95	168	Permanent
16	Adit-2	Devghat-4	0.09		0.09		Temporary
17	Adit-3	Devghat-4	0.07	0.03	0.04	4	Temporary
18	Adit-4	Devghat-4	0.16		0.16	5	Temporary
19	Permanent Camp Area-A	Bandipur-6	0.44	0.44		3	Permanent
20	Employer Camp Alternative-2	Bharatpur-29	2.28	2.28		13	Permanent
21	Powerhouse Area	Devghat-4	16.69	6.3	10.39	46	Permanent
22	Surge Shaft	Devghat-4	0.864	0.084	0.78	3	Permanent
23	Access Road to Surge Shaft Adit 4 & Adit 3	Devghat-4	2.05	0.9	1.14	32	Temporary
24	RBM-1		5.54		5.54		Temporary
25	RBM-2		7.34		7.34		Temporary
26	RBM-3		6.28		6.28		Temporary
27	RBM-4		3.91		3.91	1	Temporary
28	RBM-5		2.28		2.28		Temporary
29	Rock Quarry - B		5.37		5.37		Temporary
Total Area (Ha)			271.45	26.864	244.63	437	

5.3.3 Caste/Ethnicity/Religion

As per the NSO 2021, Hindus make up most of the district's population, comprising approximately 84.1% of the total population. Buddhists account for 9.7%, Muslims for 1.6%, Christians for 2,3%, and other religions constitute of 2.3%.

The dominant caste of the Tanahu District was found to be Magar, comprising 26% of the population, followed by Brahmin-Hill, Gurung, and Chhetri, each making up 11.4. and 11.5% of the population. Newar made up 7.6%. Furthermore, other castes such as Sarki, Damai, Gharti/Bhujel, and several others were also identified in the district.

The HHs affected by the project were primarily composed of two major ethnic groups, namely:

(a) Brahmin/Chhetri/ Thakuri
(b) Janajati/Adivasi

The table below presented provides further details:

Table 5. 35: Ethnical distribution of the sampled population (Source: Baseline Study, 2022)

Caste/Ethnic Group	**Sub-group**	**Male**		**Female**		**Both**	
		Nos.	**%**	**Nos.**	**%**	**Nos.**	**%**
Adhivasi/Janajati	Gurung	307	31.36 %	251	25.64%	558	57.00 %
	Magar	186	19.00 %	160	16.34%	346	35.34 %
	Bote	10	1.02%	12	1.23%	22	2.25%
	Bhujel	14	1.43%	14	1.43%	28	2.86%
	Total	517	52.81 %	437	0.446373851	954	97.45 %
Higher Caste (Brahmin/Chhetry/Sanyasi)	Brahmin	11	1.12%	6	0.61%	17	1.74%
	Chhetry	5	0.51%	3	0.31%	8	0.82%
	Total	16	1.63%	9	0.009193054	25	2.55%
Total		533		446		979	100.00 %

Most of the surveyed households belong to Indigenous Communities, accounting for 97.45% of the total population. Among these communities, Gurung and Magar together comprise 92.34% of the affected population. The surveyed households are primarily located in Bandipur (65 households), Devghat (51 households), and Vyas (48 households) Rural Municipalities, with the remaining indigenous households being from Aanbu Khaireni (12 households). The figure includes 4 households of Bote and 3 households of Bhujel, both in Devghat consider to be belonging the marginal castes amongst the indigenous group, were also identified as PAFs in the project-affected area. The so-called higher constitutes less than 3% (5 households only) within the area.

5.3.4 Age distribution

The age distribution among the SPAFs showed that the majority, accounting for 67.3% of the population, falls within the economically active age group of 16-60 years. The age group of 6-15 years, which can be considered as school-going population, represented 12.7% of the population. The remaining population comprised of economically inactive groups, with 5% below 5 years of age and 15% above 60 years of age.

Table 5. 36: Age wise distribution of sampled households (Source: Baseline Survey, 2022)

Age Group	Gender				Total	
	Male		Female			
	Nos.	%	Nos.	%	Nos.	%
Upto 5 Yrs	31	3.16%	21	2.14%	52	5.31%
6 to 14 Yrs	70	7.15%	36	3.67%	110	11.23%
15 to 30 Yrs	190	19.40%	145	14.81%	335	34.21%
31 to 59 Yrs	157	16.03%	168	17.16%	325	33.19%
60+ Yrs	85	8.62%	76	7.76%	161	16.44%
Total	533		446	45.4%	979	100.0%

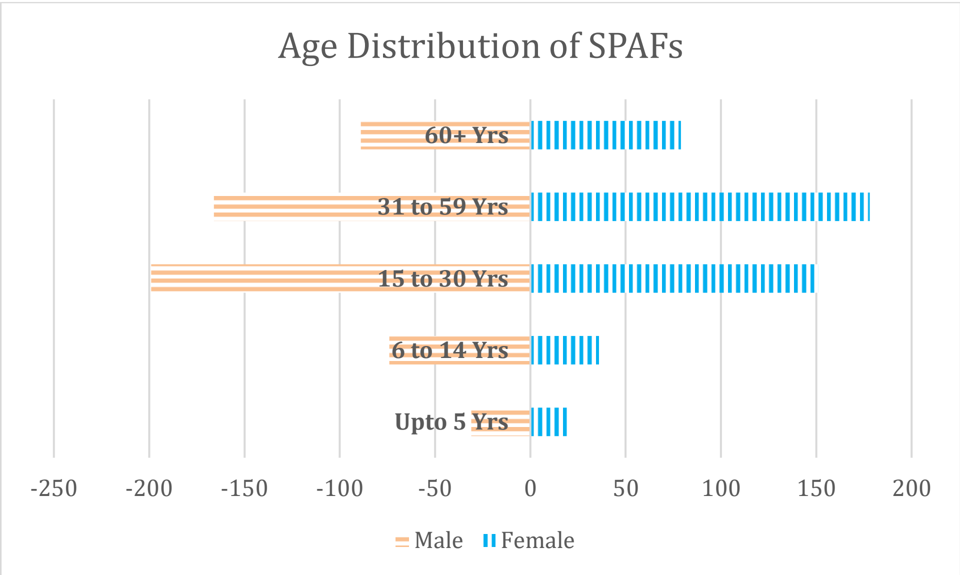


Figure 65: Age distribution of SPAFs

5.3.5 Language

Although Nepali serves as the lingua franca for most of the population, a variety of mother tongues were recorded among different castes and ethnic groups. Many of these indigenous languages are passed down through oral traditions and have a rich local heritage of traditional folk stories and songs. It is worth noting that Magar and Gurung languages have their own scripts.

Table 5. 37: Distribution of Population by mother tongue

Mother Tongue	Total [%]	Male [%]	Female [%]
Nepali	62.7	62.4	63
Magar Dhut	19.7	19.2	20.1
Gurung	8.1	8	8.2
Nepalbhasa	3.5	3.6	3.5
Darai	1.1	1.09	1.1
Tamang	0.9	0.9	0.9
Bhojpuri	0.6	0.9	0.5
Khash	0.5	0.5	0.4
Bhujel	0.4	0.4	0.4

Source: NSO 2021

Amongst the SPAFs, Nepali language is commonly used for communication. Besides that, Gurung and Magar language are spoken within the community in the project-affected area.

5.3.6 Festivals

The project area shares common festivals with other hilly areas of Nepal, but the way they are celebrated is unique to this location. Major festivals celebrated in the project area include Dashain, Tihar, Loshar, Maghe Sakranti, Fagu Purnima, Baisakh Sakranti, Chandi Purnima, Buddha Purnima, and Saune Sakranti.

The people of the project area also observe significant life-cycle rituals, including the Newaran (Naming Ceremony), Chhewar marriage, and Death. They also worship their ancestor/lineage gods, deities, forest land, rivers, mountains, and other entities according to their belief systems.

Please refer to the table below for some important festivals celebrated in the area:

Table 5. 38: Major festivals of the PAF

SN	Festival	Celebration Date	Celebration Method
1	Dashain	September or October month each year	Dashain or Bada Dashain also referred as Bijaya Dashami in Sanskrit is a major hindu religious festival in Nepal. The festival starts from the Shukla Paksha (bright lunar night) of the month of Ashwin and ends on Purnima, the full moon. This festival represents the victory of the goddess Durga. This festival is celebrated for 15 days.

SN	Festival	Celebration Date	Celebration Method
2	Tihar	October or November each year	Tihar, also known as Deepawali and Yamapanchak, is the second biggest festival after Dashain. It is a five day long festival mostly celebrated by Hindus. This festival is not only about people's celebrations but also about how people honor certain animals, including crow, dog, cow etc.
3	Loshar		Losar is one of the main festivals in Nepal. The festival is celebrated in Buddhist religion . The literal meaning of Losar is New Year and follows the cycle of 12 years called Lohokor. Barga (Lo) is the unique name with reputed attributes like mouse, cow, tiger, cat, garuda, serpent, horse, sheep, monkey, bird, dog, and deer. On the day of the festival, the people visit the monasteries and stupas to pray, worship, and have blessings from the monks for happiness and well-being. The ethnic people in traditional costumes perform their cultural singing and dancing, welcoming the New Year with feasts and family gatherings. Types of Loshar celebrated in Nepal are Tamu Losar, sonam Losar and Gyalpo losar.
4	Buddha Purnima	Full Moon day of May	Buddha's birthday also known as Buddha Jayanti, also known as his day of enlightenment - Buddha Purnima is a buddhist festival commemorating the birth of Gautam Buddha, who was the founder of Buddhism.
5	Maghe Sakranti	Month of Magh (January)	Maghe Sakranti festival is one of the major festivals celebrated in the month of Magh (14th January). The festival is also known as Makar Sankranti. The festival is considered to be the beginning of warmer days in comparison to the cold months of December. It is a solstice festival.
6	Holi Festival	on the full moon day during the month of Falgun (March)	Holi festival is also known as the festival of color. It manifests the victory of good over evil and celebrates the divine love of Radha and Krishna. It is held during the full moon day in the Hindu calendar month of Falgun (March). Holi is also known as Fagu Purnima.

5.3.7 Settlements

The project area comprises scattered settlements of varying sizes, ranging from as small as two houses to over 30 houses. Despite this diversity, there exists a harmonious and peaceful coexistence among different castes and ethnic groups within these settlements, indicating a mixed type of community. Although most households belong to indigenous and ethnic communities such as Magar, Gurung, and Majhi.

The primary settlements that are expected to be affected by the project are:
Masdighat is situated in the reservoir, approximately 6.5 km upstream of the suggested barrage site. It is a small village consisting of around 16 households. The reservoir will reach the periphery of the farmland located on the terraced bank, resulting in some edges of the farmland being submerged. However, none of the houses will be inundated. The village is connected by a suspension bridge over the Seti River, which will not be submerged by the reservoir.

Figure 66: Masdighat

Khaharetar is situated on the left bank of the Seti River, approximately 5 km upstream of the barrage site. This settlement falls under the jurisdiction of Bandipur - 6 and comprises around 30 households. Due to the reservoir's formation, the Shree Seti Ganga Primary School, the suspended bridge over the Seti River, and cultivated land located on the bank of the Seti River are expected to be inundated.

Figure 67: Khaharetar

Sarang Ghat is situated immediately downstream of the barrage. The settlement mainly occupies the left bank of the Seti River and comprises around 40 households falling under the jurisdiction of Bandipur 6. Additionally, there are 20 households and a school located on the right bank, which belongs to Devghat - 3. While the physical construction of the barrage is not anticipated to affect the settlement, there is a proposed plan to set up a camp in the left bank of Sarang Ghat on cultivated land.

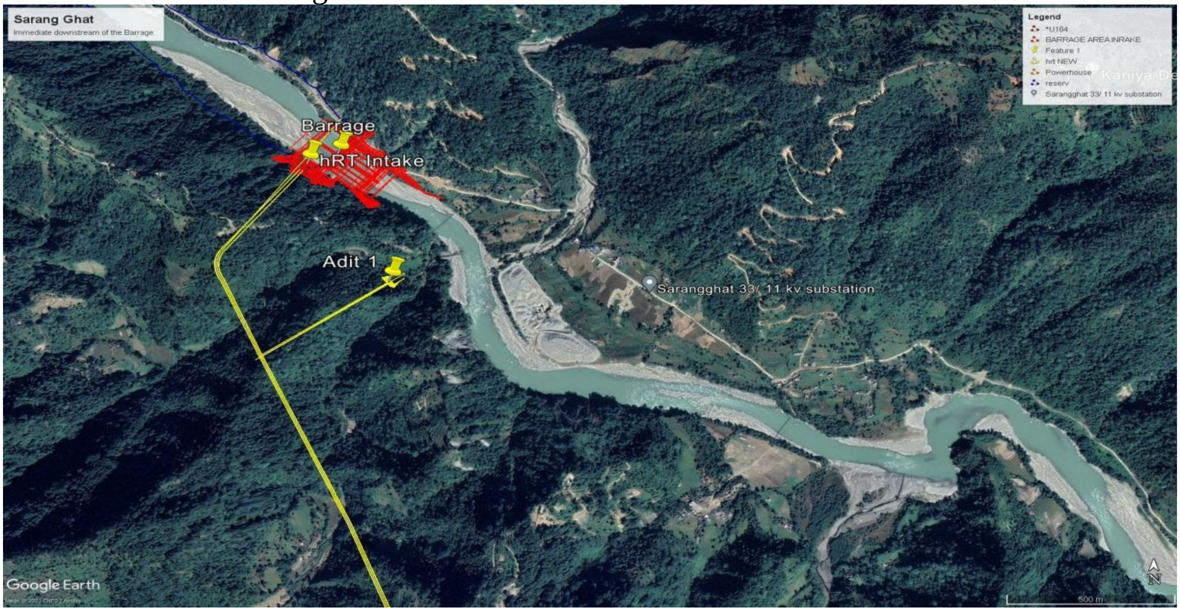


Figure 68: Sarang Ghat

Gai Ghat settlement, which is located on the proposed powerhouse site, falls under the jurisdiction of Devghat - 3. It is situated on the right bank of the Trishuli River, approximately 2 km downstream from the confluence between the Seti and Trishuli Rivers, known as Ghumaune. The settlement comprises about 30 households.

Figure 69: Gai Ghat

The houses in the area are constructed using mud and stone, with stone/slate, corrugated/non-corrugated metal sheets, and thatched roofs. However, there are some concrete houses in the market areas of Mastighat, Khareghat, Sarangghat, and Gaighat, which have a higher population concentration than other areas. Mastighat, Khareghat, and Sarangghat are the nearest settlements to the headworks and have Gurung and Magars as the major inhabitants. Similarly, Majhis and Bhujels are the major inhabitants of Gaighat and Ghumaune, the nearest settlements to the powerhouse area. Additionally, Labdighat, Bhutkhola, and Pyughar are the nearest settlements in the reduced flow zone.

5.3.8 Annual Income and Expenditure

In terms of income, the most significant contributions come from remittances (25.51%), followed by business income (19.11%) and herbs (14.55%). On the expense side, food is the most substantial outgoing expense (30.03%), followed by education (19.55%) and clothing (10.58%). These findings suggest that remittances play a pivotal role in the surveyed households' finances, while expenditures on basic necessities like food and education constitute a significant portion of their expenses. This data provides valuable insights into the financial priorities and sources of income for these households, highlighting areas that may require further attention or planning.

The average income of the sampled HHs is 255,069.04 and the average expenditure is 15,367.95. This variation in the income and expenditure values can be attributed to the high sources of money coming from remittance. This influx of remittance money significantly inflates the average income figure. However, despite this higher income, the households still exhibit relatively modest average expenditures, implying that they might be saving a significant portion of their remittance income or directing it towards investments or other savings-oriented purposes. This statement highlights the importance of remittances in shaping the financial landscape of these households and underscores the potential need for financial planning or investment strategies to make optimal use of these funds.

Table 5. 39: Income and Expenditure of the sampled HHs (Baseline Survey 2022, EIA Study)

Average Income and Expenses of the Surveyed HHs				
Income Sources	Avg NRs/Year		Expense Sources	Avg NRs/Year
Crops	71,611.11		Food	50,779.89
Vegetables	17,780.43		Cloths	17,879.12
Cash Crops	6,255.00		Education	33,047.62
Fruits	42,951.82		Health Services	6,890.16
Livestock	104,101.41		Festivals	15,366.85
Animal Products	88,117.86		Smoking/Drinking	9,175.29
Herbs	482,500.00		Agricultural Products	3,700.45

Services	347,304.00		Transportation	13,316.94
Business	633,727.27		Gas	8,016.29
Remittance	845,913.79		Water/Electricity Bills	5,731.37
Pension	288,030.00		Cultural Activities	5,143.48
Labor	334,500.00			
Social Allowance	53,104.76			
Average Income/Year	255,069.04		Average Expenses/Year	15,367.95

5.3.9 Occupation

The project affected area exhibits a mixed occupational structure consisting of both farm and non-farm activities. Farming activities such as agriculture and livestock rearing are subsistence in nature, with small landholdings and minimal inputs. Non-farm activities include foreign employment, seasonal migration, small trade, and businesses, agro and forest-based micro-enterprises, and daily wage labor. Remittances from Gulf countries like Saudi Arabia, Qatar, UAE, Malaysia, and India, as well as salaries and pensions from armed forces in Britain and India, constitute major household income sources. Engagement in the Indian and British armies, and the Singapore police force, is popular particularly among the Adivasi Janajati groups (Gurung and Magar) residing in the project area.
The details of occupation of the project affected population is provided in the table below.

Table 5. 40: Distribution of occupation of the project affected population (Source: Baseline Survey, 2022)

Occupation	**Population by Occupation**					
	Aanbu Khaireni	**Bandipur**	**Devghat**	**Vyas**	**Bharatpur**	**Total**
Agriculture	21	85	73	98		277
Livestock	0	7	6	5	0	18
Government Job	1	9	9	8	3	27
Private Job	3	38	28	34	6	103
Business	0	15	4	4	4	23
Farm Laborer	0	5	3	4	0	12
Unskilled job	0	2	12	2	2	16
Foreign Remittance	6	35	19	16	5	76
Housewife	6	22	21	15	2	64
Pension	1	6	3	5	0	15
Old/disabled	4	25	18	16	3	63
Social Work	0	1	0	0	0	1
Unemployment	0	2	7	5	1	14

Student	12	80	61	75	6	228
Children	1	8	15	10	0	34
Others	0	3	4	1	1	8
Total	55	343	283	298	45	979

5.3.10 Educational institutes

In Tanahu district, there are a total of 1,565 educational institutions, with approximately 92% belonging to the public sector and about 8% to the private sector. Private education institutes are primarily concentrated in urban areas with high population density, whereas public educational institutions provide education in rural areas.

Table 5. 41: Educational Institutions in the Tanahu District

Type	Kindergarten	Primary	Secondary	Higher Secondary	Campus	Technical Education	Cultural Education	Special Education	Informal (Classes for Housewife)
Public	347	304	74	108	15	3	3	10	5
Private	125	37	35	52	0	0	0	0	0
Total	472	341	109	160	15	3	3	10	5

Source: District Profile of Tanahun, 2018)

Table 5. 42: Distribution of educational institution of the project municipalities

Local Level	Kindergarten	Primary(1-5)			Primary (6-8)			Secondary			Higher Secondary			Community Learning Center	Short Kentdra	Total
		Pub.	Pvt.	Tot	Pub.	Pvt.	Tot	Pub.	Pvt.	Tot	Pub.	Pvt.	Tot	Total	Total	
Byas	78	45	9	54	16	14	30	11	19	30	12	3	15	8	4	129
Aanbu Khaireni	23	27	2	29	6	1	7	3	5	8	2	0	2	1	1	46

Devghat	30	26	1	27	6	1	7	4	0	4	3	0	3	1	2	41
Bandipur	25	27	3	30	3	3	6	4	1	5	2	1	3	1	1	44
Rhising	39	25	3	28	12	1	13	6	0	6	3	0	3	0	2	50

Source: District profile of Tanahu, 2018

Table 5. 43: Colleges in Tanahu District

SN	Name and Address	S.N	Name and Address
1	Tribhuvan Campus, Manechauki	8	Bhanu Bhakta Campus, Khairenitar
2	Aanbu Khaireni Campus, Aanbu Khaireni	9	Aadikavi Bhanubhakta Campus, Damauli
3	Purkot Kalika Campus, Purkot	10	Barahi College, Damauli
4	Tanahu Sarada College, Bhanu	11	Damauli College, Damauli
5	C.K.B.K Campus, Nahala, Bandipur	12	Parasar College, Damauli
6	Bandipur Campus, Bandipur	13	Mahesh Sanskritik Gurukul, Devghat
7	Janajyoti Campus, Bhimad	14	Shahid Krishna Campus, Dulegauda

Source: District Profile of Tanahun, 2018)

Table 5. 44: Educational institution of the project affected municipality-wards

SN	Name of Education Institution	Project Affected Wards
1	Sukla Ma Vi	Rishing-1
2	Amar Ma Vi	Rishing-1
3	Dipak Aadharbhut Bidhyalaya	Rishing-1
4	Bhaskar Aadharbhut Bidhyalaya	Rishing-1
5	Shiva Shakti Pra Vi	Rishing-1
6	Jivan Pra Vi	Rishing-1
7	Shanti Ma Vi	Rishing-3
8	Saraswati Aadharbhut Bidhyalaya	Rishing-3
9	Krishna Pra Vi	Rishing-3
10	Bhirkot Aadharbhut Bidhyalaya	Rishing-3
11	Shiva Sundar Pra Vi	Rishing-3
12	Janashakti Pra Vi	Rishing-3
13	Jal Devi Pra Vi	Rishing-3
14	Siddha Beni Ni. Ma. Vi	Byas-13
15	Jana Jagriti Ganga Ma. Vi	Byas-13
16	Gudifachyang Ni Ma Vi	Byas-13
17	Sitala Pra Vi	Byas-13
18	Bal Kalyan Pra Vi	Byas-13

19	Buddha Pra Vi	Byas-13
20	Beni Mitra Pra Vi	Byas-13
21	Amar Jyoti Ni Ma Vi	Byas-14
22	Keshavtar Uchha Ma Vi	Byas-14
23	Keshavtar Pra Vi	Byas-14
24	Chabdi Barahi Pra Vi	Byas-14
25	Adarsha Sikshya Ma Vi	Devghat-2
26	Kali Ganga Ma Vi	Devghat-2
27	Junodaya Aadharbhut Bidhyalaya	Devghat-2
28	Sarwodaya Aadharbhut Bidhyalaya	Devghat-2
29	Laxmi Aadharbhut Bidhyalaya	Devghat-2
30	Janasewa Aadharbhut Bidhyalaya	Devghat-2
31	Siddha Aadharbhut Bidhyalaya	Devghat-2
32	Indrapari Aadharbhut Bidhyalaya	Devghat-2
33	Kamala Aadharbhut Bidhyalaya	Devghat-2
34	Janaki Aadharbhut Bidhyalaya	Devghat-2
35	Bhrikuti Madhyamik Bidhyalaya	Devghat-3
36	Balkesh Aadharbhut Bidhyalaya	Devghat-3
37	Shankar Aadharbhut Bidhyalaya	Devghat-3
38	Gorakhkalika Aadharbhut Bidhyalaya	Devghat-3
39	Jaldevi Aadharbhut Bidhyalaya	Devghat-3
40	Rastriya Aadharbhut Bidhyalaya	Devghat-3
41	Chandika Aadharbhut Bidhyalaya	Devghat-3
42	Kalika Aadharbhut Bidhyalaya	Devghat-3
43	Jana Jyoti Aadharbhut Bidhyalaya	Devghat-4
44	Jana Shakti Aadharbhut Bidhyalaya	Devghat-4
45	Rastriya Aadharbhut Bidhyalaya	Devghat-4
46	Janata Aadharbhut Bidhyalaya	Devghat-4
47	Siddha Aadharbhut Bidhyalaya	Devghat-4
48	Jana Jyoti Pra Vi	Bandipur-6
49	Jana Jagriti Pra Vi	Bandipur-6
50	Udaya Pra Vi	Bandipur-6
51	Arun Ma Vi	Bandipur-6
52	Seti Ganga Pra Vi	Bandipur-6
53	Jay Nepal Pra Vi	Bandipur-6
54	Surya Pra Vi	Bandipur-6
55	Sunita Pra Vi	Bandipur-6
56	Laxmi Ma.Vi	Anbukhaireni-6
57	Indradevi Aadharbhut Bidhyalaya	Anbukhaireni-5
58	Chandidevi Aadharbhut Bidhyalaya	Anbukhaireni-6
59	Sayapatri Pra Vi	Anbukhaireni-5
60	Bikash Jyoti Pra Vi	Anbukhaireni-5
61	Pancha Kanya Pra Vi	Anbukhaireni-5

62	Kamadhenu Pra Vi	Anbukhaireni-5
63	Arunodaya Pra Vi	Anbukhaireni-5
64	Bishwesshwar Pra Vi	Anbukhaireni-6
65	Ananda Puri Pra Vi	Anbukhaireni-6
66	Bal Kanya Pra Vi	Anbukhaireni-6
67	Chimkeshwori Pra Vi	Anbukhaireni-5
68	Dharmodaya Pra Vi	Anbukhaireni-6
69	Sahid Lal Dhwaj Pra Vi	Anbukhaireni-6
70	Siddha Jana Ekata Pra Vi	Anbukhaireni-6
71	Krishna Pra Vi	Anbukhaireni-6
72	Milan Pra Vi	Anbukhaireni-6
73	Jal Devi Pra Vi	Anbukhaireni-5
74	Aadharbhut Bidhyalaya Kusumtar	Bharatpur-29
75	Aadharbhut Bidhyalaya Kamalpur	Bharatpur-29
76	Aadharbhut Bidhyalaya Bharlang	Bharatpur-29
77	Aadharbhut Bidhyalaya Tandrang	Bharatpur-29
78	Aadharbhut Bidhyalaya Syaule	Bharatpur-29
79	Aadharbhut Bidhyalaya Ratmate	Bharatpur-29
80	Aadharbhut Bidhyalaya Fewatar	Bharatpur-29
81	Aadharbhut Bidhyalaya Chauki	Bharatpur-29
82	Aadharbhut Bidhyalaya Bhorle	Bharatpur-29
83	Aadharbhut Bidhyalaya Dodeni	Bharatpur-29
84	Aadharbhut Bidhyalaya Dumre	Bharatpur-29
85	Kawilas Madhyamik Bidhyalaya Jugedi	Bharatpur-29
86	Aadharbhut Bidhyalaya Lama Gaun	Bharatpur-29
87	Kawilas Samudayik English Boarding School	Bharatpur-29

Source: District Profile of Tanahun, 2018)

During the site visit, observations were made to map the educational institutions that would be impacted by the project. The findings revealed that two educational institutions would be directly affected by the project. The details of these institutions are provided in the table below.

Table 5. 45: Schools affected by the project (Baseline Survey, 2022)

S.N	Name of Educational Institute	Location	Coordinates	Observations	Remarks
1.	Shree Seti Ganga Primary School	Khaharetar, Bandipur	27°52'23.21"N; 84°21'5.53"E	The school lies on the left bank of Seti River. The school will be completely inundated by	

S.N	Name of Educational Institute	Location	Coordinates	Observations	Remarks
				the reservoir formation.	
2.	Shree Janta Primary School	Gaighat-Devghat-4	27°49'5.44"N; 84°26'18.40"E	The school lies in the right bank of the trishuli river in the powerhouse location.	The school shall be affected by the construction activities in the powerhouse area, particularly tailrace.

Figure 70: Shree Setiganga Primary (Basic) School

Figure 71: Shree Janata Primary (Basic) School

5.3.11 Literacy

According to the 2022 census, Nepal's literacy rate stands at 70%, but there is a significant gender gap in literacy rates. Adult women's literacy rate is only 55.11%, while adult men's literacy rate is about 75.58% in Nepal. The literacy rate in most of the project-affected municipalities is lower than the national average. The project-affected municipality's average literacy rate is 72.076%, with Byas performing better and Anbu Khaireni approaching the national level, while the rest are performing poorly.

Table 5. 46: Distribution of literacy level amongst the population of project municipalities

Local Level	Gender	Population Underage 5	Literate Population	Literacy Rate
Aanbu Khaireni RM	Total	18,898	14,179	75.03
	Male	8,540	7,048	82.53
	Female	10,358	7,131	68.85
Bandipur RM	Total	18,409	13,220	71.81
	Male	8,233	6,633	80.57

Local Level	Gender	Population Underage 5	Literate Population	Literacy Rate
	Female	10,176	6,587	64.73
Byas UM	Total	64,623	51,645	79.92
	Male	28,335	24,832	87.64
	Female	36,288	26,813	73.89
Devghat RM	Total	14,646	9,844	67.21
	Male	6,747	5,116	75.52
	Female	7,899	4,728	59.86
Rhising RM	Total	23,295	7,521	66.41
	Male	9,873	7,549	76.18
	Female	13,422	7,949	59.22

Source: NSO 2021

Out of the total SPAFs, 165 HHs were found to be literate, meaning they can read and write. On the other hand, only 20 HH heads were identified as illiterate, indicating that they cannot read and write. This data suggests that a relatively small portion of HH heads among the PAFs lack basic literacy skills.

When considering the entire SPAF population, a large portion, specifically 91.42% was reported to be literate. This rate excludes 3.37% of the population who were underage and, thus, not included in the literacy statistics. The high literacy rate among the SPAF population indicates that a significant majority of individuals in the affected area possess reading and writing abilities. In comparison with the literacy rate in the affected municipalities, the literacy rate of SPAF population is significantly higher.

The data also revealed that there is no significant variation in the literacy rates between men and women populations in the project area. The literacy rate between men and women was reported to be 54.44% and 45.56%. The relative similar rates suggests that efforts to promote literacy have been relatively equitable for both genders.

The table 61 highlights the proportions of individuals who have completed different levels of education. It indicated that the majority has completed primary education, whereas, a relatively small number of individuals have pursued education beyond the bachelor’s level. About 34% of the population has completed primary level education, followed by 19% attended up to secondary level, and 7.76% has passed SEE exam. The data also indicated that only a small number of populations has pursued bachelor’s level and even smaller number pursued master’s level.

The project areas within Bandipur, Vyas, and Devghat Municipalities were reported to have higher concentration of educated individuals. Bandipur has the highest percentage, with

31%, followed by Vyas 27%, and Devghat 25%. This data suggests that these areas may have better education facilities, opportunities, or other factors contributing to higher education attainment among their populations.

Table 5. 47: Education status of the SPAFs (Source: Baseline Survey 2022, EIA Study)

Education	**Male**		**Female**		**Total**	
	Nos.	**%**	**Nos.**	**%**	**Nos.**	**%**
Illiterate	17	1.74%	34	3.47%	51	5.21%
Literate	33	3.37%	43	4.39%	76	7.76%
Primary Education	199	20.33%	142	14.50%	341	34.83%
Secondary Education	115	11.75%	73	7.46%	188	19.20%
SLC/SEE	52	5.31%	22	2.25%	74	7.56%
12th	86	8.78%	108	11.03%	194	19.82%
Bachelor	9	0.92%	9	0.92%	18	1.84%
Master and above	2	0.20%	2	0.20%	4	0.41%
Underage	20	2.04%	13	1.33%	33	3.37%
Total	407	54.44%	446	45.56%	979	100.00%

Consultations with the locals and particularly schools and teachers were carried out to gather their perspectives, opinions, and concerns. Some of the concerns raised were:

- lack of adequate infrastructure, which includes basic facilities of education such as libraries, playgrounds, buildings, and classrooms.
- Shortage of books, stationery, and other learning
- Lack of training for teachers
- Long commute times for some students such as those attending Bhirukuti Secondary School in Devghat-3, must walk for up to two hours a day to attend classes.

In conclusion, the findings from the public consultations emphasize the challenges faced by educational institutions in the project area, including insufficient infrastructure, teaching materials, and training for teachers. The long commute times for some students further compounds the issues.

5.3.12 Migration Pattern

Migration plays a crucial role in Nepal's economic and social development, as the country heavily relies on remittances sent by its migrant workers. Remittances contribute significantly to the national economy, supporting the livelihoods of many families and fostering economic activities within the country.

According to the International Organization for Migration's country profile of Nepal 2019, foreign employment is the primary reason for migration amongst the Nepali people. The 2021 census on population and housing showed that nearly half of Nepali HH had a family member who either worked abroad or had returned after working overseas. Initially, Nepali migrant workers sought employment opportunities in neighboring India due to its proximity and the open border between the two countries. However, from the mid-1980s, there has been shift in migration destinations, with an increasing number of Nepali migrating to Gulf countries and Malaysia for work.

Based on the consultations with the locals, it was evident that the interest in foreign employment is on the rise among younger members of the community. This indicates that migration for work opportunities remains an appealing option for many Nepalis. The 2011 census data highlights Nepal's relatively emigration rate of 10.77 per 1000 population, signifying the number of people leaving the country for work abroad. In contrast, the immigration rate stood at 0.46 per 1000 people, representing the number of individuals entering Nepal from other countries. The social data collected from the PAFs revealed that out of 185 HHs surveyed, 100 reported having at least one family member who had migrated abroad for work. A total of 160 individuals had migrated abroad, with 23 choosing to settle permanently and 137 opting for temporary migration. Among those who migrated temporarily, 116 were male and 21 females, while 20 males and 3 females had migrated permanently from the project area.

Table 5. 48: Migration status of the PAFs (Baseline Survey 2022, EIA Study)

Municipality Name	**Migrated HHs**	
	No	**Yes**
Aanbu Khaireni	6	6
Bandipur	24	51
Devghat	24	26
Vyas	31	17
Total	85	100

The survey provided valuable insights into migration patterns within various regions of the project area. It indicated that Bandipur had the highest migration rate, followed by Devghat, Vyas, Bharatpur, and Aanbu Khaireni municipalities. The data also showed that internal migration was prevalent in the project area, making up 47% of the surveyed population. Additionally, 32% of the migrated population went to Gulf Countries, while a smaller percentage migrated to other countries in Europe and the USA.

The primary reason cited for migration among the surveyed population was seeking employment and job opportunities. This suggests that economic factor play a central role in driving migration, with individuals seeking better work prospects outside their current location. Some respondents also mentioned migration for business or education purposes, indicating that there is diverse motivation behind migration in the study area.

5.3.13 Water Supply and Sanitation

According to the Nepal Multiple Indicator Cluster Survey 2076, which offers valuable insights into the state of water access in HHs across the country, more than half of the HHs in Nepal, 51.6%, have access to piped water. This indicates that piped water supply is relatively prevalent, benefiting a significant portion of the population.

Furthermore, it also highlighted that the variation in piped water access across the provinces of Nepal. Among all the provinces, the Gandaki Province stands out with the second-highest percentage – 86% of HHs having access to piped water. This figure suggests that piped water infrastructure is well-established an widely available in the Gandaki Province compared to other regions within the country.

The table below provides further details on the drinking water sources in Tanahu district.

Table 5. 49: Access to the drinking water

Description	**Total HHs**	**Tap/Pipe (within compounf)**	**Tap/Pipe (outside compounf)**	**Tube well**	**Covered Dug well/Well**	**Uncovered Dug well/Well**	**Stone spouts**	**River/Streams**	**Others**	**Not Responded**
Total	88,513	45,855	30,495	0	2,060	3,221	5,627	407	669	179
Percent	100	51.8	34.5	0	2.3	3.6	6.4	0.5	0.8	0.2

Source: NSO 2021

The information provided above, gives valuable insights into the access to drinking water during that period. The report indicated that a considerable portion of the district's population had access to drinking water with 83% of the total population. This suggested that significant progress had been made to improve water availability in the district compared to the previous data from 2011, where only 38% had access to the clean drinking water.

The EIA survey revealed that the majority of surveyed HHs relied on piped water supply as their primary source for drinking water. This indicates that piped water infrastructure is well established and widely accessible to these families, ensuring a more reliable and convenient supply of clean water.

As for the secondary sources, surveyed HHs commonly use well water. Wells are likely to be a practical backup option when piped water supply is temporarily unavailable or for areas where piped water infrastructure might not reach. Additionally, spring sources are also widely utilized as tertiary water sources, providing an alternative for those HHs in need of additional water supply options.

Interesting, only a small number of surveyed HHs, specifically 3, reported using water directly from the river or Kholsa as their primary source. This might indicate that these HHs face challenges in accessing more reliable and treated water sources. Drinking water directly from rivers or Kholsas might vary higher risks of waterborne diseases and contamination compared to piped water. Out of these 3 HHs, only 1 HH was found to taking a precautionary step to ensure safety. They were actively boiling the water before to consumption, which is a common method to purify water and make it safe to drink.

The status of water supply in the sampled households are provided in table below:

Table 5. 50: Status of Water Supply in Sampled Households (Source: Baseline Suvey 2022, EIA Study)

Mun/Ward	Number of Households		
	Piped Water	**Well/Kuwa**	**River/Kholsa**
Devghat-3	39	0	0
Devghat-4	10	0	0
Devghat-6	2	0	0
Bandipur-6	66	5	3
Vyas-14	47	1	0
Anbu Khaireni-14	11	1	0
Total	175	7	3

5.3.14 Toilet Facilities

As per the 2021 census, 99% of households in Tanahu district have access to toilet facilities. Even though Tanahu district was declared an Open Defecation Free Zone on July 18, 2012, it is not reflective of the current situation on the ground as there are still households without access to toilets.

Table 5. 51: Toilet facilities in the Tanahu District

Description	Total HHs	No Access to Toilet	Access to Toilet			Public Toilet
			Flush Toilet (public sewerage)	**Flush Toilet (septic tank)**	**Pit Toilet**	
Total	88,513	887	2,041	63,447	21,848	260
Percent	100	1	2.3	71.7	24.7	0.3

Source: NSO 2021

Among all the HHs surveyed, the majority (92.05%) had pan latrines (170 HHs), while only 8 HHs had modern latrines. Only 6 HH had a pit latrine, while 1 HH did not have any latrine at all. 9 HHs did not provide a response.

Table 5. 52: Availability of latrine at the PAF HHs (Baseline Survey 2022, EIA Study)

Municipality	Pit Latrin	Pan Toilet	Modern Toilet	No Toilet	Total	
	Nos.	Nos.	Nos.	Nos.	Nos.	%
Aanbu Khaireni	0	12	0	0	12	6.82%
Bandipur	1	57	7	0	65	36.93 %
Devghat	4	46	1	0	51	28.98 %
Vyas	0	47	0	1	48	27.27 %
Total (Sum)	6	170	8	1	176	100.0 %
% of Total	2.84%	92.05%	4.55%	0.57%	100.00 %	

Data on hand washing practices among SPAF was collected and found to be satisfactory, with 95.45% of the surveyed HHs reporting the use of soap and water. However, 3.41% of HHs reported using only water, and 2 households (1.148%) had responded that they used to use water and soil for washing their hands.

Table 5. 53: Washing practices among SPAF (Baseline Survey 2022, EIA Study)

Municipality	Only water	Soap and water	Soil and water	Total	
				Nos.	% of Total
Aanbu Khaireni	0	12	0	12	6.82%
Bandipur	3	60	2	65	36.93%
Devghat	3	48	0	51	28.98%
Vyas	0	48	0	48	27.27%
Total	7	176	2	185	100.0%
% of Total	3.41%	95.45%	1.148%	100.00%	

Out of the surveyed HHs, 157 reported having animal sheds. Of these, 85 sheds were located near the house, 3 were in the basement of the house, and 69 were constructed far from the house.

5.3.15 Dietary Habits and Food Security

The dietary habits of households depend on various factors such as location, wealth, and age of inhabitants. Findings from FGDs and KIIs revealed that households tend to consume a variety of foods including rice, wheat, maize, millet, lentils, green vegetables, potato curry, chicken/goat meat, milk, and locally made alcohol. Children usually eat dal-bhat at home and buy junk food for tiffin. Young males tend to eat more junk food like instant noodles, chips, biscuits, and soft drinks. Adults engaged in agricultural work, home-based businesses, and those over 60 years of age tend to consume more locally produced foods, including locally made beer.

The socioeconomic survey considered two indicators to reflect on the food security status. The first indicator was the number of households that took out loans to pay for food. Out of 20 households who took loans, none used the loan to buy food. The second indicator was households' self-assessment of their income's sufficiency to cover their food needs. Out of 185 households, 74 reported sufficient food for all year round, 52 reported that food lasts for 6-11 months, 41 reported that food lasts for 1-6 months, and 4 households reported difficulty meeting their food demand for just 1 month. However, cross-checking revealed that one household had taken a loan to buy land, and other households managed to get food through remittance money. Overall, considering both indicators, the food security in the project-affected area can be assumed to be high-medium.

5.3.16 Electricity

A total of 97.2% of the households have access to electricity in the Tanahu (NSO 2021). According to the NSO 2021, 97.2% of the households in the area have access to electricity. The remaining households use alternative sources of energy, with 0.3% using kerosene, 0.03% using biogas, and 2.4% using solar and other sources. The table below provides the number of households using energy from various sources.

Table 5. 54: Type of energy used by the HHs in the Tanahu District

Description	Total HHs	Energy Sources				
		Electricity	Kerosene	Biogas	Solar	Others
Total	88,513	86,061	288	24	1,941	199
Percent	100	97.2	0.3	0.03	2.2	0.2

Source: NSO 201

Even though 97.2% of households in Tanahu have access to electricity, only a small percentage of them, 0.1%, use it for cooking. The majority, 67.9%, still rely on firewood for cooking, while 22.3% use LPG, 8.5% use biogas, 0.4% use kerosene, and 0.1% use cow dung. The table below shows the types of energy used for cooking in Tanahu District.

Table 5. 55: Type of energy used for cooking by the HHs in the Tanahu District

Description	Total HHs	Number of HHs that use energy source for cooking							
		Wood	Kerosene	LPG	Cow Dung	Biogas	Electricity	Others	Not Mentioned
Total	78,286	53,130	326	17,475	103	6,639	112	56	436
Percent	100	67.9	0.4	22.3	0.1	8.5	0.1	0.1	0.6

Source: District Profile Tanahu, 2075

The surveyed households relied on various sources of energy for cooking. Fuelwood was the predominant energy source and was the top priority for 139 households, while 42 households reported that LPG was their primary source. Some households also used biogas and kerosene for cooking. Only one household each from the Brahmin and Bote castes were found to be using biogas as their primary source. During the survey, it was noted that some households had constructed biogas plants in their homes, but these were not in working condition.

Table 5. 56: Source of energy for lighting in project affected HHs (Baseline Survey, 2022)

SN	Source for Lighting	Highly Use	Sometimes	Occasionally
1	Grid Electricity	182	2	-
2	Solar	3	135	-
3	Tuki	-	16	10
4	Diyalo	-	9	20

The surveyed households relied on various sources of energy for cooking. Fuelwood was the predominant energy source and was the top priority for 139 households, while 42 households reported that LPG was their primary source. Some households also used biogas and kerosene for cooking. Only one household each from the Brahmin and Bote castes were found to be using biogas as their primary source. During the survey, it was noted that some households had constructed biogas plants in their homes, but these were not in working condition.

Table 5. 57: Source of energy for cooking for the project affected HHs (Baseline Survey, 2022)

SN	Source for Cooking	1st Priority	2nd Priority	3rd Priority
1	Fuel Wood	139	38	2
2	Biogas	2	1	3
3	LPG	42	128	2
4	Electricity	1	6	37
5	Kerosine	1	1	2

The presence of modern electrical and electronic household appliances, such as television, computers, rice cookers, fridges, microwave ovens, mobile phones, cloth irons, and fans, is an indicator of the living conditions of households. According to the survey, 96.21% of households use mobile phones, 57.29% have a television, 58.91% own a fan, 41.08% use a rice cooker, and 28.10% have a fridge. However, only 11.35% of households reported owning a computer.

5.3.17 Road

All the municipalities in Tanahu district, both urban and rural, have access to road networks. The overall length of roads in the district, including city roads, is 1938.39 km. Among them, 161.49 km are black topped, 81.12 km are graveled, and 1694.47 km are earthen roads. There are 92 suspension bridges and 3 motorway bridges in the district. The longest bridge in the district is built over the Madi River in Damauli.

Table 5. 58: Road network in the Tanahu District

Road Classification	Type of Road			
	Earthen	Gravel	Black topped	Total
Village Road Core Network (VRCN	1059.58	37.21	0	1097
District Road Core Network (DRCN)	634.89	44.71	15.73	695.3
Roads in gullies of city	0	0	15.58	15.58
Highways and Main Roads under DOR	0	0	130.18	130.18
Total	1694.47	81.92	161.49	1938.06
Suspension Bridge	12 numbers			

Source: Division Road Office, Tanahu, 2018

The project site spans across 11 different wards within 5 distinct local bodies, comprising one metropolitan city, one municipality, and three rural municipalities, in the Tanahu and Chitwan districts. The sole road that links the entire project area to the Prithvi Highway and Muglin Narayangarh Highway is the earthen Buddha Singh Road. While neighboring villages and settlements are also connected through the Buddha Singh Road, the roads' quality is subpar and can only be used during the winter season.

Table 5. 59: Bridges in the project area. (Baseline Survey 2022, EIA Study)

SN	Bridge Type	Coordinates		Project Component	Name of Settlement	Right Bank	Left Bank
		Latitude	Longitude				
1	Suspension Bridge	27°54'59.84"N	84°18'29.36"E	Reservoir	Sode	Rishing-1	Byas-13
2	Permanent Bridge	27°54'56.75"N	84°18'39.95"E	Reservoir	Sode	Rishing-1	Byas-13
3	Suspension Bridge	27°54'3.55"N	84°19'18.04"E	Reservoir		Rishing-3	Byas-14
4	Suspension Bridge	27°52'50.41"N	84°20'6.65"E	Reservoir		Devghat-2	Byas-14
5	Suspension Bridge	27°52'22.38"N	84°21'4.52"E	Reservoir	Masdi ghat	Devghat-3	Bandipur-6

6	Suspension Bridge	27°52'9.35"N	84°22'6.36"E	Reservoir		Devghat-3	Bandipur-6
7	Suspension Bridge	27°51'22.02"N	84°23'51.75"E	Downstream of Headworks, Dewatered Zone	Saranghat	Devghat-3	Bandipur-6
8	Suspension Bridge	27°50'59.39"N	84°24'26.08"E	Dewatered Zone	Saranghat	Devghat-3	Bandipur-6
9	Suspension Bridge	27°50'41.58"N	84°25'8.25"E	Dewatered Zone		Devghat-4	Bandipur-6
10	Suspension Bridge	27°50'6.44"N	84°26'24.98"E	Dewatered Zone		Devghat-4	Anbukhaireni-6
11	Suspension Bridge	27°49'59.73"N	84°27'49.30"E	Dewatered Zone		Devghat-4	Anbukhaireni-5
12	Suspension Bridge	27°49'12.89"N	84°26'32.39"E	Powerhouse area	Gaighat	Devghat-4	Bharatpur-29

5.3.18 Health Facilities

The project area has healthcare facilities distributed in different project municipalities, which is presented in the table below.

Table 5. 60: Distribution of health facilities in the project area.

Governance Units	Provinces	Districts	Name of Government Unit	Hospital	Primary Health Care Centers	Non-public health facilities	Total health facilities (Public	Health Post	Urban Health Centers	Community Health Unit	Other Health Facilities	Total
District	Gandaki Province	Tanahu	TANAHU	3	2	46	8	10	0	69	25	163
Municipality	Gandaki Province	Tanahu	Bhanu Municipality	0	1	6	0	2	0	9	3	21
Municipality	Gandaki Province	Tanahu	Byas Municipality	1	0	10	4	0	0	15	9	39
Rural Municipality	Gandaki Province	Tanahu	Myagde Rural Municipality	0	0	3	0	0	0	3	0	6

Municipality	Gandaki Province	Tanahu	Shuklagandaki Municipality	1	0	6	3	1	0	11	6	28
Municipality	Gandaki Province	Tanahu	Bhimad Municipality	0	1	4	0	3	0	8	1	17
Rural Municipality	Gandaki Province	Tanahu	Ghiring Rural Municipality	0	0	3	0	2	0	5	0	10
Rural Municipality	Gandaki Province	Tanahu	Rhishing Rural Municipality	0	0	5	0	0	0	5	0	10
Rural Municipality	Gandaki Province	Tanahu	Devghat Rural Municipality	0	0	5	0	1	0	6	1	13
Rural Municipality	Gandaki Province	Tanahu	Bandipur Rural Municipality	1	0	1	1	1	0	4	2	10
Rural Municipality	Gandaki Province	Tanahu	Aanbu Khaireni Rural Municipality	0	0	3	0	0	0	3	3	9
				3	2	46	8	10	0	69	25	163

5.3.19 Cultivated land and Irrigation.

Based on the 2017 agriculture statistics from the District Agriculture Development Office, approximately 42% of the district's land is arable. Additionally, out of the total 17,762 hectares with irrigation potential, 14,755 hectares are currently being irrigated. Please find the details below:

Table 5. 61: Irrigation statistics of the Tanahu District

SN	Description	Area [ha]
1	Area of Tanahu district	1,54,600
2	Arable Land	65,065
3	Land with irrigation potential	17,762
4	Irrigated Land	

4a	Projects from Central Level	265
4b	Projects from District Level	78
4c	Hill Food Program	634
4d	From Local Level	430
4e	Projects from Agricultural Development Bank	584
4f	ILC program	1,475
4g	NISP program	510
4h	IWRMP	479
4i	Marmat Sambar Tatha Digo Bikash Karuakram	399
4j	From District Agricultural Development Program	2,018
4k	NITP program	121
4l	Majhaula Irrigation Projects	614
4m	Traditional Agricultural Canals	7,148
		14,755

Source: District Agriculture Development Office, 2017

Of the surveyed HHs, the land of 150 HHs were reported to own pakho land, 80 HHs have irrigated cultivated land, 11 HHs - kharbari/ forested land and 5 HHs having non-irrigated cultivated land. The details are presented below:

Table 5. 62: Land type owned by PAF (Baseline Survey 2022, EIA Study)

Municipality	**Ward**	**Irrigated**	**Non-Irrigated**	**Pakho Land**	**Kharbari/Forest**
Aanbu Khaireni	6	11	0	12	0
Bandipur	3	0	0	1	0
	4	0	0	1	0
	6	33	3	58	5
Devghat	3	20	1	25	2
	4	8	1	8	0
	6	3	0	3	0
Vyas	14	5	0	42	4
Total		80	5	150	11

A few households owned various types of land. For instance, one household in Devghat and two households in Bandipur owned both irrigated and non-irrigated cultivated land.

Additionally, one household in Bandipur had three types of land- irrigated, pakho, and forest land, and two households in Bandipur reported owning both irrigated cultivated land and forest land, while one household in Bandipur had both pakho and forested land.

One household in Bandipur-6 reported using non-titled land for irrigation for the past 40 years, which amounts to 1526.21 sq meters (3 ropani) of irrigated land.

Out of the SPAF HHs in the project area, 80 reported that their cultivated lands are currently being irrigated using spring water (riparian water) from sources such as Bagarkhola, Bakase Khola, Balkhola, Bor Khola, Chauni Khola, Dadh Khola, Juga Gaira, Jhatini, Jolgoni, Kadampani, Khahare, Listi, Mijarkhola, Moharekhola, Risti Khola, Shalokhola, Sodheri, Sunekhola, Tandro, and Thado Khola.

The Seti river is not used for irrigation, but is sometimes used for activities such as bathing, swimming, and ritual purposes including cremation of dead bodies by local communities. Cremation sites can be found in the downstream area.

5.3.20 Agricultural production

A significant proportion, approximately 73%, of the population in Tanahu District is engaged in agriculture as their primary occupation. Among them, 61% are men and 83% are women. The district's agricultural sector focuses on cultivating various crops, including rice, maize, buckwheat, wheat, millet, barley, and potato. Furthermore, Tanahu District also contributes to fruit production, with crops such as bananas, oranges, and lichis being cultivated. Additionally, secondary fruits like mangoes, pineapples, pears, and watermelons are also reported to be grown. Cash crops play a vital role in the district's economy, with significant production of sugarcane, tobacco, mustard, lentils, coffee, silk, ginger, and sesame seeds. Moreover, Tanahu District is known for cultivating a variety of vegetables, including cauliflower, cabbage, radish, chili, carrot, cucumber, pumpkin, bottle gourd, brinjal, tomato, sponge gourd, bitter gourd, green peas, and sweet potato.

In the project area, a mixed cropping pattern is prevalent. The traditional farming system involves cultivating a diverse range of crops to fulfill the family's food requirements, feed livestock, and generate income for purchasing daily necessities. Depending on the size and type of landholdings, farmers cultivate 2-3 crops simultaneously on the same plot of land. The households have developed their own cropping patterns for Khet land (irrigated lowlands) and Bari land (uplands). The specific cropping pattern adopted in these lands varies according to the season.

During the wet season, the primary irrigated crops grown are rice, followed by wheat in the dry season. In the rain-fed areas, maize and millet are the main crops cultivated during the wet season, while wheat and barley are grown during the dry season. Farmers also practice intercropping, where rain-fed wheat and barley are grown alongside mustard, and maize is intercropped with black gram, soybean, beans, or pigeon peas. This practice maximizes land productivity and utilization.

Table 5. 63: Agricultural production of the Tanahu District

Cereal					Lentils Crops			
Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)		Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)
Rice	17968	67756	3.77		Black Lentil	3050	2079	0.68
Maize	25970	72649	2.79		Soyabean	314	285	0.9
Wheat	1875	3674	1.95		Red Lentil	200	172	0.86
Millet	6340	5570	0.87		Black Eyed Bean	272	357	1.31
Buckwheat	175	132	0.75		Rice Bean	175	76.5	0.43
Oils					Vegetables and Sugarcane			
Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)		Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)
Mustard	465	289	0.62		Potato	800	7640	9.55
Mustard Seed	30	20.6	0.68		Vegetables	3187	33125	10.39
Sesame Seeds	109	88	0.80		Seasonal Vegetables	265	2504	9.44
Peanuts	4	3.4	0.85		Sugarcane	42	1010	24.04
Fruits					Spices			
Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)		Crop	Area (Ha)	Production (MT)	Productivity (MT/Ha)
Orange	995	5555	5.58		Ginger	595	7596	12.76
Banana	300	4114	13.18		Garlic	168	741	4.41
Licchi	37	204	5.51		Chilli	88	300	3.40
Mango	170	1190	7		Onion	117	1404	12
Jackfruit	87	1392	16		Turmeric	168	780	4.64
Pineapple	70	490	7		Coriander	10	26	2.6

Details on Bee Farming	Hives			Production)KG)
	local Breed	Hybrid Breed	Total	
Bees	430	3855	4285	17500
Details on Fish Farming	No of Ponds	Area (Ha)	Production)MT)	Productivity (MT/Ha)
Fish	177	37	48	1.29

Livestock	Type of Livestock			Total
	Modern Breed	Mixed Breed	Local Breed	
Cow/Ox	2789	2619	87511	92919
Buffalo	15217	7542	93900	116658
Goat	0	40878	342506	299565
Sheep	0	198	350	548
Pig	4123	5608	42997	52729
Chicken, Layers	63690	0	338510	402200
Chicken, Broiler	97119	0	0	97119
Duck	426	0	803	1229

Source: District Agricultural Development Office, Tanahu, 2017

The major crops and vegetables grown by the households in the project area are Rice, Maize, Wheat, Millet, Buckwheat, Mustard, Potato, Chilli etc.

The households in the project area engage in rearing various livestock, including cattle, goats, buffalo, pigs, ducks, and poultry. Cattle and buffalo are primarily kept for milk, ghee (clarified butter), and manure, while goats, pigs, and chickens are raised for meat production and to generate income.

During the survey, respondents were inquired about their preferences for skill-based training that they would like to receive from the project. Most of the respondents indicated that their first priority was training in livestock farming. Alongside livestock farming, people also expressed their interest in receiving training related to computers and goat farming. Additionally, a considerable number of Project Affected Families (SPAFs), specifically 25 households, expressed their willingness to work at the project.

5.3.21 House Structure and Facility

The physical living conditions, specifically the housing, are categorized based on the materials used for the construction of the floor, walls, and roof. The surveyed households are divided into four categories, each reflecting different construction materials.

Approximately 67% of the houses fall under the semi-modern category. These houses have walls made of either stone or mud, and their roofs are covered with slate or galvanized sheets. Around 17.3% of the houses are classified as modern houses. They feature walls constructed from stone or bricks, and their floors are cemented for durability.

A total of 10.8% of the houses are categorized as traditional houses. These houses have walls made of stones or mud and roofs composed of straw or mud.

Only a small percentage, approximately 2.7%, of the houses are classified as huts. The walls of these huts are not permanent and are constructed using bamboo and wood, while the roofs are covered with straw or steel sheets.

Table 5. 64: Type of SPAF houses (Baseline Survey, 2022)

SN	House Type	Frequency	Percent
1	Traditional	20	10.8
2	Semi-Modern	124	67.0
3	Modern	32	17.3
4	hut/chapra	5	2.7
5	Missing/DNR	4	2.2
Total		185	100.0

A typical household consists of a main building used for living, along with additional structures such as an animal shed and toilets. According to the survey, out of the total households surveyed, 157 households reported having animal sheds. Among these, 85 animal sheds were located near the main house, 3 were constructed in the basement of the house, and 69 were built at a distance from the main house.

In some households, a portion of the main house is utilized as a shop or commercial space, while in other cases, separate structures are designated for such purposes.

Table 5. 65: Type of Kitchen with the SPAF (Source: Baseline Survey, 2022)

Type of Kitchen		
Kitchen Type	**Frequency**	**Percent**
Improved Kitchen	76	41.10
Traditional Kitchen	101	54.60
Both	3	1.60
Missing	5	2.70
Total	185	100.00

5.3.22 Market and Industries

Damauli Bazar and Narayangarh Bazar serve as the primary market centers for the residents of the project area. Additionally, there are local market centers such as Mastighat, Sarangghat, Ghumaune, Abu Khairini, Muglin, and Gaighat.

No industries or industrial zones have been reported within the project area, except for a resort located at Khareghat on the right bank of the Seti River. However, this resort has been closed following the COVID-19 pandemic. It is worth mentioning that the resort used to attract visitors interested in rafting sports, particularly along the Khareghat to Narayanghat route via Ghumaune and Gaighat. Unfortunately, the resort falls within the inundation area of the reservoir, and the downstream flow is expected to be affected by the dam, thus impacting rafting activities in the region.

5.3.23 Major Cultural and Historical places

Table below shows the culturally important and historically significant places in Tanahu district.

Table 5. 66: Historically significant sites of Tanahu District

Cultural	Devgaht, Chabdi Barahi, Dhorbarahi, Thaniko Than, Shivapanchayen Temple, Akala Temple, Tanahu Bhagwati Temple, Mahadev Than (Satiswara), Parshar Ashram
Historical	Tanahusur Durbar, Ghasikuwa, Kot Durbar, Rishirani Pokhari, Byas, aadhimul etc

Source: District Profile (2073/74) 2015

In the project area, there are several locations that attract tourists, including Chandra Surya Ghumba (stupa) and Bhorle Gai Khori in Bharatpur-29, as well as Ghantachuli hill in Devghat-4.

Respondents also identified culturally significant places in the region, such as Gaikhuri Temple in Devghat-4 and Chandra Surya Ghumba (Stupa) in Bharatpur-29.

The majority of the population in the project area belongs to indigenous and ethnic communities. These communities have preserved traditional systems that involve worshiping villages, landmarks, hills, mountains, rivers, streams, lakes, ponds, and trails. They hold the belief that deities exist and reside on Earth. Rather than being represented in human form, deities are worshiped through natural objects like stones and trees. It is believed that deities can communicate with humans, often manifesting themselves through shamans or spirit possessors.
Service to deities is carried out by their respective priests or shamans. Regular worship is not mandatory, and offerings are made on specific occasions, while propitiating deities is done as the need arises. This tradition stems from the understanding that deities can be of a harsh nature and therefore require propitiation rather than mere adoration.

Rituals aimed at propitiating deities serve various purposes, such as recovering from ailments, ensuring the well-being of children, securing successful economic activities, alleviating anxieties, and restoring hope and confidence. Festivals dedicated to the deities are celebrated, and special sacrifices are performed to ward off trials and tribulations.

5.3.24 Graveyard, Cremation Sites and Rituals

The mourning rituals following a death may vary among ethnic groups and communities. Different practices can be observed, including cremation by the riverbanks or burials in hillside burial grounds.

Within the project area, several cremation sites, known as ghats, were reported along the banks of the Seti River. These ghats, such as Masdighat, Mayagaun, Khahare Tar/Kahare Ghat, Nalbung, Lungri, Dagara, Koithim, Benikot, Rumse, Harkapur, Najung, Govantal, Solang, and Kharibhitta, are frequently used by the local population for cremations.

During the fieldwork, the team confirmed that these ghats do not have any structures built on them, emphasizing their primary purpose as cremation spots along the riverbank.

Table 5. 67: Cremation sites in the project area (Baseline Survey, 2022)

Cremation Sites	
Masighat	Mayagaun
Khahare Tar/Khahare Ghat	Nalbung
Lungri	Dagara
Koithim	Benikot
Rumse	Harkapur
Najung	Govantal
Solang	Kharibhitta

Open-air cremation, while holding religious significance and remaining a tradition for centuries, raises concerns regarding environmental pollution. The process of cremation itself can contribute to air pollution, and the disposal of ashes in water bodies can further contribute to water pollution. Despite these issues, the deeply rooted religious and cultural significance of open-air cremation makes it unlikely to be replaced by alternative technologies.

Additionally, burial grounds were identified near the power house area in Devghat. It was reported that a few households from the Bhujel community have embraced Christianity, leading them to adopt burial as the final ritual practice for the deceased. This indicates a diversification of funeral practices within the community due to changes in religious affiliation.

5.3.25 Perception towards the Project

Among the Project Affected Families (SPAFs), a total of 123 households (HHs) acknowledged their awareness about the project, while the remaining 62 HHs were unaware of its existence. Out of the 123 HHs who were aware, 39% reported being informed by their local leaders, another 39% learned about the project through their neighbors, and 20% received information directly from the hydropower project staff. Additionally, 1 HH mentioned that they acquired information about the project through radio broadcasts.

Regarding their support for the project, 90% of the HHs expressed a positive attitude towards its development. Only 0.5% (1 HH) held a negative view, while 8.6% of the HHs chose not to respond to the question regarding their support.

Most households (92%) expressed optimistic views regarding the positive impacts expected from the project. They anticipate various benefits, including:

- Increased employment opportunities that will be available to them.
- A potential rise in land prices, leading to increased property value.
- Anticipation of social and economic opportunities that will emerge with the operation of Buddha Singh Marga.
- Development of entrepreneurship skills within the community.
- Creation of high-wage job opportunities.
- Improved transportation facilities, enhancing connectivity and accessibility.
- Potential for tourism development in the area.

Furthermore, households expressed their anticipation of skill training programs being provided by the project, which would enhance their capabilities. Additionally, they expressed interest in investing in the shares of the project, recognizing it as an opportunity for financial participation and potential returns.

5.3.26 Water Use Rights

The water of Seti river in the downstream of the dam site is not used for irrigation or water mill operations. People utilize the small river rivulets for irrigation and drinking water purposes. Potential use of the Seti river water for irrigation or water mills is highly unlikely even in the future beacause of topographic constraints. The only water use of Seti River is downstream of the dam site for occasional bathing, swimming, and ritual purposes such as cremation of dead bodies by local communities.

Piped water and springs are the major sources of drinking water for the households of the project area. It has been reported that the households have managed drinking water locally.

Rafting activities were also carried out as a recreational tourism by Ker and Downey resort. But this resort has been closed since the start of COVID-19 pandemic and has not been in operation since then.

6 Analysis of Alternatives

The process of alternative analysis entails assessing various project options to assess and contrast their potential environmental, social, and economic effects. This section provides a concise comparison of potential alternatives across different project design and implementation aspects, considering the magnitude of their environmental impacts and explaining the reasons behind the choices made. The study considered the following alternatives:

- No project alternative (Section 6.1)
- System alternatives (Section 6.2)
- Location alternatives, including ancillary facilities (Section 6.3)
- Design/Technology alternatives (Section 6.4)

6.1 No project alternative

From an environmental perspective, the "no project" alternative could be viewed as favorable compared to project implementation, as it would prevent the occurrence of any negative impacts linked with project development. However, in the absence of the project, there would be no contribution to the country's energy needs. Furthermore, potential social and socio-economic advantages for the nation would be sacrificed, and the quality of life in the project region would remain suboptimal. This option could potentially impede the nation's long-term development plans. The project, on the other hand, offers reliable power supply and enhanced services, which are essential prerequisites to attain comprehensive benefits.

Nepal is rich in hydro resources, with the development potential of 83,000 megawatts (MW) and commercially exploitable hydropower generating potential of about 42,000 MW. Nepal suffers from a severe shortage of power. Most of the existing hydropower plants are of the run-of-the-river type where the electricity generation fluctuates and is highly seasonal.

The government recognizes that it must accelerate the development of its abundant hydropower potential as an important step forward in its efforts to reduce poverty and stimulate economic growth. Hydropower development provides clean energy to enhance economic and social development in the rural and urban areas, it enables Nepal to generate revenue from exports of excess energy to neighboring countries.

Electricity demand peaks during the dry season or the winter months, when generation from hydropower plants is at its lowest. On the other hand, generation is at its highest during the rainy season, when there is less demand. The project's target is basically to produce as much energy as possible during the dry season.

In fact, in Nepal, mainly run of river projects are developing, which tend to feed for power and energy, but during the wet season. During the dry season, however, the availability of energy and power remains well below the demand and limits the agricultural and industrial development, as well as the welfare of the population.

From an environmental point of view, the “without forest” scenario will not allow for the implementation of this project. The reservoir area, and some of the areas proposed for construction and activity sites have a varying quantity of forests. The project proposes to create a ‘green belt’ of forest which will substantially increase the forest cover, habitats for wildlife, community/lease forest use areas, and catchment slope maintenance. Moreover, in this regard it is appropriate to consider.

A large capacity for hydroelectric production, particularly during the dry season, allows a considerable saving in the present deforestation trend and for the air pollution in urban areas, and allows improving the level of welfare, education and health in the country by ensuring the supply of energy and supporting industrialization and agriculture.

This again leads to the opportunity, in planning at country level, to have large accumulation reservoirs, especially by making the most of the sites where physical conditions exist to achieve them and where investments have already been made.

Accumulating potential energy in concentrated and favorable sites for reservoirs is an advantage, always in terms of general planning and environmental protection. Many reservoirs scattered throughout the territory constitute a multiplicity of points of impact and a difficulty in management and increase of overall installation cost.
The project has apparently been positioned as a favorable morphological and environmental condition, comparatively, to maximize the reservoir.

6.2 Location alternatives, including ancillary facilities.

6.2.1 Diversion Structure

The project had initially identified 4 alternative dam sites, namely Original, ALT – 1, ALT – 2, ALT – 3, which were subsequently subjected to geological and geotechnical assessments through on-site investigations. Furthermore, 2 additional dam sites, namely ALT – D1A and ALT – 4 were also identified.

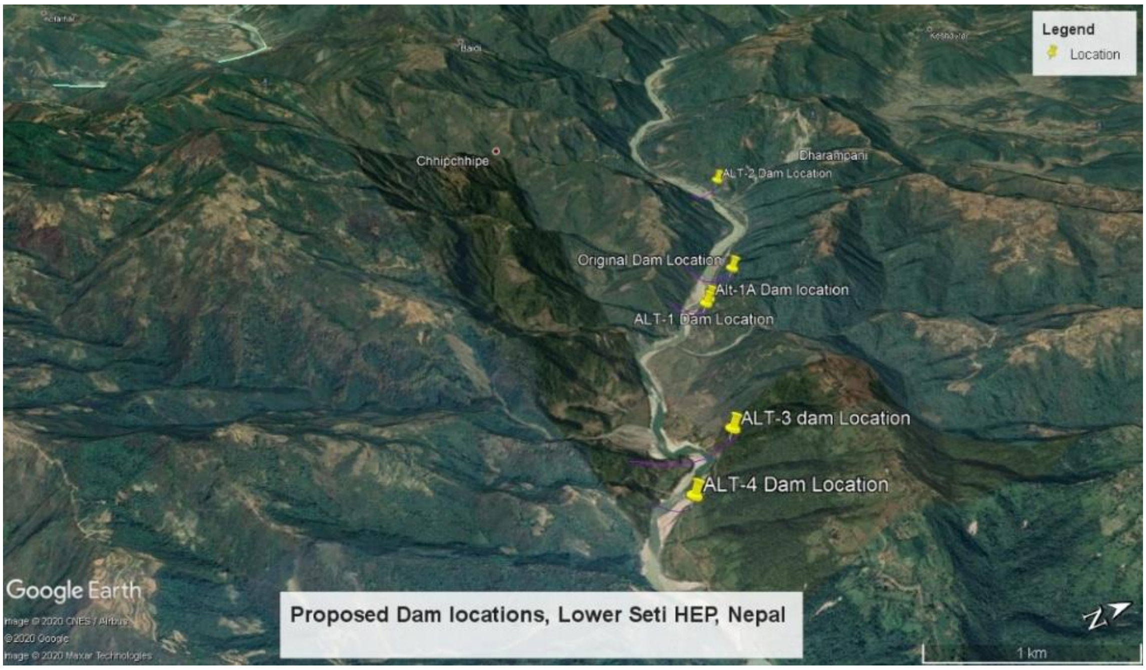


Figure 72: Google Earth image showing the proposed dam axis

Among the alternatives mentioned earlier, a closer examination revealed that 3 sites, specifically ALT – D1A, ALT – 2, and ALT-4, demonstrated feasibility. However, its important to note that each of these selected sites came with its own set of advantages and disadvantages. Below are the key observations for all these sites, which are based on the site investigations.

6.2.1.1 Alternate Dam-1 (D1) Site

The dam site is characterized by the meandering flow of the Seti River, with its course gently winding through the area. Notably, wide point bar deposits can be observed on both sides of the riverbanks, particularly at the concave area of the meanders. The dominant geological composition at the site consists mainly of slate and phyllite. However, it's important to mention that bands of carbonaceous slate/phyllite are present both upstream and downstream of the site. The rock formations generally exhibit a broad wavy or wrapping pattern, indicative of folding deformation.

There are sections where the slate and phyllite beds display signs of shearing and even pulverization, particularly noticeable in certain locations along the road cut section that runs parallel to the river. On the right bank of the river, exposed rock formations extend to a significant height. Beyond this point, thick layers of overburden, colluvium, and old slide debris are exposed. In contrast, the left bank is predominantly covered by old debris, except for areas near the river's edge where rock formations are visible.

A distinct feature downstream of the identified dam axis is the presence of a wide and deep stream on the left bank. Notably, rock formations are not exposed along the cutting section of this stream. The significant depth of this stream and the considerable accumulation of debris on the left bank make this site less suitable for dam construction.

In summary, due to the considerable presence of thick debris and the deep stream on the left bank, this site was deemed unfeasible for the proposed dam construction. The geological and topographical characteristics of the area, including the presence of wide point bar deposits and the complexities of rock formations, play a crucial role in determining the site's suitability for the construction of the dam.

6.2.1.2 Alternate Dam-2 (D2) Site

The ALT-2 (D2) dam site exhibits distinctive characteristics that impact its feasibility for dam construction. In this location, the river flows relatively straight towards the east. Notably, wide point channel bar deposits are present both upstream and downstream of the proposed dam axis on both sides of the riverbanks. Limited exposures of slate and phyllite rock formations are observable from the riverbank to areas upslope at a considerable elevation. Beyond these exposures, there is a significant presence of thick overburden and colluvium.

A noteworthy aspect is the relatively improved quality of the rock mass, primarily consisting of phyllite with bands of carbonaceous phyllite, which is exposed up to a considerable height on both sides of the riverbanks. However, despite the promising geological conditions, there are specific factors that need to be considered when evaluating the site's suitability for dam construction.

One key consideration is the fact that the ALT-2 site represents the most upstream option, resulting in potential challenges related to the availability of live storage for the dam. Additionally, the length of the Headrace Tunnel (HRT) required for this alternative is anticipated to be longer than that of other available options. This extended HRT length has implications for the project's design, cost, and overall efficiency.

Furthermore, the ALT-2 site's topography presents additional complexities. The relatively steep slope on the right bank and the presence of a landslide in the downstream area necessitate careful planning. Specifically, the construction of an underground de-sander would be required, which would significantly increase the project's cost.

In conclusion, while the ALT-2 (D2) site offers certain advantages such as improved rock mass quality and availability of space for dam construction, there are noteworthy drawbacks to consider. These include the challenges associated with minimum live storage, the extended length of the HRT, and the need for costly mitigation measures like an underground de-sander. Balancing the benefits and challenges of this site is crucial when determining its overall feasibility for the proposed dam project. The geological, topographical, and logistical factors associated with the Alt-2 site collectively influence its potential role in the project's successful implementation.

6.2.1.3 Original Dam Site

The original dam alternative site (D-O) exhibits specific geological and topographical characteristics that need to be thoroughly evaluated for its feasibility in the context of the proposed dam project. At this site, the predominant geological feature consists of thick overburden, colluvium, and old debris present on both sides of the riverbanks. This composition extends from the riverbank and continues upwards to the height of the dam location. Moreover, this mixture of materials continues further upslope for a significant distance.

The most notable consideration in assessing the feasibility of thissite is its techno-economic viability. Several key factors contribute to the determination that this site may not be suitable from a technical and economic perspective.

Firstly, the substantial presence of thick overburden, colluvium, and old debris creates significant challenges for dam construction. The need for extensive stabilization measures above the dam body during the construction phase is a critical factor. The necessity for such stabilization measures would likely result in increased construction costs, complexity, and potential delays in the project timeline.

Furthermore, the challenges associated with the presence of these materials are not limited to the construction phase alone. Post-construction, ongoing expenses would be required for the continuous stabilization of the overburden. This recurring expenditure is anticipated due to the inherent instability of the materials present at the site.

Considering these factors collectively, this site appears to be unfeasible from both a techno-economic standpoint. The site's geological composition necessitates significant stabilization efforts during both the construction and post-construction phases.

Additionally, the anticipated recurring costs associated with stabilization measures make this site an impractical choice in terms of project efficiency and financial viability.

In conclusion, while this Original Dam (D-O) site may have certain advantages, such as potential available space and specific geological characteristics, the challenges related to overburden stabilization and the associated economic implications outweigh these benefits. Careful consideration of the site's unique characteristics is essential when determining its suitability within the larger context of the dam project's objectives and constraints.

6.2.1.4 Alternate Dam-3 (D3) Site

The Alt-3 (D3) dam site presents distinct geological and topographical characteristics that warrant a detailed evaluation of its feasibility within the context of the proposed dam project. At this site, the river follows a hairpin meandering pattern, indicating sharp turns and bends along its course. The geological composition predominantly consists of phyllite and slate materials, which are found mainly beneath the overburden.

A notable feature of the ALT-3 site is the requirement for a longer dam length and an increased dam height. This consideration arises due to the specific topographical layout and the meandering nature of the river in this area. The longer dam axis and the elevated height needed for the dam construction add to the complexity of the project at this location.

Additionally, the ALT-3 site poses additional challenges related to its social and environmental impact. The presence of several villages and cultivated lands on both riverbanks immediately upstream of the proposed dam axis is a significant factor. The submergence caused by the dam's reservoir would result in the inundation of these areas, leading to the displacement of communities and loss of productive agricultural land.

These social and environmental concerns, coupled with the technical challenges posed by the longer dam length and increased height, contribute to the unfavorable assessment of the ALT-3 site. The necessity to balance the project's technical feasibility with its social and environmental impact is a critical aspect of site selection.

In summary, while the ALT-3 site may offer certain geological advantages, such as the presence of phyllite and slate beneath the overburden, the challenges associated with the river's hairpin meandering pattern, longer dam length, increased dam height, and the potential displacement of communities make this site less favorable. The site's complexity in terms of engineering requirements and its potential social and environmental consequences need to be thoroughly considered when evaluating its feasibility within the broader scope of the dam project.

6.2.1.5 Alternate Dam-4 (D4) Site

An additional potential dam site has been identified downstream from the Alt-3 (D-3) site. This site presents distinctive geological characteristics, with rock formations either exposed or found beneath slope wash materials. This geological composition sets it apart from the other potential dam sites and prompts further exploration of its feasibility within the context of the dam project.

One of the notable features of this site is its requirement for a longer and considerably higher dam structure. The topography of the area necessitates the construction of a taller dam compared to other alternatives. Despite this need, the site offers a significant advantage in terms of live storage capacity. The reservoir formed by the dam at this location would have the potential to hold a considerably larger volume of water compared to the alternative dam axes. This enhanced live storage capacity can be attributed to its downstream position relative to the other sites, as well as the presence of wider valleys upstream.

Moreover, this site appears to have the potential for accommodating the proposed de-sander basins on a terrace located downstream from the dam axis. This aspect could streamline the implementation of the de-sanding process, enhancing the site's technical feasibility.

Hydraulically, this site offers an advantage as well, with the length of the Headrace Tunnel (HRT) expected to be the shortest among all the considered alternatives. This is due to its position as the most downstream site within the project area.

However, the feasibility of this downstream site must be carefully evaluated in light of its potential impacts on the social and environmental aspects. Notably, the presence of villages and cultivated lands on both sides of the riverbanks upstream from the proposed dam axis poses a significant concern. The creation of the reservoir would result in the submergence of these communities and agricultural areas, which raises substantial social and environmental challenges.
Given the critical issue of submergence of villages and cultivated lands, this site is excluded from consideration. While the geological and technical attributes of the site may present promising aspects, the decision-making process must strike a balance between technical feasibility and the potential social and environmental impacts.

6.2.1.6 Alternate Dam-1A (D1A) Site

An additional potential dam site has been identified, situated approximately 90 meters upstream from the D1 (Alt-1) site. This new site presents distinctive geological features that warrant closer examination for its potential inclusion in the dam project.

The geological composition of this site is notable, with the exposed rock formations providing valuable insights. On the right bank of the river, the rock mass consists of phyllite, like the composition observed at the Alt-2 (D2) site. This phyllite includes bands of carbonaceous phyllite, contributing to the geological diversity of the site. Additionally, the exposed rock on the left river edge is composed of fresh to moderately fresh phyllite, further adding to the geological variation present.

It is important to highlight that the rock quality and characteristics observed at this site influence its feasibility for dam construction. The presence of highly weathered poor to very poor phyllite raises considerations for stability and engineering design. These geological aspects would play a crucial role in determining the technical feasibility and long-term stability of the dam structure.

While the geology of the site provides valuable insights, other factors must also be considered. The anticipated dam length at this site is expected to be considerably longer compared to other alternatives. This aspect is influenced by the topography of the area, which necessitates a longer dam structure to effectively harness the hydroelectric potential of the river.

The elevation of the riverbed at approximately EL.246 meters, along with the availability of the desired intake level, adds to the technical advantages of this site. These aspects contribute to the overall feasibility of dam construction and operation.

Among the potential benefits of this site, its relatively larger live storage capacity stands out. The site's downstream location compared to other alternatives could contribute to a larger reservoir capacity, enabling the storage of a greater volume of water for power generation and other purposes.

Additionally, the possibility of implementing a surface de-sander at this site is an advantage worth considering. A surface de-sander could aid in managing sediment and enhancing the efficiency of the hydropower generation process.
While this new site presents promising geological, technical, and operational attributes, it is crucial to assess its potential impacts on social, environmental, and economic aspects. The decision-making process should carefully weigh the advantages and challenges of this site against those of the other alternatives to determine its suitability within the broader context of the dam project.

6.2.1.7 Comparative Analysis of all the Sites

Table 6. 1: a comparative analysis of all the diversion structure sites

Proposed Dam Axis	General	Advantages	Disadvantages
Original	Co-ordinates: Right Bank 27º51’40.15”N, 84º23’21.33”E Left Bank 27º51’43.52”N, 84º23’26.97”E Dam top elevation: 290m Length(NSL-NSL):266.6m (Google Earth) Dam Height: 50m (Google Earth) Submergence area: 268.18 Ha	Shorter dam height	Longer dam length Rock is not exposed on the left bank. Thick debris is present. Huge slope stability measures will be required from far above the dam body on left bank. Less submergence indicates low live storage Submergence of U/S habitats
Dam 1	Co-ordinate: Right Bank 27°51’26.01” N, 84°23’40.28” E Left Bank	Relatively shorter dam length. More submergence indicates more live storage.	Rock is not exposed on the left bank. Thick debris is present.

	27°51'29.30" N, 84°23'44.29" E Dam top elevation: 290m Length (NSL-NSL): 244.5m (Google Earth)/ 198.1m (Actual survey length) Dam Height: 55m (Google Earth)/ 44m (ERT Survey) Submergence area: 285.53Ha		Huge slope stability measures will be required from far above the dam body on left bank. A wide kholsi is present adjacent to the dam axis where construction of dam may not be feasible. Surface desander basin is not possible. Submergence of upstream habitats.
Dam 2 Upstream most site	Co-ordinate: (UTM Co-ordinate) Right Bank N 3083404.1727, E 537008.1260 Left Bank N 3083557.9075, E 536990.6991 Dam top elevation: 290m Length (NSL-NSL): 218.4 (Google Earth)/154.66m (Actual survey length) Dam Height: 45m (Google Earth)/ 47m (ERT Survey) Submergence area: 209.86Ha	Relatively shorter dam length. Rock (phyllite with bands of carbonaceous phyllite) is exposed on both the banks. Dam height is less which is techno-economic	Longest HRT required. Surface desander is not possible due to presence of landslide on the D/S of dam axis. Less submergence area indicates less live storage Submergence of upstream habitats
Dam 3	Co-ordinate: Right Bank 27°50'51.69" N, 84°29'46.72" E Left Bank 27°51'03.87" N, 84°24'47.10" E Dam top elevation: 290.0m Length (NSL-NSL): 476.0m (Google Earth) Dam Height: 70m (Google Earth)	More submergence indicates more live storage. Shorter HRT length. Surface desander is possible.	Debris is present on the left bank. Longer length & height. Submergence of upstream villages. A hairpin meander is present which is not feasible for dam.

	Submergence area: 412.52Ha		
Dam 1A 2.5 km downstream of D-2 site (selection for minimum investigation)	Co-ordinate (UTM Co-ordinate) Right Bank N 3082122.60, E 538996.59 Left Bank N 3082278.61, E 539142.47 Dam top elevation: 290m Length (NSL-NSL): 237.0m (Google Earth)/ 213.71m (Actual Survey) * Dam Height: 65m (Google Earth)/ 44m (Value calculated from earlier ERT Survey along D1) Submergence area: 283.51Ha	Rock (phyllite with bands of carbonaceous phyllite) is exposed on both the banks. Relatively shorter dam length & height. More submergence indicates more live storage. Surface desander is possible.	Poor rockmass is present on left bank road cut section. Two kholsi are present along the initial stretch of HRT alignment where cover is less, require adequate support. Longer HRT.
Dam 4	Co-ordinate Right Bank 27°50’40.51” N, 84°23’01.08” E Left Bank 27°50’49.32” N, 84°23’06.02” E Dam top elevation: 290m Length (NSL-NSL): 377.1m (Google Earth) Dam Height: 80m (Google Earth) Submergence area: 434.54Ha	Rock (phyllite with bands of carbonaceous phyllite) is exposed on both the abutments. More submergence indicates more live storage. Shortest HRT length. Surface desander may be possible.	Longer dam length & height. Submergence of upstream villages.

6.2.1.8 Selection of Dam Site

The process of selecting the most suitable dam sites among the alternatives involved comprehensive assessments conducted by the Consultants. After visiting the potential dam sites and evaluating various factors, the sites designated as D1 and D2 were ultimately chosen for further consideration. The selection of these sites was based on a range of crucial criteria, including geological characteristics, dam length, slope stability, the presence of kholsis (deep gullies), the placement of intake structures, the feasibility of incorporating a surface de-sander, and the minimization of population displacement. With these factors in mind, tentative layouts were developed for both D1 and D2 dam axes.

Several key considerations played a pivotal role in the finalization of the dam axis selection:

a) ***Geological studies***: A detailed geological mapping exercise was carried out along the entire stretch of the river, encompassing the area from D1A to D2 dam sites. This survey revealed that the predominant geological formation in the region consisted of phyllite with bands of carbonaceous phyllite. This geological makeup was consistent across both dam sites, indicating a comparable foundation for construction.
b) ***Location of project component***: The location of vital project components, such as the intake structures and desanders, factored significantly into the decision-making process. The D1A axis offered advantageous conditions for accommodating these structures on the surface. In contrast, placing these structures on the D2 axis posed challenges due to its geological and topographical characteristics. Additionally, the length of the Head Race Tunnel (HRT) at the D2 dam axis was estimated to be around 8 kilometers, whereas at the D1A location, the HRT length was projected to be approximately 6 kilometers. This difference in tunnel length led to potential cost savings for the project when situated at the D1A axis.
c) ***Cost-benefit analysis***: An in-depth cost-benefit analysis was conducted, comparing the potential outcomes of selecting the dam at either the D1A or D2 axis. It was determined that opting for the dam at the D1A axis would result in a lower cost per megawatt (MW) of energy generated compared to the D2 axis.

After thorough evaluations of geo-technical factors and economic considerations, the decision was reached to proceed with the Dam at the D1A axis. This conclusion was based on a comprehensive assessment that weighed geological stability, technical feasibility, cost-effectiveness, and the overall project's sustainability. Consequently, the project layout was finalized in alignment with this chosen dam axis, ensuring a well-informed and strategic approach to the dam's construction and operation.

6.2.2 Head Race Tunnel (HRT)

6.2.2.1 Economic Diameter of the Tunnel

The determination of the optimal diameter for a headrace tunnel involves a systematic approach aimed at minimizing overall costs while ensuring efficient energy transfer and structural integrity. This decision is influenced by a range of factors and considerations to achieve an economically viable solution.

The adopted philosophy centers around achieving the minimum total value of two main components:

a) ***Annual Recurring Cost*** **-** This factor accounts for the ongoing expenses associated with the tunnel over its defined economic life, which aligns with the expected operational duration of the entire power plant. This includes maintenance, repairs, and any other recurring costs incurred in relation to the tunnel's functionality.
b) ***Cost of Energy Losses due to Friction in the tunnel*** - Friction within the tunnel leads to energy losses as the water flows through it. These losses contribute to inefficiencies in the energy transfer process. It is essential to minimize these losses to ensure that the generated energy output aligns with expectations.

The construction cost of the tunnel constitutes a significant portion of its overall cost. This includes related to excavation, concrete lining, and additional structural elements such as shotcrete or rock bolting for reinforcement. These factors play a pivotal role in determining the financial implications of the tunnel's construction.

Additionally, considerations regarding tunnel velocity are paramount in deciding the tunnel's economic diameter. While the Indian Standard (IS) code suggests a maximum permissible velocity of 6 m/sec for concrete-lined tunnels, industry practice often settles on a conventionally adopted range of 3 to 4.5 m/sec. This range is influenced by various factors, including the total head losses within the entire system and the need to balance construction ease with efficiency.

In the initial assessment phase, a preliminary tunnel diameter of 8.25 meters was established. This diameter was selected with several key considerations in mind:

- ***Velocity*** - The selected diameter corresponds to a calculated velocity of 3.24 m/sec. This velocity aligns with the conventionally adopted range, ensuring an efficient balance between energy transfer and head losses in the tunnel.
- ***Construction Ease*** - The chosen diameter was deemed suitable for expedited and straightforward construction, acknowledging the practical challenges associated with excavation and lining processes.
- ***Overall Project Context*** - The diameter selection was made within the broader context of the entire project. Factors such as energy generation goals, overall cost-effectiveness, and structural integrity were considered to ensure alignment with the project's objectives.

The decision to opt for a specific tunnel diameter reflects a careful evaluation of multiple interrelated factors, seeking a solution that maximizes operational efficiency, minimizes costs, and adheres to industry best practices.

6.2.2.2 General Alignment of the HRT

The planning, design, and construction of the Head Race Tunnel (HRT) for the project involved a comprehensive analysis of various factors to ensure its effective functioning and structural integrity. Several considerations were made during this process, which encompassed geological and topographical aspects.

The proposed HRT spans a length of 6.763 kilometers and features a modified horseshoe or circular shape with an 8.25-meter diameter. This design aims to facilitate the transport of sediment-free water from the intake point to the surge shaft and subsequently into the inclined pressure shaft. The chosen circular shape on the right bank of the Seti River has been tailored to accommodate a discharge capacity of 206.9 cubic meters per second (cumec).

The alignment of the HRT was meticulously determined, taking into consideration several factors:

- ***Topography***: The natural terrain of the area played a pivotal role in determining the optimal alignment of the HRT. This approach ensures that the tunnel follows a path that is both feasible to construct and minimally disruptive to the surrounding landscape.

- ***Geological Conditions***: The geological makeup of the right bank, where the HRT is situated, significantly influenced the tunnel's alignment. The presence of suitable rock cover was essential to ensure the stability of the tunnel's structure and prevent potential issues related to excavation and rock stability.
- ***Rock Cover***: Adequate rock cover, which refers to the thickness of rock overlaying the tunnel, is vital for its stability and longevity. The alignment was chosen in such a way that sufficient rock cover would be available along the entire length of the tunnel, reducing the risk of structural instability.

To arrive at the most optimal HRT design, seven alternative options were rigorously evaluated. These alternatives were labelled as ALT-1&1A, ALT-2&2A, ALT-3&3A, and ALT-4. Each alternative was assessed based on technical feasibility, considering factors such as geology, topography, and rock mass conditions.

After a detailed study of these alternatives, it was determined that ALT-4 emerged as the most feasible option. This conclusion was reached due to several factors:

- ***Rock mass Condition*** - ALT-4 demonstrated comparatively better rockmass conditions, ensuring the stability of the tunnel structure and minimizing potential concerns related to rock stability during construction and operation.
- ***Cover and Interferences*** - ALT-4 offered the maximum cover to prevent squeezing conditions and maintain required minimum covers. It also resulted in the least number of interferences with the regional synform axis, enhancing overall stability.
- ***Bends and Alignment*** - ALT-4 featured the least sharp bends along its alignment, contributing to smoother water flow and operational efficiency.

This thorough evaluation and comparison of the alternative options underscores the meticulous approach undertaken in selecting the most suitable alignment for the HRT. By considering geological, topographical, and structural aspects, the chosen design ensures the successful conveyance of water and the long-term stability of the HRT within the project context.

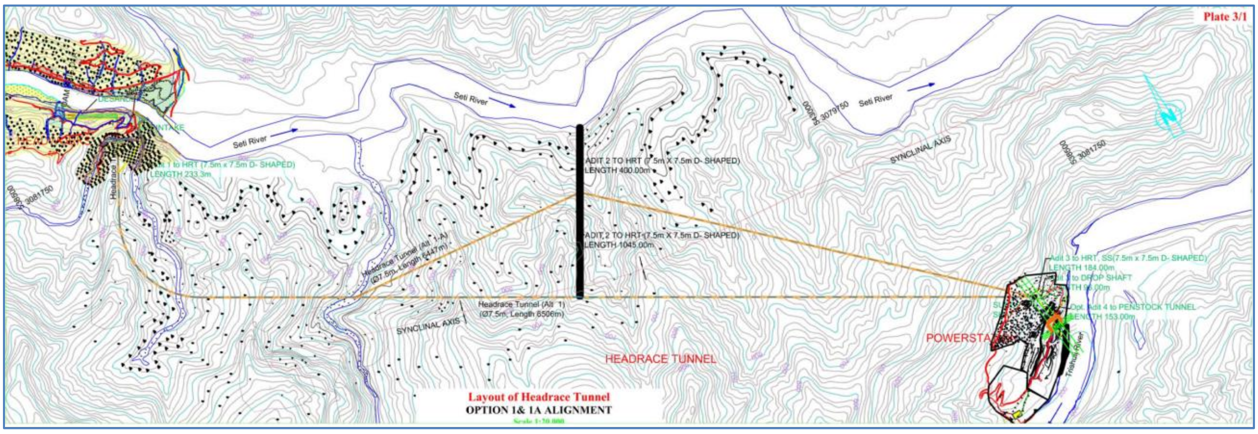


Figure 73: Layout of HRT Alternative 1 and 1A

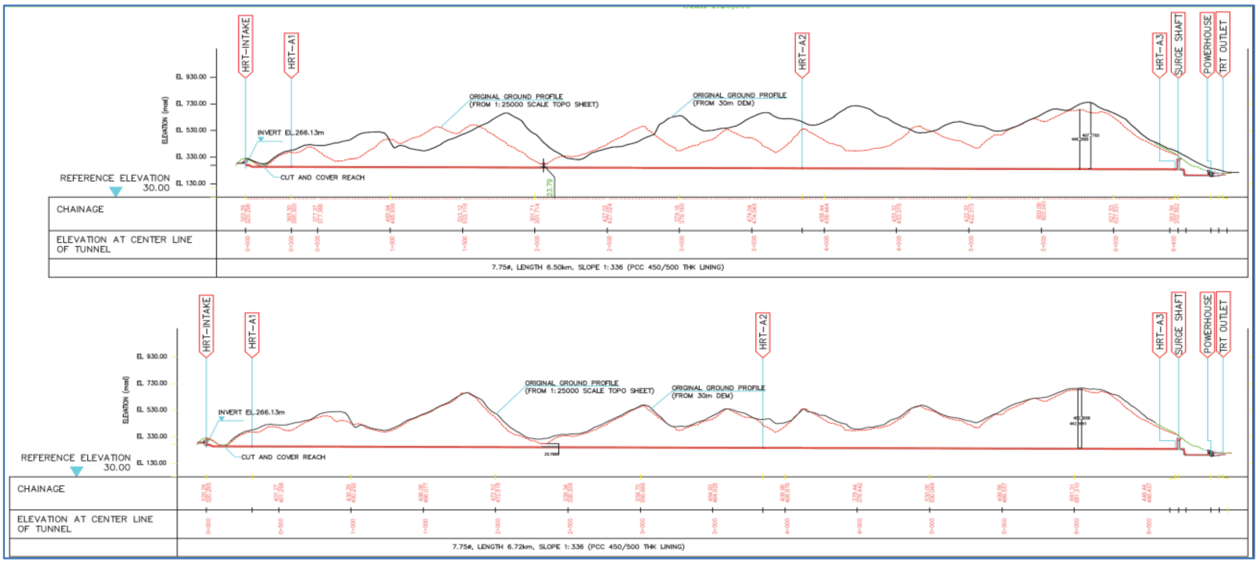


Figure 74: Longitudinal Profile of HRT Alternative 1 and 1A

Table 6. 2: Comparative Analysis of Alternative 1 and 1A

Parameters	ALT-1	ALT-1A	Remarks
Length	6.5Km	6.7Km	
No. of Kink	1	3	
Max. Cover	446.0m	442.0m	
Min. Cover	23.79m	23.78m	Not Feasible
Stretch (<300m Cover)	5.17Km	5.1Km	
Stretch (300m-450m Cover)	1.33Km	1.65Km	Squeezing condition
Stretch (>450m Cover)	0.076m	0.076m	
Rockmass condition	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 50%-60% Class-V (Very poor)/ VI (Exceptionally poor) 20%-30% along the HRT	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 55%-65% Class-V (Very poor)/ VI (Exceptionally poor) 15%-25% along the HRT	
Effect of Synform	13° angle 250m stretch	42° angle 83m stretch	

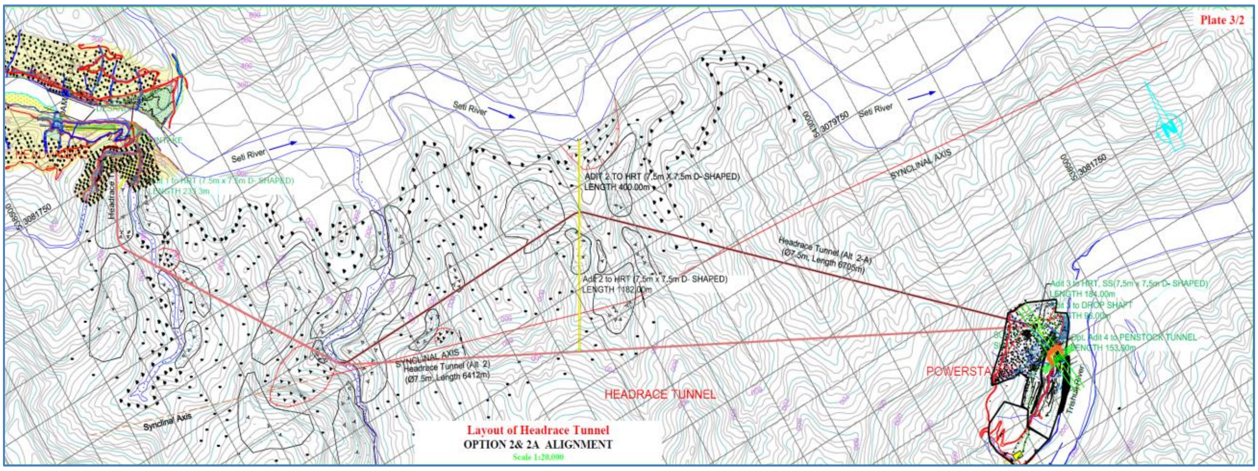


Figure 75: Layout of HRT Alternative 2 and 2A

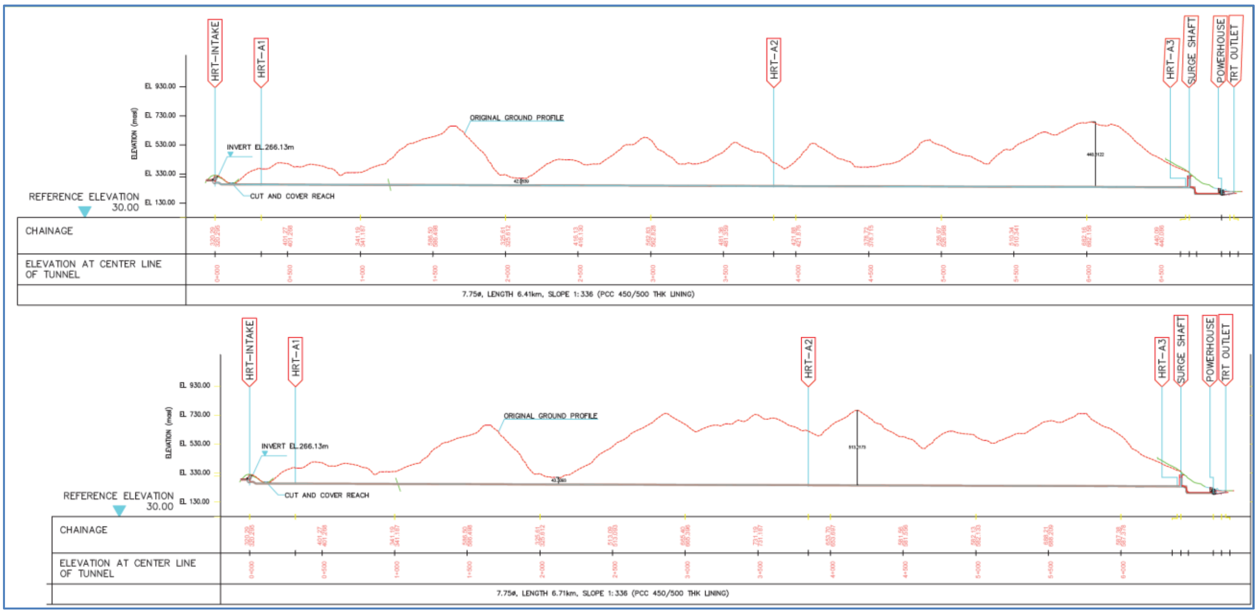


Figure 76: Longitudinal Profile of HRT Alternative 2 and 2A

Table 6. 3: Comparative Analysis of Alternative 2 and 2A

Parameters	**ALT-2**	**ALT-2A**	**Remarks**
Length	6.4Km	6.7Km	
No. of Kink	1	2	
Max. Cover	448.0m	513.0m	
Min. Cover	43.30m	42.95m	Slightly low cover
Stretch (<300m Cover)	5.3Km	5.1Km	
Stretch (300m-450m Cover)	2.51Km	1.6Km	Squeezing condition

Parameters	**ALT-2**	**ALT-2A**	**Remarks**
Stretch (>450m Cover)	0.56m	-	Squeezing condition
Rockmass condition	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 55%-65% Class-V (Very poor)/ VI (Exceptionally poor) 15%-25% along the HRT	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 50%-60% Class-V (Very poor)/ VI (Exceptionally poor) 20%-30% along the HRT	
Effect of Synform	10° angle 260m stretch	10° angle 260m stretch 39° angle 78m stretch	

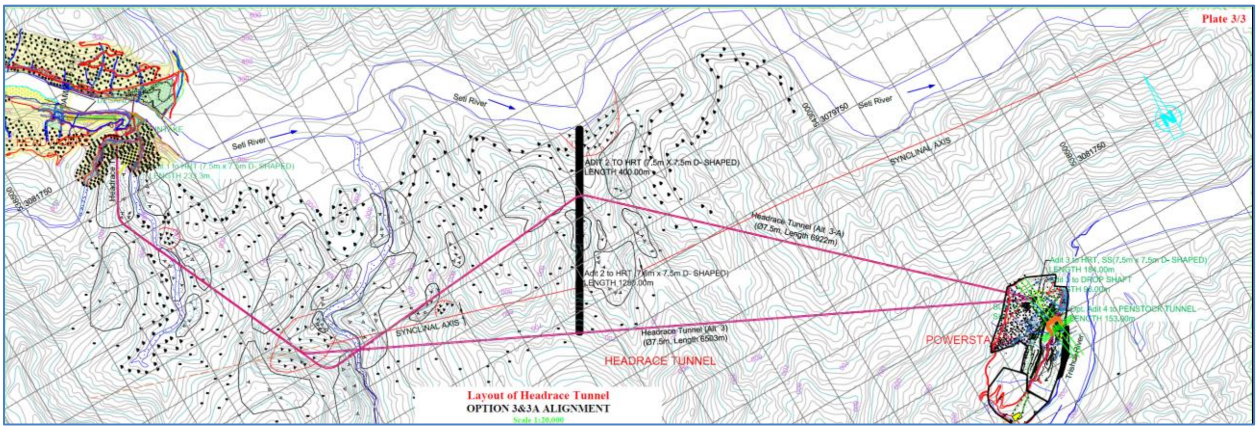


Figure 77: Layout of HRT Alternative 3 and 3A

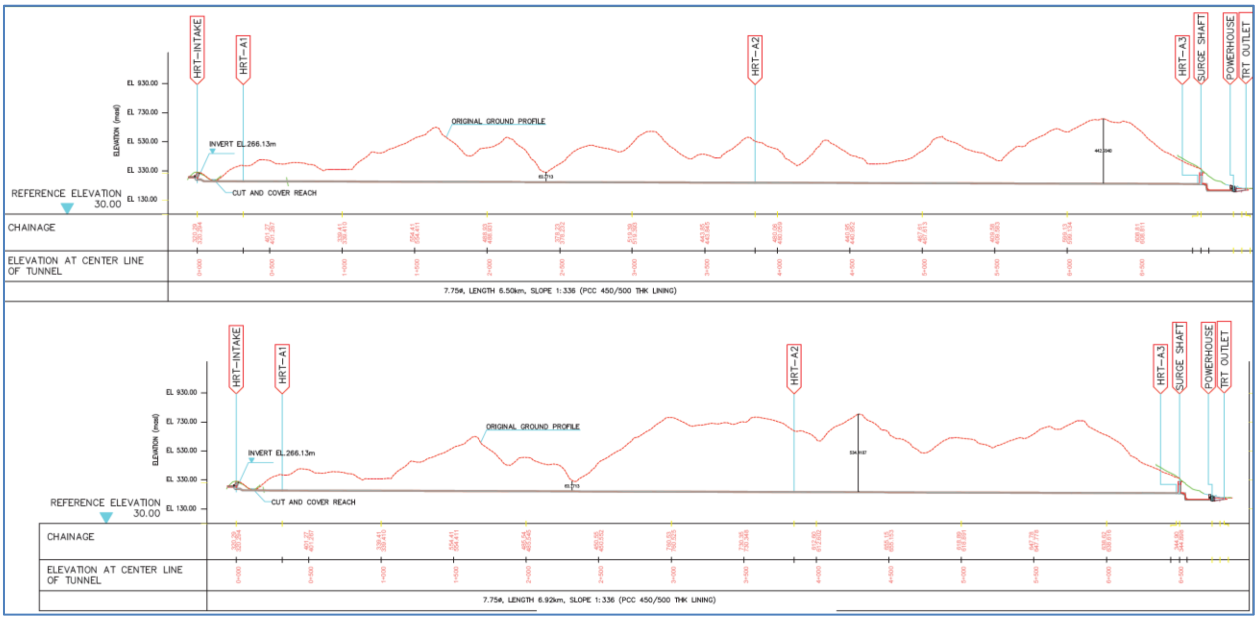


Figure 78: Longitudinal Profile of HRT Alternative 3 and 3A

Table 6. 4: Comparative Analysis of Alternative 3 and 3A

Parameters	ALT-3	ALT-3A	Remarks
Length	6.5Km	6.9Km	
No. of Kink	2	3	
Max. Cover	534.0m	442.0m	
Min. Cover	63.77m	63.77m	
Stretch (<300m Cover)	2.6Km	5.4Km	
Stretch (300m-450m Cover)	3.1Km	1.1Km	Squeezing condition
Stretch (>450m Cover)	0.8Km	-	Squeezing condition
Rockmass condition	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 55%-65% Class-V (Very poor)/ VI (Exceptionally poor) 15%-25% along the HRT	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 50%-60% Class-V (Very poor)/ VI (Exceptionally poor) 20%-30% along the HRT	
Effect of Synform	49° angle 73m stretch	49° angle 73m stretch 22° angle 135m stretch 39° angle 110m stretch	

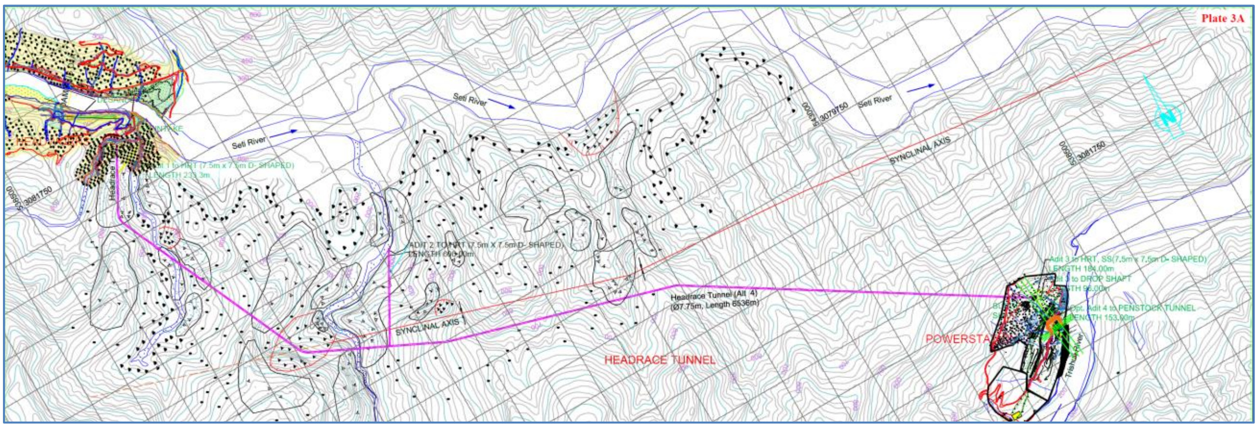


Figure 79: Layout of HRT Alternative 4

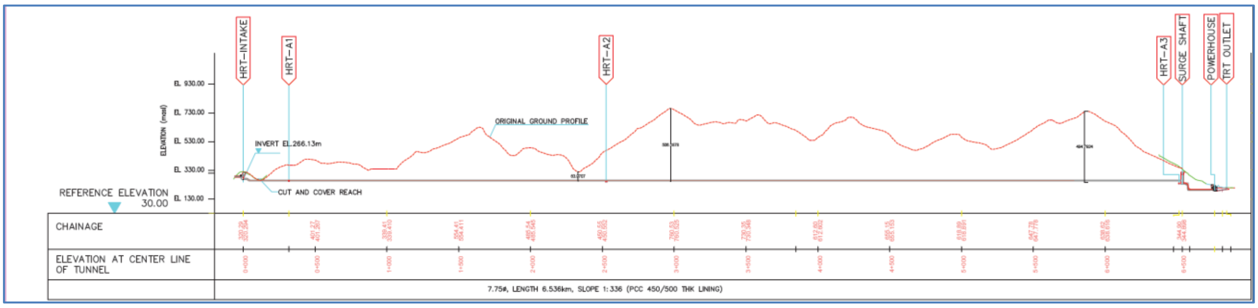


Figure 80: Longitudinal Profile of HRT Alternative 4

Table 6. 5: Analysis of HRT Alternative 4

Parameters	**ALT-4**	**Remarks**
Length	6.5Km	
No. of Kink	4	
Max. Cover	506.0m	
Min. Cover	63.97m	
Stretch (<300m Cover)	3.4Km	
Stretch (300m-450m Cover)	1.8Km	EOG condition
Stretch (>450m Cover)	0.3Km	
Rockmass condition	Class-III (Fair) will be about 10%-20%, Class-IV (Poor) 60%-70% Class-V (Very poor)/ VI (Exceptionally poor) 10%-20% along the HRT	
Effect of Synform	49° angle 73m stretch	

Table 6. 6: Summary of all proposed HRTs

Parameters	Length	No. of Kink	Max. Cover	Min. Cover	Stretch (<300m Cover)	Stretch (300m-450m Cover)	Stretch (>450m Cover)	Effect of Synform	Remarks
Alt-1	6.5Km	1	446.0m	23.79m	5.17Km	1.33Km	0.076Km	13° angle 250m stretch	Not Feasible
Alt-1A	6.7Km	3	442.0m	23.78m	5.1Km	1.65Km	0.076Km	42° angle 83m stretch	
Alt-2	6.4Km	1	448.0m	43.30m	5.3Km	2.51Km	0.56Km	10° angle 260m stretch	
Alt-2A	6.7Km	2	513.0m	42.95m	5.1Km	1.6Km	-	1. 10° angle 260m stretch 2. 39° angle 78m stretch	
Alt-3	6.5Km	2	534.0m	63.77m	2.6Km	3.1Km	0.8Km	49° angle 73m stretch	
Alt-3A	6.9Km	3	442.0m	63.77m	5.4Km	1.1Km	-	1. 49° angle 73m stretch 2. 22° angle 135m stretch 3. 39° angle 110m stretch	
Alt-4	6.5Km	4	506.0m	63.97m	3.4Km	1.8Km	0.3Km	49° angle 73m stretch	Feasible

6.2.3 Powerhouse

The intended powerhouse site is situated on the right bank of the Trishuli River, approximately 2 kilometers downstream from its confluence with the Seti River, near the village of Gaighat. During the initial assessment, the Consultants conducted a site visit to evaluate various powerhouse options, including the Original, Option-1, and Option-2 proposals. Subsequently, three additional alternate sites were identified, consisting of two underground powerhouse options (Option-3 and Option-4) and a surface powerhouse option (Option-5). Hereafter, the key observations regarding all the alternative options are detailed.

At the ***Original Surface Powerhouse site***, located between sites P1 and P2, the presence of alluvial terrace deposits and aged slide debris was noted. Furthermore, a significant kholsi (ravine) traverses the area, rendering this site unfavorable. Site P1 requires substantial foundation depth, and the back slope would be subject to overburden and a sliding zone. The placement of the surge shaft would be challenging, making this site unfeasible.

At the ***Alt-2 (P-2) powerhouse*** location, thick colluvium and old slide debris were exposed, indicating potential slope instability. Addressing this instability would necessitate extensive stabilization measures, both during and after construction, due to the likelihood of reactivation of the old slide. Consequently, this site also lacks feasibility.

The ***Alt-1 (P-1)*** site is positioned beneath a large slide scarp. Geological maps indicate the presence of old landslide debris and colluviums. While site visits revealed the existence of these materials and additional alluvial terraces, only colluvium and debris are depicted on the geological map. Colluvium and debris are susceptible to instability, leading to subsidence and creep movement, potentially causing new landslides within the debris. River terrace deposits, though relatively stable, require conventional slope protection measures along the cut slope of the surface powerhouse. Rock exposure or shallow-depth presence is anticipated at the surge shaft area of this powerhouse option. To address uncertainties, two underground powerhouse options (Alt-3 and Alt-4) and a surface powerhouse option (Alt-5) have been identified.

The underground powerhouse ***Alt-3 (P-3)*** is downstream of Alt-2 (P-2). The site features thin slope wash material with intermittent rock outcrops, suggesting suitability for an underground powerhouse. The underground powerhouse Alt-4 (P-4) is upstream of a suspension bridge, characterized by a rocky escarpment. However, the presence of extensive wedge failure and open stress release joints deems this site unsuitable.

The selected surface powerhouse ***Alt-5 (P-5)*** is positioned just downstream of the suspension bridge. Rock exposure along the village road and the river edge, as well as sporadic rock outcrops at the powerhouse and riverbank, suggests the presence of phyllite at shallow depths. The upslope area exhibits stable slopes with exposed rock or shallow soil. This site is deemed the most stable and suitable for the proposed surface powerhouse (SPH). Despite the possibility of slight additional head loss due to its location upstream of Alt-1 (P-1), this site offers stability and feasibility. The exposed siliceous phyllite/slate is considered competent, making the surface powerhouse complex Alt-5 (P-5) both technically and economically viable, as well as environmentally friendly.

Figure 81: Google earth images showing proposed powerhouse locations of Tallo Seti HEP

Among the array of six alternative options evaluated, the choice ultimately fell upon the newly introduced Option-5 (PH-5) surface powerhouse (as depicted in Figure 6-10). This selection was driven by the promising geological conditions observed at the site. The presence of rock, specifically slate, was either visibly exposed or existed beneath a shallow layer of soil. This attribute marked the site as a strong contender.

Additionally, the proposed placement of the surge shaft added to the favorable aspects of the site. Positioned on a stable slope, the surge shaft area exhibited the presence of rock beneath a thin overlay of slope wash material and colluvium. This promising geological composition signaled a robust foundation for the proposed surge shaft structure.

Given these advantageous geological and geotechnical characteristics, Option-5 (PH-5) emerged as the preferred choice for the powerhouse location. The presence of exposed slate or rock, coupled with the stable slope conditions, not only ensures a secure foundation for the surface powerhouse but also suggests that construction and subsequent operational challenges would likely be minimized. This careful evaluation of geological features underscores the site's suitability for the installation of the proposed powerhouse complex.

6.2.3.1 Powerhouse (Comparative study between alternate orientations)

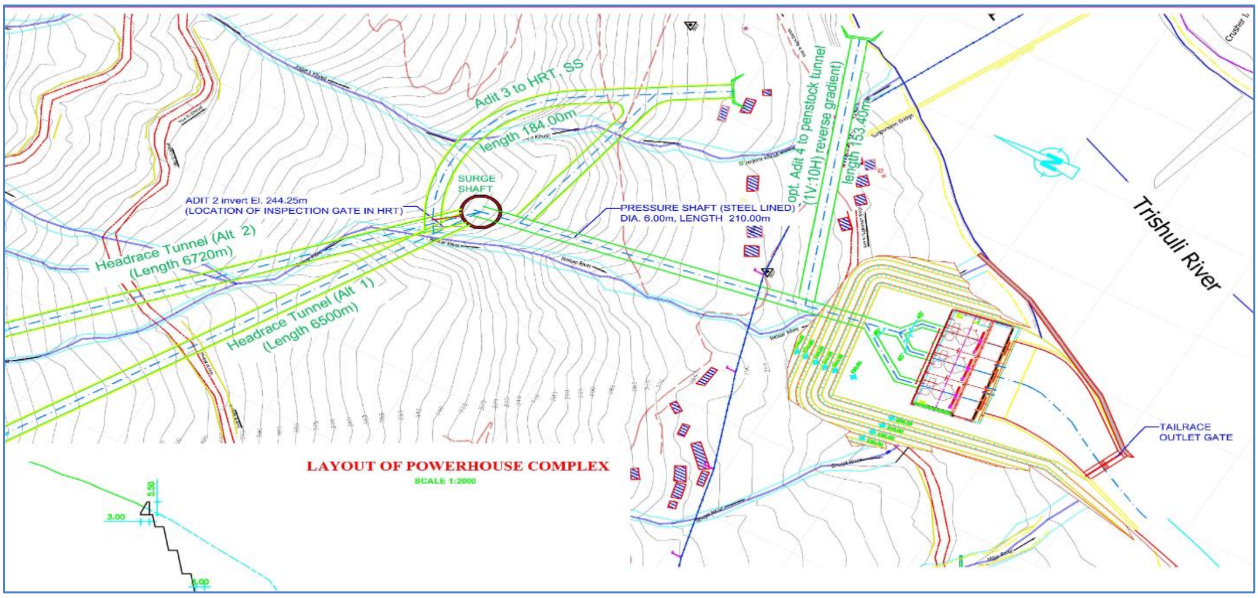


Figure 82: Alternative Plan of Pressure Shaft Alignment

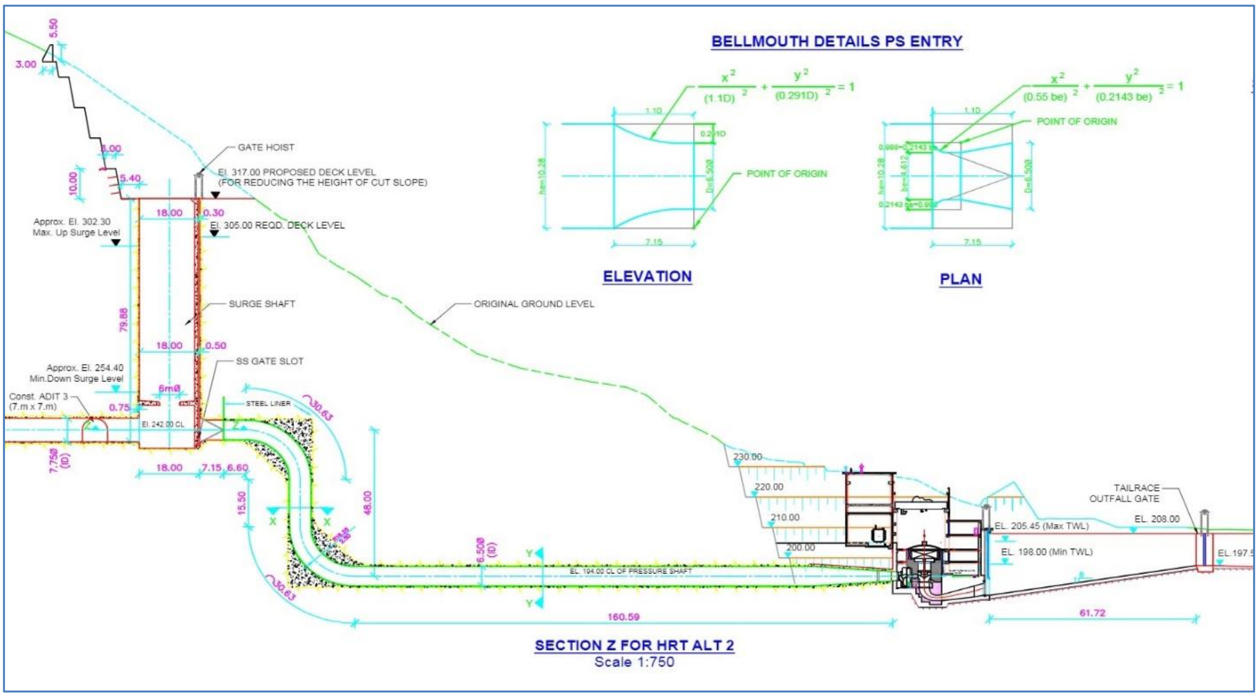


Figure 83: Section Showing the Pressure Shaft

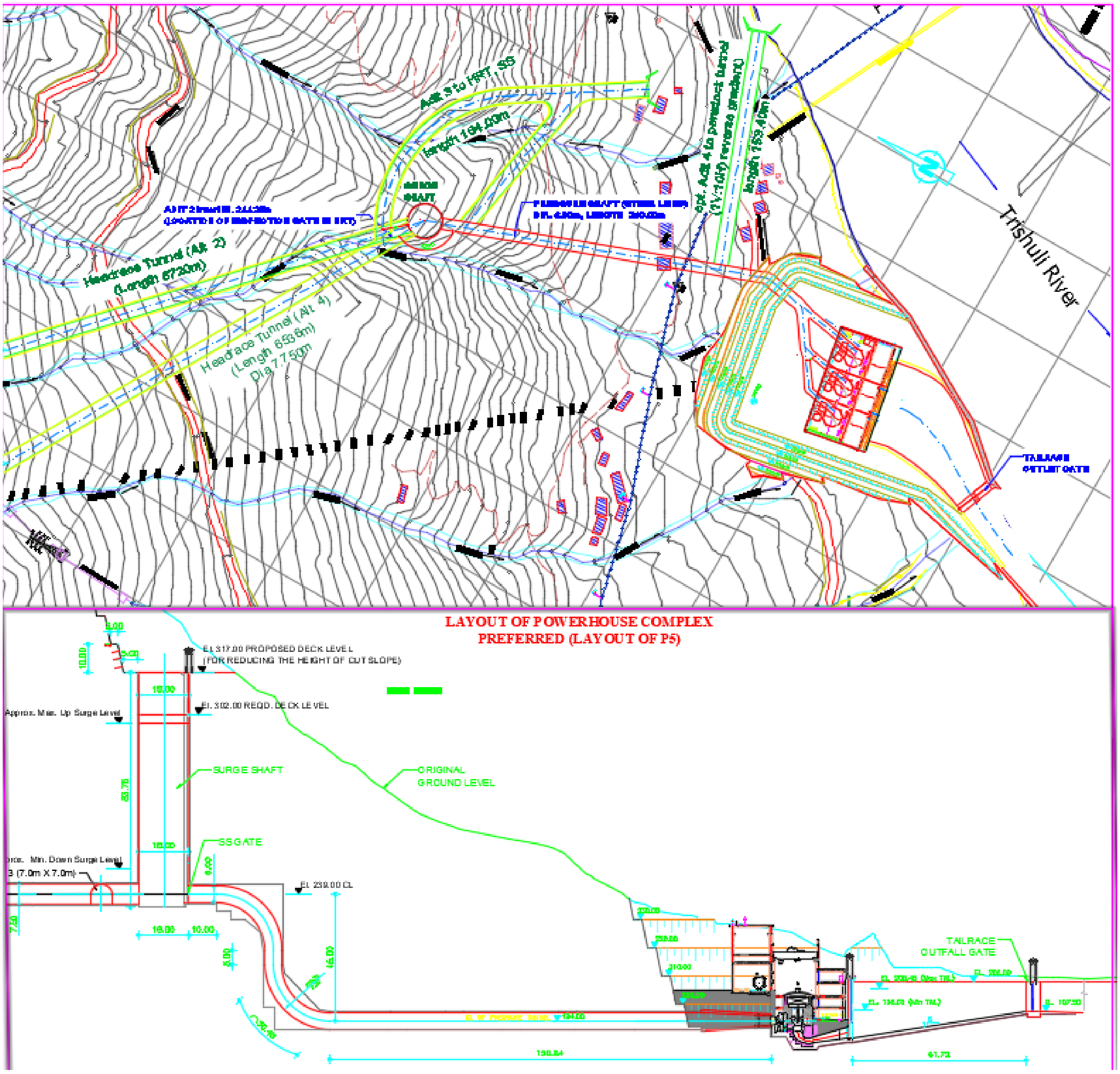


Figure 84: Alternative Plan of Pressure Shaft and Section

Table 6. 7: Comparative Table between Alternatives PH-A and PH-B

S.N.	Aspect	PH-A (Oblique to the slope/ contour)	PH-B (Parallel to slope/ contour)	Remarks
1.	Depth of rock	<2m	<2m	Depth of overburden is same
2.	Vertical Excavation (Perpendicular to PH)	56.4m (El.190m-246.4m)	56.3m (El.190m - 246.3m)	Vertical excavation is same

S.N.	Aspect	PH-A (Oblique to the slope/ contour)	PH-B (Parallel to slope/ contour)	Remarks
3.	Excavation along pressure shaft	55m	69m	Length of excavation at about 14m more than PH-A.
4.	Stability analysis through stereographic projection	3 wedges (J1^J2,J1^J4, J2^J4) 1 Planar failure along J1 (Fig.1)	3 wedges (J1^J2,J1^J4, J2^J4) (Fig.2)	Rock-bolting will be required for both the cases. The same rock bolts will prevent planar/topple failures also in case of PH-A. As the angle of the strike of foliation & cut slope of PH-A is 7º, chances of toppling cannot be ruled out. 80º dip also noticed due to local folding which may cause toppling locally in case of PH-A.
5.	House affected	1 (under construction)	1 (under construction)	Same house in both cases

6.3 Design/Technology alternatives

6.3.1 Comparative analysis between Dam and Barrage

Informed by the results of rigorous geotechnical investigations involving drilling activities and comprehensive geological assessments, a strategic decision was made to alter the type of diversion structure. This change was deemed necessary to ensure the utmost safety and suitability of the structure's foundation within the geological context. As a result of this well-informed modification, the proposed diversion structure has taken the form of a Barrage structure situated at the D-1A location. This particular location was selected after thorough consideration of the geological characteristics, which are conducive to the stable and secure foundation required for the Barrage structure.

The revised design features a Barrage structure that has been optimized in terms of height, aligning with the geological attributes of the D-1A site. The foundation conditions, notably the presence of phyllite rock, played a pivotal role in determining this modification. The inherent stability and load-bearing capacity of the phyllite rock at the D-1A location make it an ideal candidate for supporting the Barrage structure. This change in the diversion structure type demonstrates a proactive approach, driven by a thorough understanding of the geological and geotechnical conditions on site, to ensure the long-term safety and efficacy of the project.

The comparative analysis between Dam and Barrage is given below:

Table 6. 8: Comparative analysis between Dam and barrage

S.N.	Description	Dam	Barrage	Remarks
1	Height of Structure	64 m	31 m	Reduced height
2	Length of Structure	250 m	189 m	Reduced length
3	Submergence Area	2.59 km^2	1.72 km^2	Reduction in submergence area
4	Design Discharge	178.47 m3/s	206.90 m3/s	
5	Installed Capacity	126 MW	126 MW	Same
6	Energy	561.2 GWh	520.8 GWh	
7	Project Cost	2810.13 Cr NPR 234.18 M USD	2635.29 Cr NPR 219.60 M USD	Reduction in Cost
8	IRR	16.04	15.60	

6.3.2 Reasons to adopt Barrage

6.3.2.1 Project Layout

In the process of developing the project layout, the sub-surface exploration activities yielded valuable insights into the geological composition of the site. The explorations revealed the presence of Phyllite along with distinct layers that contain partings of carbonaceous phyllite and bands of carbonaceous phyllite. As a result of this geological composition, it was anticipated that the project would require deep foundations to ensure stability and structural integrity.

However, it is crucial to emphasize that carbonaceous phyllite is characterized by its poor quality as a rock material. It possesses exceptionally low bearing capacity and deformation modulus, making it susceptible to transforming into a paste-like substance under saturated conditions. The viability of the project's foundation relies heavily on the thickness and frequency of these carbonaceous bands within the rock layers. The presence of such bands influences the project's foundation design and whether protective measures such as dental treatment or raft foundations can be employed effectively to facilitate the transfer of loads from structures like concrete dams to the surrounding phyllite rock.

In light of these geological considerations, an additional step was taken to enhance understanding and ensure the safety of the project. Specifically, the proposal to conduct two inclined drill holes was put forth. The purpose of these drill holes was twofold: first, to gain a more precise understanding of the frequency, thickness, and orientation of the carbonaceous bands within the phyllite rock; and second, to bridge the information gap across the riverbed area. The information gathered from these drill holes was intended to provide the necessary data for designing a structurally sound and feasible diversion structure that could effectively manage the challenges posed by the carbonaceous phyllite bands. This approach reflects a proactive commitment to addressing geological complexities in a manner that safeguards the project's integrity and longevity.

6.3.2.2 Based on type of Diversion structure

The foundations of the proposed barrage are strategically designed to be supported by a raft foundation, which encompasses a width equivalent to 2-3 blocks of the dam structure. This design approach is chosen for its ability to provide a substantial bearing capacity that surpasses the measured bearing capacity by a factor of 3-5 times. This enhanced bearing capacity is particularly valuable when dealing with rock strata that exhibit low bearing pressure. The utilization of raft foundations serves to distribute the loads more effectively, contributing to structural stability and durability.

Raft foundations, through their broad contact with the underlying soil or rock, offer a significantly greater capacity to withstand vertical and horizontal loads compared to conventional shallow foundations. This design choice becomes even preferable when dealing with rock strata that have limited bearing capacity, as it mitigates the risk of foundation failure and ensures the overall structural integrity of the barrage.

In the context of constructing the barrage, there are distinct considerations related to geological conditions and the structural design approach. While the construction of a barrage may involve fewer geological surprises, it places greater emphasis on meticulous design and engineering. This reliance on design precision makes the barrage structure an attractive choice, particularly when supported by robust geotechnical information. The selected approach aligns with the goal of minimizing uncertainties tied to geological variations and promoting a structure that is driven by well-defined engineering principles.

Furthermore, the choice of barrage as the preferred type of diversion structure is influenced by the height limitation inherent to this design. Barrages have historically been constructed with a maximum height of approximately 32 meters in India. This height limitation is guided by a combination of engineering considerations and the need to ensure the stability and safety of the structure. By adhering to this height constraint, the design can strike a balance between effective water management and structural reliability.

In summary, the decision to employ a raft foundation-supported barrage structure is a deliberate one, aimed at addressing the specific geological conditions, engineering requirements, and height limitations. This approach offers a practical solution that aligns with both geotechnical insights and design principles, contributing to the overall success of the project.

Reduction of Submergence Area

Aditionally, one of the most significant environmental benefits of adopting a Barrage structure is the reduction in the submergence area. The barrage, with its lower height and smaller footprint, results in submergence areas of 1.72km2 compared to the dam of 2.59km2. This reduction translates into a smaller impact on local ecosystem, reducing the amount of land that would need to be submerged. Consequently, this minimizes habitat loss for local widlife and reduces the displacement of local communities reliant on the land for farming, forestry, and other traditional livelihoods.

Lower Impact on Aquatic Ecosystems

The Barrage structure is designed with a reduced height (32 meters compared to the Dam's 64 meters), resulting in less alteration to the natural flow of the river and its aquatic ecosystems. While both structures would alter the river's hydrodynamics, a Barrage allows for more natural river conditions, as it typically causes less disturbance to fish migration patterns and water quality compared to a full dam. This is particularly crucial in maintaining local biodiversity, including aquatic species that rely on natural river flow for breeding and sustenance.

Minimized Soil Erosion and Sedimentation:
The construction of a full dam typically involves significant changes to river flow dynamics, often resulting in increased sedimentation, soil erosion, and altered water quality downstream. A Barrage, with its relatively lower structure and different operational mechanics, reduces the degree of water impoundment and the corresponding changes to the natural sediment transport process. This helps in maintaining downstream water quality and prevents large-scale erosion along the riverbanks.

6.3.3 Head Race Tunnel

In the process of designing and constructing the Head Race Tunnel (HRT), several crucial factors were carefully considered to ensure the optimal performance and successful completion of the project. The following key considerations were considered:

(a) ***Number of constructions Faces, Length and Position of Adits*** - One of the primary concerns in tunnel construction is to streamline the construction process and enhance efficiency. This involves determining the number of construction faces, the lengths of these faces, and the strategic placement of adits. By optimizing these factors, the construction schedule can be effectively managed, reducing potential delays and maximizing productivity. The position and length of adits are planned to facilitate smooth excavation and minimize logistical challenges during the construction phase. This approach not only contributes to timely completion but also ensures a safer and more organized construction environment.

(b) ***Size of the Tunnel*** - The dimensions of the tunnel, including its diameter, were established based on a multifaceted evaluation involving hydraulic, economic, and operational considerations. The tunnel's size plays a critical role in determining the velocity of water flow, head loss, and overall efficiency of water conveyance. The chosen diameter must strike a balance between allowing an adequate flow rate while minimizing energy losses due to friction. Additionally, economic factors come into play as the tunnel's dimensions impact construction costs, materials, and operational efficiency. This comprehensive assessment ensures that the selected tunnel size aligns with hydraulic requirements, economic viability, and operational functionality.

In the construction of the Head Race Tunnel (HRT), the stability and support of the excavated sections are critical considerations to ensure the safety and long-term durability of the tunnel structure. To address these concerns, a comprehensive support system has been designed, which includes shotcrete, rock bolting, and, in certain geologically weaker areas, the utilization of steel ribs.

The process begins with the excavation of the tunnel, which involves the removal of rock material to create the tunnel void. As this void is created, the surrounding rock mass is exposed, and its stability is a primary concern. In sections where the geological conditions are relatively stable and the rock quality is sufficient to provide natural support, shotcrete and rock bolting are employed.

- ***Shotcrete*** is a technique in which a mixture of cement, aggregates, and water is sprayed onto the exposed rock surfaces. This application forms a layer that acts as an immediate support, preventing loose rock fragments from falling and enhancing the overall stability of the tunnel. Shotcrete also helps in preventing water ingress and provides an initial structural integrity to the tunnel walls.
- ***Rock bolting*** involves the insertion of steel rods or bolts into the rock mass and securing them with grout. This technique reinforces the rock structure by effectively "stitching" the rock layers together. Rock bolts are particularly useful in reinforcing fractured or weak rock sections, providing added support and preventing potential collapses.
- ***Steel Ribs*** - In areas where the geological conditions are deemed weaker or less stable, additional support measures are required. Steel ribs, also known as rock reinforcement, are used in such sections. These ribs are metal frames installed along the tunnel walls to provide structural support and prevent rockfalls or collapses. The steel ribs help distribute the loads and pressures exerted by the surrounding rock, enhancing the overall stability of the tunnel.

The decision to apply these support measures varies along the tunnel alignment and is guided by the Geological Baseline Report (GBR). The GBR assesses the geological conditions, rock quality, and potential risks along different sections of the tunnel. By analyzing the information in the GBR, the project team can determine where and to what extent shotcrete, rock bolting, or steel ribs are required for safe and efficient tunnel construction.

Overall, the combination of shotcrete, rock bolting, and steel ribs, if necessary, ensures that the excavated sections of the HRT remain stable, secure, and capable of withstanding the geological forces and conditions throughout the tunnel's operational life.

Concrete lining has been selected as the preferred option for the headrace tunnel for several compelling reasons:

- ***Friction Reduction -*** Concrete lining is chosen to mitigate head losses resulting from friction within the tunnel. By providing a smooth and consistent inner surface, the concrete lining facilitates the efficient flow of water, minimizing energy losses due to frictional resistance.
- ***Seepage Control -*** The concrete lining acts as an impermeable barrier, limiting seepage flows through the tunnel. This helps prevent the unwanted infiltration of water into surrounding rock formations and maintains the integrity of the tunnel structure.
- ***Erosion Prevention -*** Loose rock particles and sediments present in the water could potentially cause erosion along the tunnel walls. The concrete lining acts as a protective barrier, preventing erosion and the dislodging of joint fillings, ensuring

the long-term integrity of the tunnel structure and minimizing potential damage to downstream equipment, such as turbines.

- ***Stability Assurance*** **-** Concrete lining contributes to the overall stability of the tunnel under varying hydrostatic and hydrodynamic load conditions. It reinforces the tunnel's structural integrity, providing resistance against external forces and maintaining its shape and alignment over time.

In conclusion, the decision to use concrete lining for the headrace tunnel is driven by its ability to reduce frictional losses, control seepage, prevent erosion, and ensure sustained stability under changing hydraulic conditions. These benefits collectively contribute to the optimal performance and longevity of the tunnel system.

The chosen approach for the headrace tunnel involves the use of un-reinforced concrete linings, which are selected for their ease of placement, improved concrete quality, and enhanced durability. The effectiveness of the pressure tunnel's concrete lining in preventing leakage into and out of the tunnel is further enhanced through a comprehensive grouting process that is systematically applied to the surrounding rock. This systematic grouting serves various distinctive functions and takes different forms, playing a crucial role in ensuring the overall integrity of the tunnel structure.

Two main types of grouting processes are implemented in this philosophy:

- ***Contact Grouting*** - This form of grouting focuses on establishing a solid and consistent bond between the cast concrete lining of the tunnel and the surrounding rock or shotcrete. Ensuring proper contact is vital to creating a continuous and cohesive barrier that effectively prevents water infiltration and maintains the structural integrity of the tunnel. By filling any gaps or voids between the lining and the rock, contact grouting guarantees a seamless connection that can withstand the pressure and load exerted on the tunnel.
- ***Consolidation Grouting*** - Another significant aspect of the grouting strategy is consolidation grouting. This involves injecting grout into zones of the rock surrounding the tunnel that may have become loosened during excavation. The process serves to stabilize and reinforce these areas, reducing the permeability of the rock and enhancing its overall strength. By minimizing permeability, consolidation grouting significantly reduces the potential for water infiltration, ensuring that the tunnel remains watertight and secure.

In summary, the practice of incorporating un-reinforced concrete linings along with meticulous grouting techniques enhances the headrace tunnel's ability to prevent leakage, withstand hydraulic pressures, and maintain long-term structural stability. Contact grouting establishes a strong connection between the tunnel lining and the surrounding rock, while consolidation grouting reinforces the rock's integrity and minimizes permeability. Together, these measures contribute to a robust and reliable tunnel system that effectively fulfills its critical role in the project.

The proposed lining for the headrace tunnel (HRT) involves the application of plain cement concrete (PCC) lining, which will have a thickness ranging from 450 to 500 mm. In certain sections of the tunnel, reinforcement of the lining might be necessary, followed by subsequent implementation of Contact Grouting or consolidation grouting through pre-drilled grout holes in the lining. In zones characterized by weak and fragmented rock, a strategy of consolidation grouting is also intended. To address water concerns in areas with surcharged conditions, drainage holes will be strategically incorporated to alleviate external water pressure, whether stemming from perched water or an aquifer. Once the concrete lining is in place, these drainage holes will be sealed to prevent any reverse flow from the interior of the tunnel to the rock, thereby ensuring the tunnel's safety.

Throughout the entire alignment of the HRT, a critical aspect is the establishment of minimum rock covers, which will be maintained at a level no less than three times the diameter of the tunnel. However, it's important to note that this might not be the case at the initial stretch of the HRT located just downstream of the bell mouth intake. Here, a design approach involving a goose neck or a cut and cover reinforced concrete duct, possibly with a steel liner, is being considered to effectively address the specific requirements of that section.

6.3.4 Desilting Arrangements

The efficient removal of sediment from water before it enters the power generation process is of utmost importance. This practice not only ensures the extended lifespan of the plant but also significantly reduces maintenance costs associated with mechanical equipment. Desilting facilities play a vital role in this regard, particularly in scenarios where there is no large reservoir available or the existing reservoir is relatively small. These facilities facilitate the settling of sediments before the water enters the power intake, thereby preventing potential damage to the equipment and ensuring smoother operation.

In projects involving larger reservoirs, the need for desilting facilities is often diminished. This is because the reservoir itself serves as a natural sedimentation basin where the flow velocities are low, allowing sediments to settle out over time. However, the requirement for a desilting facility for the Tallo Seti (Tanahun) Hydropower Project will be determined based on the results obtained from mathematical reservoir modeling. Nevertheless, the hydraulic design has already been undertaken using the available data.

One crucial parameter in the design of a de-sanding system is the settling velocity of sediment. Accurately determining this value in the field is challenging, and it's often acquired through laboratory experiments or estimated using empirical formulas. In this context, the following approach has been utilized:

The settling velocity (w) for the de-sanding process has been adopted at a temperature of 20°C. This value has been derived from a table formulated by R.S. Varshney, which in turn is based on a curve presented by Hunter Rouse in his work "Engineering Hydraulics." This data aids in the accurate design of the desilting facility, ensuring its effectiveness in removing sediments from the water flow and maintaining the integrity of the hydropower system.

Table 6. 9: Fall velocity of suspended sediment

Particle size	Fall velocity in cm/s-Water temperature ºC			Settling velocity for quartz particle given by Rubey
d (mm)	0ºC	15ºC	40ºC	
0.05	0.13	0.20	0.30	0.2
0.10	0.50	0.70	1.20	0.7
0.15	1.00	1.50	2.00	1.7
0.20	1.70	2.10	3.00	2.3
0.25	2.10	3.00	4.00	3
0.30	3.00	4.00	5.00	3.8
0.40	4.20	5.30	6.50	5
0.60	7.00	9.00	11.00	-
0.80	10.00	12.00	14.00	-
1.00	13.00	15.00	17.00	-
2.00	26.00	27.50	30.00	-
4.00	42.00	43.00	44.00	-
7.00	60.00	60.00	60.00	-
10.00	72.50	72.50	72.50	-

In the process of designing the desilting basin, a settling velocity of 0.024 m/s has been selected, based on the reference mentioned earlier, which corresponds to a temperature of 20°C. It's important to note that settling velocity is a critical factor in designing a desilting system, as it determines the speed at which particles within the water can settle down and be removed from the flow.

Considering the specific conditions at the site of the diversion structure, it has been determined that the settling velocity in this area is consistently below 0.2 m/s. This information has been sourced from the comprehensive hydrological and sedimentological studies conducted for the Tallo Seti (Tanhun) Hydropower Project. As a result of this analysis, it has been deemed unnecessary to incorporate a desilting arrangement in the design.

The decision to omit the desilting arrangement is based on the fact that the existing settling velocities in the vicinity of the diversion structure are already considerably low. This implies that the sediment transport and deposition rates are naturally well-controlled, reducing the potential for sediment buildup that might impact the efficiency and operation of the hydropower system. As a result, the design focus can be shifted towards other pertinent aspects, ensuring the optimal and effective functioning of the project.

7 Impact Identification

7.1 Beneficial Impacts

7.1.1.1 Enhancement of the Local Economy

The project is expected to make a long-term contribution to the local economy, starting from its early construction phase. In the beginning the project will generate a diverse set of job openings, offering numerous employment opportunities. Throughout the construction phase, the project will necessitate 1293 full time workers over a span of 5 years. The work force is anticipated to comprise of 10% managers, 20% highly skilled workers, 27% skilled workers, and 43% unskilled workers. The project will prioritize locals during the recruitment, which underscores the project's determination to bolstering the local economy. The wages earned by local project workers are expected to primarily circulate and spend within the project area, leading to significant benefits for the local economy.

In addition to employment, the project intends to source most of its supplies, including cement, aggregates, logistical supplies, and food, as well as services like accommodation, housing, and equipment rentals, from local markets. This provides ample opportunities for local business to supply goods and services, further contributing to the economic growth of the area.

By offering these business and employment opportunities, the project is expected to discourage the out-migration of locals while simultaneously attracting in-migration to the project area. As a result, the project is expected to play a crucial role in reducing poverty to some extent.

Currently, the Tanahu Hydropower Project construction is underway upstream of the TSHPP under the same proponent- THL. THL has implemented a policy of prioritizing the recruitment of residents from the project area. According to the latest data, out of 1202 personnel hired, 326 individuals are from the project area, and among them, 31 are from the PAF.

The magnitude of this impact on the local economy, employment and poverty alleviation can be High. Since the priority for recruitment will be given to residents of project affected municipalities, thus the extent of this impact will be Local. Since this will be limited for the duration project construction, thus, considered Short-Term (ST).

7.1.1.2 Enhanced skill development

In the long run, it is expected that certain project workers who are employed locally will acquire improved or new skills. These skills will be acquired through their firsthand experience of working to higher standards of performance and by undergoing skills training facilitated by contractors. The project workers are exposed to more advanced techniques, methodologies, and practices. Additionally, contractors may provide specific training programs to equip project workers with the necessary skills for their roles.

The acquisition of these improved or new skills by local project workers has a positive impact on the overall skill base of the labor force. The enhanced skill base of the local force increases their competitiveness when seeking employment opportunities in other projects that share similarities with their previous work. Employers undertaking similar projects are likely to value workers who possess a higher level of skills and expertise. As a result, these project workers have a greater likelihood of securing employment in similar projects.
In addition to providing on-the-job training, the project aims to conduct training programs for the families affected by the project to enhance their livelihoods. These training programs, previously carried out by THL for Tanahu Hydropower Project, are proposed to be extended for this project as well. Up to this point, THL has organized training programs for 4483 individuals from the project area. These programs covered a wide range of topics such as tailoring, handloom weaving, goat rearing, and off-season vegetable farming. Additionally, training on GESI and Gender Based Violence (GBV) were also included in these training programs.

The magnitude of this impact depends on the number of locals employed in the project. Given the priority is given to residents of the project municipalities during recruitment, it is expected that the magnitude of the impact will be high (H), local (L) in extent, and long term (LT) in duration.

7.1.1.3 Improved Access

The project aims to improve accessibility in the project area by constructing access roads and bridge. Currently, the Shahid Buddha Singh Marga road, which starts from Byas Bazar along the Seti River, and extends to Ghumaune, lacks a bridge across the Trishuli River that would connect it to the Highway. Consequently, the settlements along the Seti River Valley experience a lack of proper vehicular connectivity and a sense of isolation.

The proposed access road from the Powerhouse Complex that will connect the Intake area, and the motorable bridge across the Trishuli River can address the issues of vehicular connectivity. This will effectively link the Highway with the Powerhouse Complex, significant improving the accessibility to the project area. The construction of this road will create a vital connection point, enhancing transportation and facilitating the movement of people and goods.

The improved access resulting from these infrastructures will create various opportunities for the local communities. One notable advantage is that it will enable local farmers to transport their agricultural products to the markets of Bharatpur or Mugling more cost effectively. Furthermore, it will also enable them to procure provisions and construction materials more conveniently, as they will have improved access to the markets and supply centers. Moreover, the presence of the hydropower will further contribute to its social and economic significance. During the construction period.

The impact is anticipated to be high (H) in magnitude, as it will benefit a significant population residing along the Seti River Corridor. Additionally, its extent can be considered regional (R), as it will connect not only Tanahu District bu also adjoining Districts. It will improve the connectivity between the Cities – Pokhara in Kaski with Bharatpur in Chitwan. Furthermore, the impact will be long term (LT) in duration.

7.1.1.4 Habitat Formation in the Reservoir

The reservoir formed because of the barrage, will provide new habitat for various species of waterfowl by offering favorable environment. Similar situations were observed is other man-made reservoirs in Nepal such as Jagadishpur Reservoir in Rupandehi and Bishazari taal in Chitwan. The presence of the reservoir will serve as a new stopover or resting point along the migratory routes of these waterfowl. It will provide them with essential resources, including water, food sources, and suitable nesting or roosting sites. These factors are crucial for the survival and well-being of migratory birds during their journey.

The impact is expected to have high (H) magnitude, as it has the potential to significantly improve the habitat for both the birds of the Seti River Corridor as well as migratory species. The extent of the impact can be considered regional (R) since it will benefit migratory birds across a broader area. Additionally, the impact is expected to be long-term (LT), ensuring sustained benefits for these avian populations over time.

7.1.1.5 Contribution in reduction of greenhouse gases

The implementation of clean energy, specifically hydropower, will make a significant contribution to the reduction of greenhouse gas emissions, particularly CO_2. This is because hydropower replaces the need for thermal power plants that utilize fossile fuel, which are the primary contributors to GHG emissions. This shift in energy production helps to mitigate the negative impacts of climate change and reduce the overall carbon footprint.

The calculation below is presented to estimate of carbon dioxide that the TSHPP can prevent based on the Guidebook on Calculating Greenhouse Gas Emissions for Cleaner Electricity Generation Projects by UNFCCC (2007).

- Let's assume an average emission factor of 0.5 kg CO_2/kWh, which is a conservative estimate considering the displacement of fossil fuel-based electricity generation by hydropower.
- To calculate the emissions reduction, we multiply the electricity generation (in MWh) by the emissions factor: Emission reduction = Annual electricity generation (MWh) X Emissions Factor (kg CO2/kWh)
- The TSHPP is of 126 MW capacity producing 520.78 GWh annually *i.e.,* 520,780 MWh.
- The Emissions reduction = 520,780 MWh * 0.5 kg CO2/kWh = 260,390 MT of CO_2

Therefore, the TSHPP with 126 MW capacity producing 520.78 GWh annually can potentially prevent approximately 260,390 metric tons of CO_2 per year.

To build a simplified perspective on the significance of preventing 260,390 metric tons of CO_2 per year, we can consider the carbon sequestration capacity of trees. Using a rough estimate that 1 tree can sequester 22 kg of CO_2 per year, we can calculate the equivalent number of trees.

- Number of trees = CO_2 emissions prevented / CO_2 absorption per tree per year.
- Number of trees = 260,390 metric tons / 22 kg per tree per year.
- Number of trees = 11,83,591 trees.

This means that the prevention of CO_2 emissions by the TSHPP is equivalent to the positive impact of having 11,83,591 trees actively sequestering carbon.

Additionally, considering that roughly 400 trees are found in 1 ha of forest in Nepal (although this number can vary depending on forest type and condition), we can estimate the land area that would be needed to have the same carbon sequestration capacity as the TSHPP.

- Number of ha of forest = Number of tree/ Trees per ha
- Number of ha of forest = 11,83,591 trees/ 400 trees per ha
- Number of ha of forest = 2,959 ha

Therefore, the prevention of CO_2 emissions by the TSHPP can be considered equivalent to protecting approximately 2,959 ha of forest, based on the rough estimate of 400 trees per ha in Nepal.

(Note: its important to note that these calculations are simplified and provide a general perspective on the significance of the emissions reduction.)

The magnitude of the impact is thus considered high (H), extent – transboundary (T) and duration long term.

7.2 Physical Impacts

7.2.1 Construction phase

7.2.1.1 Land use change

Powerhouse Complex

The proposed powerhouse complex is located at the Gai Ghat of Devghat Municipality. Spanning across an area of 16.69 ha, this rural settlement is located on the right bank of the Trishuli River. 38.04% of the proposed complex is covered by the cultivated land and the remaining forest. The houses are scattered along the cultivated land.

The forests in this area have undergone significant disturbance and currently consist mainly of sparsely regenerating shrubs and bushes. The cultivated lands, on the other hand, are predominantly marginal in nature, as they are distributed across steep slopes with gradient exceeding 25 – 30 degrees. For more details, please refer to the table and map provided below.

Table 7. 1: Land use of the Powerhouse (Source: Baseline Survey, EIA Study)

Land use	Area [ha]	Area [%]
Cultivated Land	6.35	38.04
Forest	10.35	61.96
Total	16.69	100.00

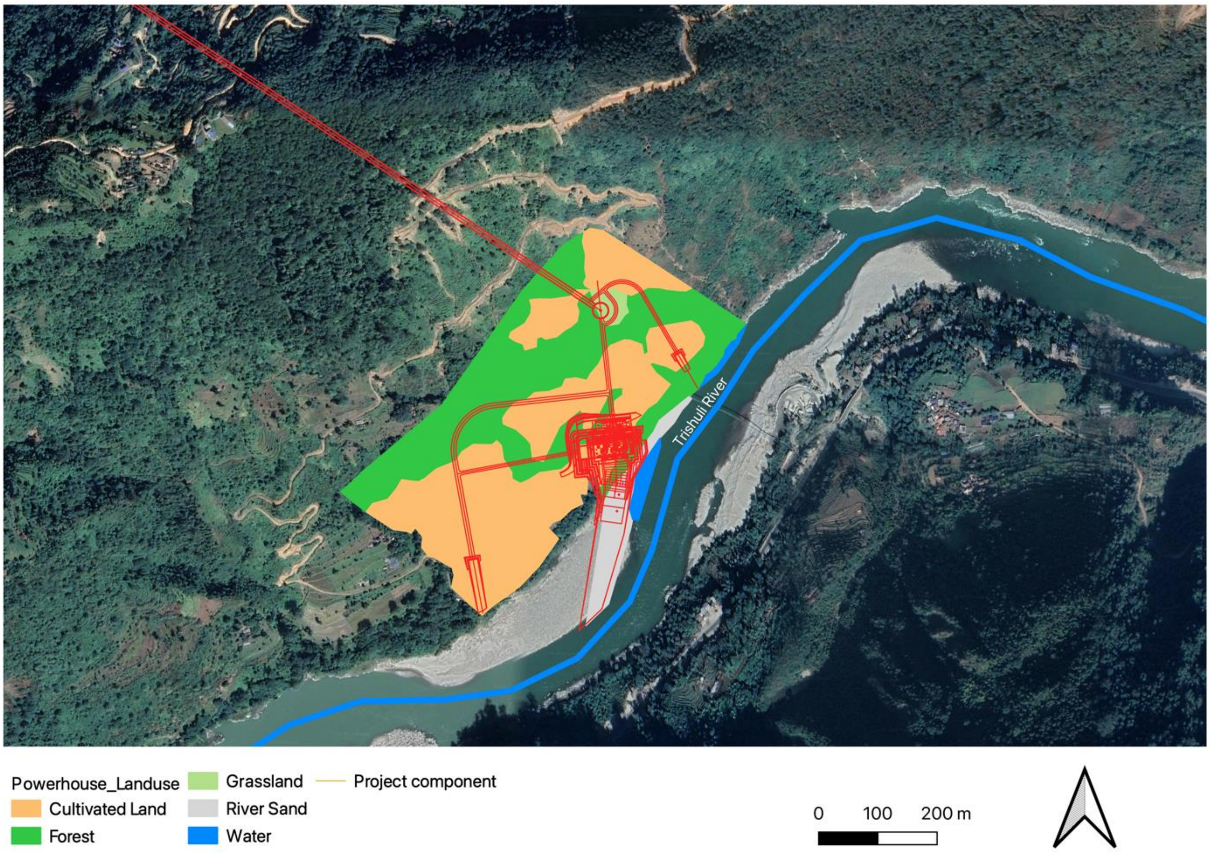


Figure 85: Land use of the Powerhouse Complex

Intake site

The proposed intake site, situated close to the settlement of Sarang Ghat in Bandipur Municipality, occupies an area of 8.63 ha. The site is primarily constructed in the middle of the river to facilitate the diversion of water from the Seti River into the Headrace Tunnel. Roughly 44.16% of the site encompasses the river itself, while the remaining 36.96% comprises the riverine forest. More information, including specific details, can be found in the table and map provided below.

Table 7. 2: Land use of intake site (Source: Baseline Survey, EIA Study)

Land use	Area [ha]	Area [%]
Forest	3.19	36.96
River Sand	1.63	18.88
Water	3.80	44.16

Grand Total	8.63	100.00

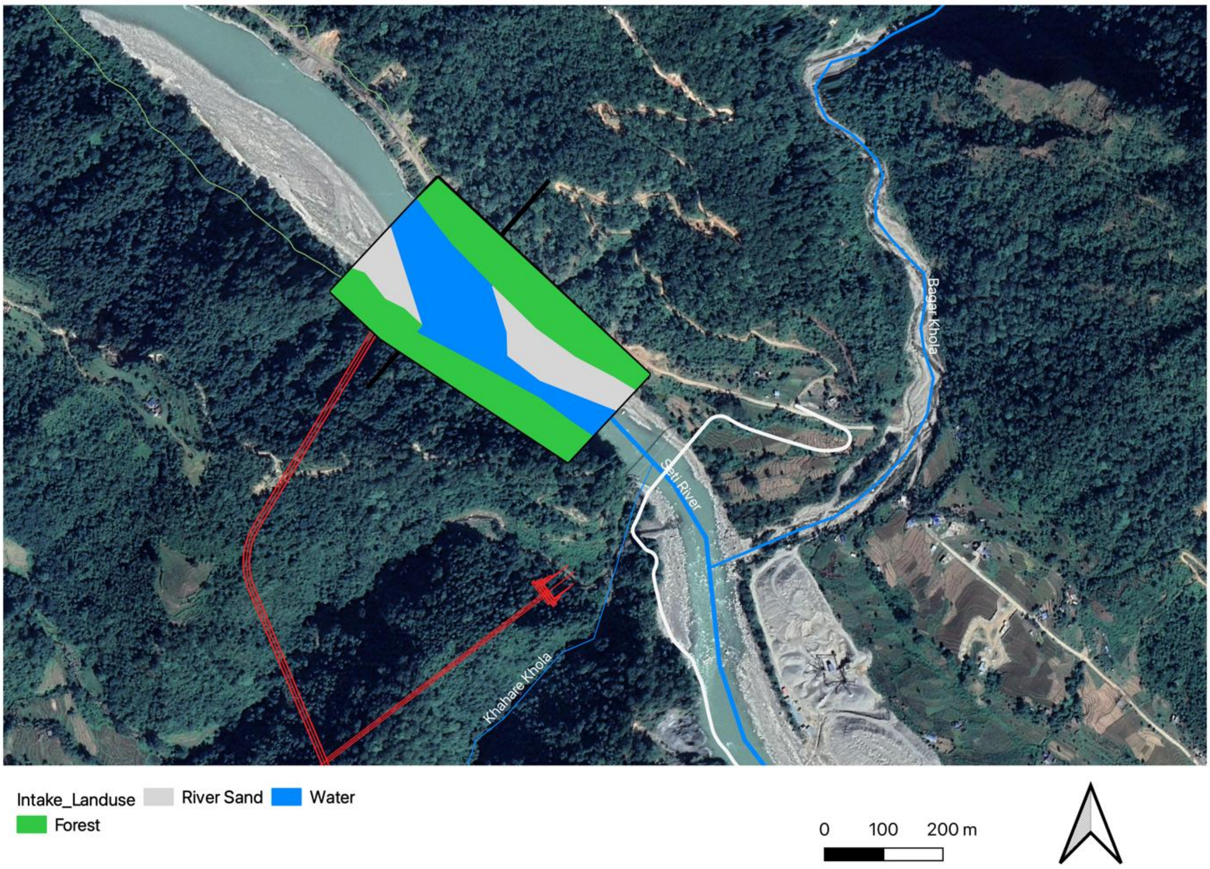


Figure 86: Land use of barrage area (Source: EIA Study)

Camps

3 temporary camps are proposed to be established to house the construction contractors and workers. Please note that Camp 1 is situated within the powerhouse complex. The land use change associated with Camp 1 has already been addressed in the earlier section discussing the powerhouse complex. It is important to note that the labor camps are temporary structures, which means that the land use changes result from them will also be temporary in nature.

Additionally, 2 permanent camps have been proposed as part of the project. The permanent camp at the headworks is proposed to be situated downstream of the barrage, approximately 304 meters downstream of the damsite, adjacent to the suspension bridge, along the left bank of the Seti River. Its establishment is estimated to convert about 0.44 ha of cultivated land. Furthermore, the permanent camp at the Powerhouse Complex is planned to be situated on the right bank of the Trishuli River near the PH complex in Gaighat,. This camp is expected to convert 2.28 ha of cultivated land. Unlike the labor camps, these are the permanent camps, and the conversion of land use will be permanent.

Table 7. 3: Temporary land use change by the labor camps (Source: Baseline Survey, EIA Study) [ha]

Camp	Location	Cultivated land	Forest	Total [ha]	Remarks
Temporary Camp C	Gai Ghat, Devghat 4	1.15	0	1.15	Temporary
Temporary Camp A	Sarang Ghat, Bandipur 6	1.15	0.25	1.4	Temporary
Temporary Camp B	Devghat 3	0.41	0.1	0.51	Temporary
Headwork Camp	Sarang Ghat, Bandipur 6	0.44	0	0.44	Permanent
Powerhouse Camp	Gaighat, Devghat-4	2.28	0	2.28	Permanent

Quarry, Borrow Area, Batching Plan

2 quarries have been proposed for extraction of construction materials for the project construction. Quarry 1 is in the Bagar Khola, roughly 1 km upstream from where it meets the Seti River. The 2nd quarry is in the Labdi Khola, approximately 200 m upstream from its confluence with the Seti River. The combined operation of these quarries is anticipated to impact a total of 6.76 ha of forested land. It is important to note that these conversions will be temporary as the quarry sites are expected to be restored upon the completion of the constructions.

A borrow has additionally been proposed, situated about 1 km upstream from the intake site along the Seti River. Its purpose is to extract alluvial deposits and coarse aggregates. Positioned on the left bank of the river, adjacent to the Buddhasingh Marga, this area is expected to convert 2.8 ha of forested land. It is worth noting that this conversion will be temporary, as the area will be restored once the construction activities are concluded.

2 batching plants have been proposed for the project. The first batching plant, located near the Headworks, is situated on the left bank of the Bar Khola in Devghat – 3. It is adjacent to the access road leading to the Adit 2. The total area occupied by this facility is 1.10 ha, out of which 0.54 ha consist of forested land, while remaining area is cultivated land.

The second batching plant is proposed near the Powerhouse Complex, positioned on the right bank of the Trishuli River, close to the settlement of Bhorle in Bharatpur-29..

It is important to note that these batching plants sites are temporary and will be resorted once the construction activities of the project are completed.

Table 7. 4: Land use change by the operation of the quarry (Source: Baseline Survey, EIA Study) [ha]

SN	Quarry	Location	Forest	Cultivated land	Total
1	Quarry B	Bagar Khola, Bandipur -6	5.37	0	5.37
2	Borrow area	Bandipur - 6	2.8	0	2.8
3	Batching Plant Powerhouse	Bhorle, Bharatpur-29	0.49	0.03	0.52

4	Batching Plant Headworks	Bandipur-6	1.10		1.10

Disposal site
The proposed disposal sites are in proximity to the Headworks and Powerhouse Complex. The disposal site near the Headworks spans approximately 6.88 ha, primarily converting the river bank of Sarang Ghat. Similarly, the disposal site near the Powerhouse Complex will affect around 2.52 ha of land (2.31 cultivated+0.22public land) in Gai Ghat. While efforts will be made to restore these sites after the completion of construction, it should be noted that returning the conditions back to their original state will pose a considerable challenge.

It should be noted that operating these disposal sites will necessitate significant river training works to safeguard against the spoils being swept away by the river. The river training works will ensure stability of the disposal sites and prevent any adverse effects on the surrounding areas.

Figure 87: Project components at the Headworks (Source: Baseline Survey, EIA Study)

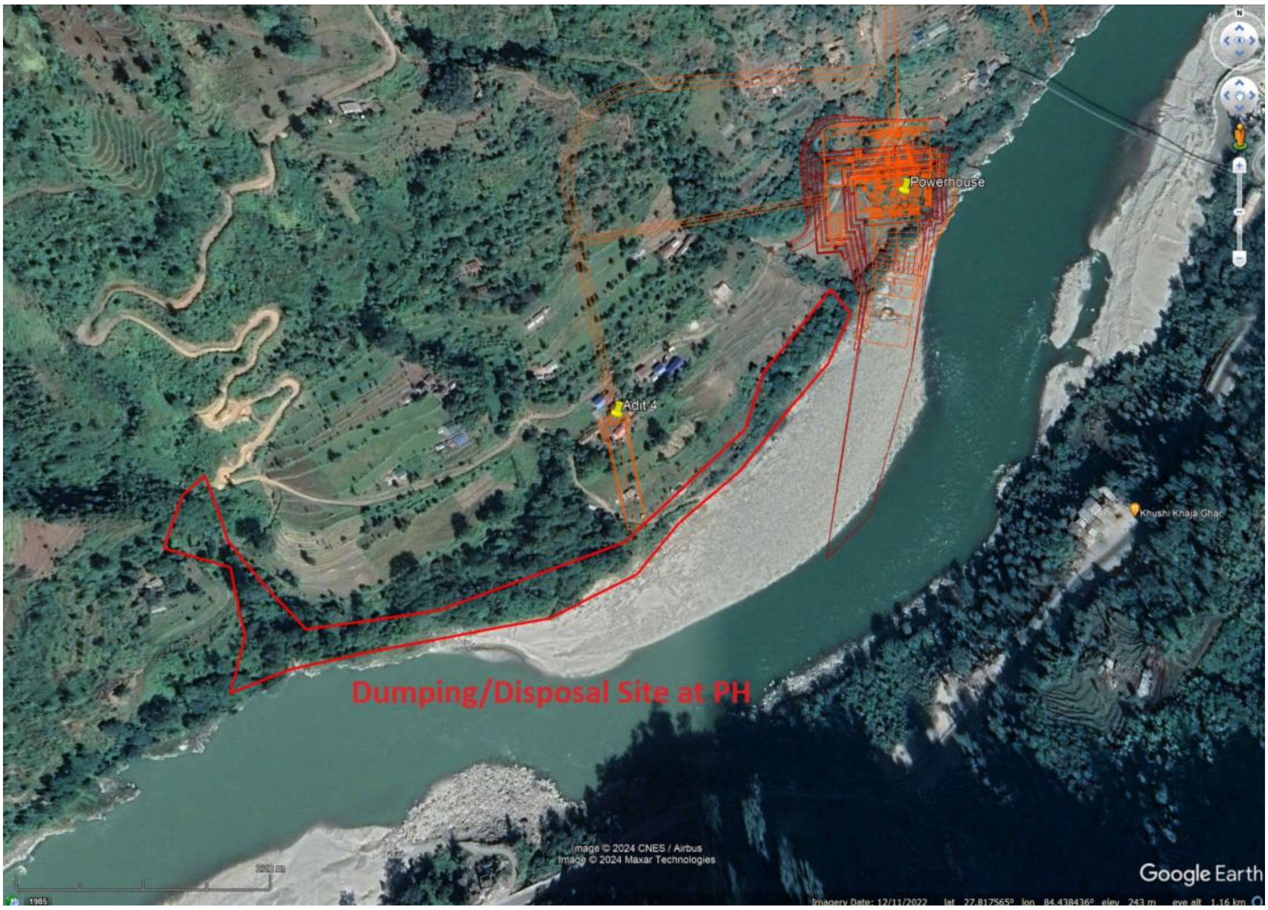


Figure 88: Project structures in the powerhouse complex (Source: Baseline Survey, EIA Study)

Access Road

Access road (Headworks to Adit 2) - A proposed access road, spanning 2.8 km is length, is planned to commence from the Headworks and extend towards Adit Site 2. To facilitate the crossing of the Seti River at the 3.62 km mark, a bridge measuring 125 m (approx.) is length is required. The construction of this access road will result in a total conversion of 0.973 ha of land, considering a carriageway width of 3.5 m. The land use conversion associated with the road, presented in the table below, indicates that approximately 0.8 ha of forested land and 0.098 ha of cultivated land will be permanently converted.

Table 7. 5: Land use conversion by the Access Road from the Headworks to the Adit 2 (Source: Baseline Survey, EIA Study)

Chainage	Land use	Area [ha]
0.000 – 0.80	Road	0.028
0.80 – 3.62	Cultivated land	0.099
3.62 – 4.70	River (Seti)	0.038
0.47 – 2.5	Forest	0.711
2.5 – 2.54	River (Bar Khola)	0.007
2.54 – 2.8	Forest	0.091
	Total	0.973

Access road from left bank of Trishuli to Powerhouse complex and Surge Shaft –A proposed access road with a length of 3.112 km will connect the Prithivi Highway with the Powerhouse Complex. To facilitate this road, a bridge approx. 216 m in length will be required across the Trishuli River at the chainage 0.258 m. The construction of this access road will result in a permanent conversion of 0.14 ha of cultivated land and 0.34 ha of the forested land. However, it is important to note that the forested areas in question are already highly disturbed, and the cultivated lands mostly are marginal due their location of the steep slopes.

Table 7. 6: Land use conversion by the access road at the Powerhouse Complex (Source: Baseline Survey, EIA Study)

Chainage	Land use	Area [ha]	Remarks
0.00 – 0.258	Forest	0.09	
0.258 – 0.474	River (Trishuli)	0.08	
0.474 - 1.079	Forest	0.21	
1.079 – 1.382	Cultivated land	0.11	Inside the Powerhouse Complex
1.382 – 2.899	Existing Road	0.53	
2.899 – 3.015	Forest (Bush)	0.04	Inside the Powerhouse Complex
3.015 - 3.112	Cultivated land (marginal)	0.03	Inside the Powerhouse Complex
	Total	1.09	

The magnitude of the change in land use is considered moderate (M). The impact's extent is local (L), and long-term (LT).

7.2.1.2 Land instability

Although no significant landslides or slope instabilities have been reported from the project construction sites, construction work in hilly areas such as the project area can have implications for slope instability, leading to landslides and soil erosion.

The construction activities involve extensive excavation, tunneling, and modification of the existing terrain. These activities can weaken the stability of slopes and hillsides, especially in areas with weak geological formations. Disruption of the natural balance and removal of vegetation can reduce the cohesion of soil, increasing the risk of slope failures and landslides. Additionally, the excavation, earthworks, and alternation of natural drainage patterns can trigger landslides in the surrounding areas. The removal of soil and rock layers, along with the increased weight and altered stress distribution, can disturb the equilibrium of slopes, making them more prone to failures. Land instability and landslides risks induced by hydropower projects in Nepal are also reported by (Ghimire & Shrestha, 2014).

Furthermore, construction activities can also instigate accelerated soil erosion. The clearing of vegetation, particularly on steep slopes, exposes soil to rainfall and surface runoff. Without the protective cover of vegetation, the erodibility of the soil increases, and sediment is transported downstream. Soil erosion can adversely affect water quality.

The anticipated impact is expected to be moderate in magnitude. It is expected to be limited within the project area, thus, expected to site specific. Additionally, these instabilities are projected to occur during the construction period, and it is anticipated that the affected area will recover once the construction is completed. Therefore, these impacts are considered short-term in duration.

7.2.1.3 River water quality

The water quality of the rivers can be compromised during the construction period because of the following activities:

- The construction workers, particularly excavation activities, land clearing, and earthmoving operations can increase erosion and sedimentation. Sediments from the construction site can be transported into rivers and streams, causing water turbidity, and reducing water clarity. Sedimentation can negatively impact aquatic ecosystems, disrupt aquatic organisms' habitats, and affect the quality of water for various uses.
- Furthermore, construction activities can introduce chemicals into water bodies. These may include sedimentation and erosion control measures such as geotextiles, concrete additives, and other construction-related chemicals. Improper handling and disposal of these substances can lead to their release into the waterways, potentially contaminating the water and adversely affecting its quality.
- The camps may store and use various chemicals, including fuels, cleaning agents and construction materials. Accidental spills, leakage, or improper handling and storage of these chemicals can result in their release into the environment, including surface water bodies.
- Labor camps require facilities for sanitation, washing, and other daily activities, leading to the generation of wastewater. If proper wastewater treatment and management systems are not in place, untreated or inadequately treated wastewater from labor camps can be discharges into nearby surface water bodies. This discharge can introduce various contaminants, including organic matter, nutrients, pathogens, and potentially harmful chemicals, into the surface water, degrading its quality.

Considering the scale and duration of the construction, these impacts could be of high magnitude, local in extent, and short-term in duration.

7.2.1.4 Possibility of drying up of the spring sources

A proposed low-pressure headrace tunnel spanning about 6.7 km in length has been designed to transport water from the reservoir to the powerhouse complex at a discharge rate of 206.9 m^3/sec. The studies (Butscher, Amann, & Huggenberger, 2011) have shown that the tunnel excavation can disturb the natural flow of groundwater, leading to a decline in the water table. The process of tunnel excavation can create voids in the ground, which may result in the draining of groundwater, potentially causing spring sources to dry up or exhibit reduced flow. The magnitude of this impact depends on various factors such as the dimensions and depth of the tunnel, the geological characteristics of the area, and the available groundwater resources.

During the field survey, the presence of spring water sources along the alignment of the tunnel was examined. It was observed that there were no spring sources within a 100 m buffer of the tunnel alignment. As a result, this impact is not anticipated in the current project. However, it is advisable to conduct a more detailed investigation during the construction phase by expanding the study area to keep track of this issues.

7.2.1.5 Air quality

The construction works can lead to air quality degradation because of the following activities:

- Excavation, earthmoving, and transportation of materials can generate dust and particulate matter, especially in dry and windy conditions. These airborne particles can include fine dust, soil, and constructed-related pollutants. Prolonged exposure to high levels of particulate matter can have adverse health effects on both workers and nearby communities, leading to respiratory problems and other respiratory ailments. The residents of Sarang Ghat and Gai Ghat are highly exposed to this impact.
- During the construction period, there will be an increase in vehicular movement for transportation of construction materials, machinery, and workforce. This can result in elevated levels of vehicle emissions. These emissions contribute to air pollution, leading to reduced air quality in the vicinity of the construction sites and access roads, thus the settlement in these areas will be highly exposed to this impact.
- The construction also involves removal of vegetation, including trees and plants, from the construction site. This clearing of vegetation can result in the loss of natural air filtration and purification processes performed by plants, leading to decreased air quality in the surrounding areas.

The magnitude of the impact is expected to be high due to the scale and duration of the construction activities. However, the extent of the impact is localized, primarily affecting the residents within the project area. The duration of impact is short-term as air quality degradation is expected to limit during the construction period.

7.2.1.6 Solid waste

The construction of the project is expected to employ approximately 1200 individuals throughout the construction period. These workforces will be stationed in 3 labor camps and 2 permanent camps. Based on the per capita waste generation rate of 377 grams/day reported by the Ministry of Urban Development in 2017, it is estimated that the workforce will produce approximately 452 kg of solid waste every day. This waste primarily consists of leftover food, food scraps, and food packaging materials. Additionally, it may include packaging materials like cardboard boxes, plastic packaging, and wooden crates. In a. nutshell, this waste will largely consist of either degradable material or recyclable materials. In the absence of proper waste management system in the camps and project areas, there is a high likelihood that this waste will end up in nearby rivers and the vicinity of the camps, degrading sanitary conditions of the project area.

Considering the scale and duration of the project, this impact is also high in magnitude, site specific in extent and short-term in duration.

7.2.1.7 Noise, vibration, and light pollution

The construction activities involved in drilling, blasting, and operating heavy equipment like dozers, rollers, batching and aggregate crushing plants, generators, pumps, compressors, and moving vehicles will generate noise in the surrounding environment of the construction area. The noise pollution impact will be particularly significant in construction areas such as the headworks area, powerhouse complex, Adits, and quarry sites, where there will be frequent blasting, excavation works, and operation of heavy machinery, as well as the movement of hauling vehicles.

The settlement near the intake – Sarang Ghat, powerhouse complex – Gai Ghat, and Adit sites may experience vibrations resulting from the blasting activities. However, the noise generated by blasting in these areas will be relatively minor as the blasting is intended to be conducted underground. Continuous monitoring of noise and vibration levels in these settlements is crucial to ensure that the noise remains within acceptable limits.

The impact of noise and vibration is indirect, of moderate magnitude, site specific and short-term in duration.

7.2.2 Operation phase

7.2.2.1 Land use change in the reservoir

When the barrage comes in operation, it leads to the creation of a reservoir. This reservoir stretches for 12.7 km, starting from the barrage and extending up to a bridge located at Hattisudhe. As the height of the barrage measures 32m, the width of the reservoir remains within the boundaries of the river channel. However, due to the formation of the reservoir, certain areas such as riverine forests, cultivated land, and some houses will experience inundation.

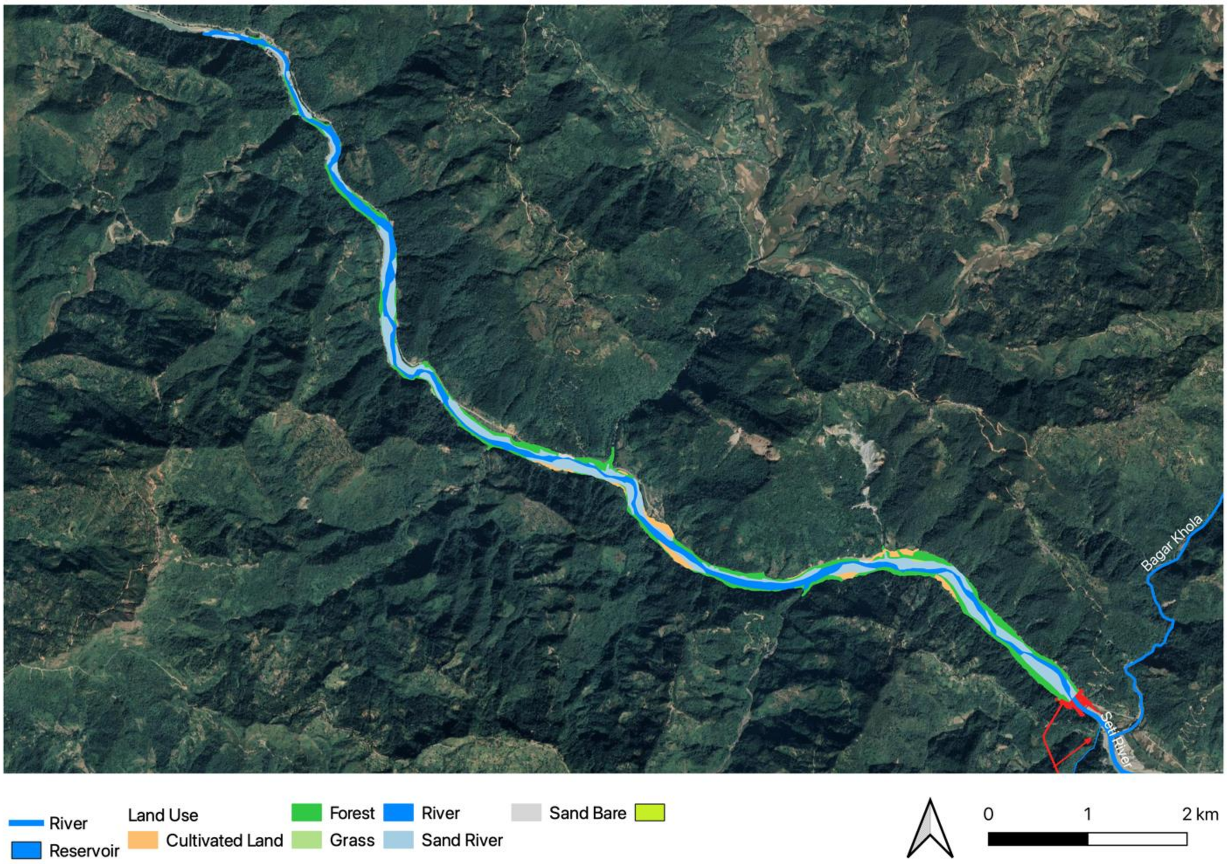


Figure 89: Land use inundated by the reservoir (Source: Baseline Survey, EIA Study)

Upon the formation of the reservoir, it will encompass a total area of 157.45 ha. This accounts for about 43.10% of the water body of the river, and around 29.43% of the river sand located on the banks, which will be submerged. Consequently, most of the reservoir, approximately 72.53 % of the reservoir area, remains within the confines of the river channel. The reservoir will inundate approximately 19.23 ha of forest land. Additionally, the reservoir will inundate 14.23 ha of cultivated area, which is about 9% of the reservoir.

Table 7. 7: Land use change in the reservoir (Source: Baseline Survey, EIA Study)

Land use	Area [ha]	Area [%]
Cultivated Land	14.23	9.03
Forest	30.29	19.23
River/River Bank	72.68	46.16
Public Land	40.25	25.56
Total	157.45	100.00

The magnitude of the change land use is considered moderate (M) as 46.16% of the reservoir remains within the river channel, however, some of the important cultivated land in the area are also inundated. The impact's extent is local (L), and long-term (LT).

7.2.2.2 Sediment condition in the river upstream of the reservoir

The reservoir will gather the incoming sediments. However, due to the project's reliance on the tailrace discharge of the Tanahu HPP, the sediment load is expected to be low. However, the sediment from the Madi River will make its way to the reservoir.

The operation of the barrage will have an impact on the hydrology but also on sediment transport pattern in the Seti River downstream of the barrage. This assessment, however, is based on assumptions and knowledge, highlighting the need for a comprehensive literature study and a detailed analysis of the hydrology and sediment transport patterns specific to the choose barrage and operational strategy.

It is important to note that the field study revealed limited sediment supply and degradation of the riverbed. Many sections of the river lacks sand and fine sediments, while stones and stationary boulder are abundant, as confirmed by observations conducted for aquatic ecology and fishery studies. Consequently, changes are expected in the riverbed once the reservoir is eventually formed.

Table 7. 8: Schematical overview of consequences downstream of the dam

<table>
<tr><th>Reach</th><th>Between dam and tailrace outlet</th><th>Downstream of tailrace outlet</th></tr>
<tr><td rowspan="4">Chainge in sediment transport vs present</td><td colspan="2">There will be a decrease in the overall sediment transport until a sediment balance is achieved in the reservoir, particularly with a reduced supply of coarse sediment. The timeframe for reaching this balance depends on factors such as the size of the reservoir and the efficiency of flushing operations.</td></tr>
<tr><td colspan="2">No significant sediment release is expected during normal operation.</td></tr>
<tr><td colspan="2">Fine sediments are discharged through turbidity current venting during flood events.</td></tr>
<tr><td colspan="2">Increased sediment transport during flushing events.</td></tr>
<tr><td rowspan="4">Change in hydrology compared to now</td><td>Significantly reduced average discharge.</td><td>Same average discharge</td></tr>
<tr><td>Especially low discharge during dry season</td><td>Increased fluctuations during peaking in the dry season</td></tr>
<tr><td>Dampening of floods and less discharge variations during monsoon.</td><td>Dampening of floods</td></tr>
<tr><td>Annual flushing events with discharge equal to or larger / largest annual flood</td><td>Annual flushing events with discharge equal to or larger /largest annual flood</td></tr>
</table>

Reach	Between dam and tailrace outlet	Downstream of tailrace outlet
Change in substrate conditions compared to now	During flushing events, it is expected that some sediment will be deposited. However, a portion or majority of these deposited sediments is likely to be remobilized throughout the rest of the monsoon season. The reduced water flow in the initial years of operation may be balanced by the limited supply of coarse sediment. Over the long term, the reduced water volume available for sediment transport will result in a finer substrate. However, the steep gradient of the river will likely prevent significant sediment buildup.	During flushing events, it is probable that sediment deposition will occur. However, a significant portion or most of the deposited sediments are expected to be mobilized throughout the remainder of the year. Particularly, erosion is likely to occur during peak flow periods in the dry season.

The magnitude of the change in land use is considered moderate (M). The impact's extent is site specific (SS), and long-term (LT).

7.2.2.3 Slope instability around the Reservoir

Since the project will be operating as a peaking plant, the level of water in the reservoir will fluctuate on a regular basis. The frequent fluctuation in water level is expected to expose the soil for drying out. In turn, when the reservoir is refilled, dried out soil tends to absorb water to become saturated. The saturated soil is more likely to fail because it is less able to support weight. Similarly, refilling the reservoir too quickly can cause slope instability as well because the soil has not had enough time to consolidate or settle properly.

The presence of weak layer of soil/rock, particularly the disturbed slopes, can be more susceptible to slope failure. These weak layers can include soft or loose soils or rocks that have low strength. When these weak layers are saturated, they become even more vulnerable to slope instability.

The following mechanism have been identified as potential triggers for sliding:

(a) Heavy rainfall – prolonged heavy rainfall during the monsoon period can increase pore pressure within the colluvium masses, leading to shallow or deep-seated slides.

(b) Inundation of slope toe - creation of the reservoir can result in the inundation of slopes' toes, leading to a reduction in shear strength for both fine-grained and granule materials. It is worth noting that landslides in reservoirs often occur during filling or within a few years thereafter, excluding exceptional events like earthquakes from this observation.

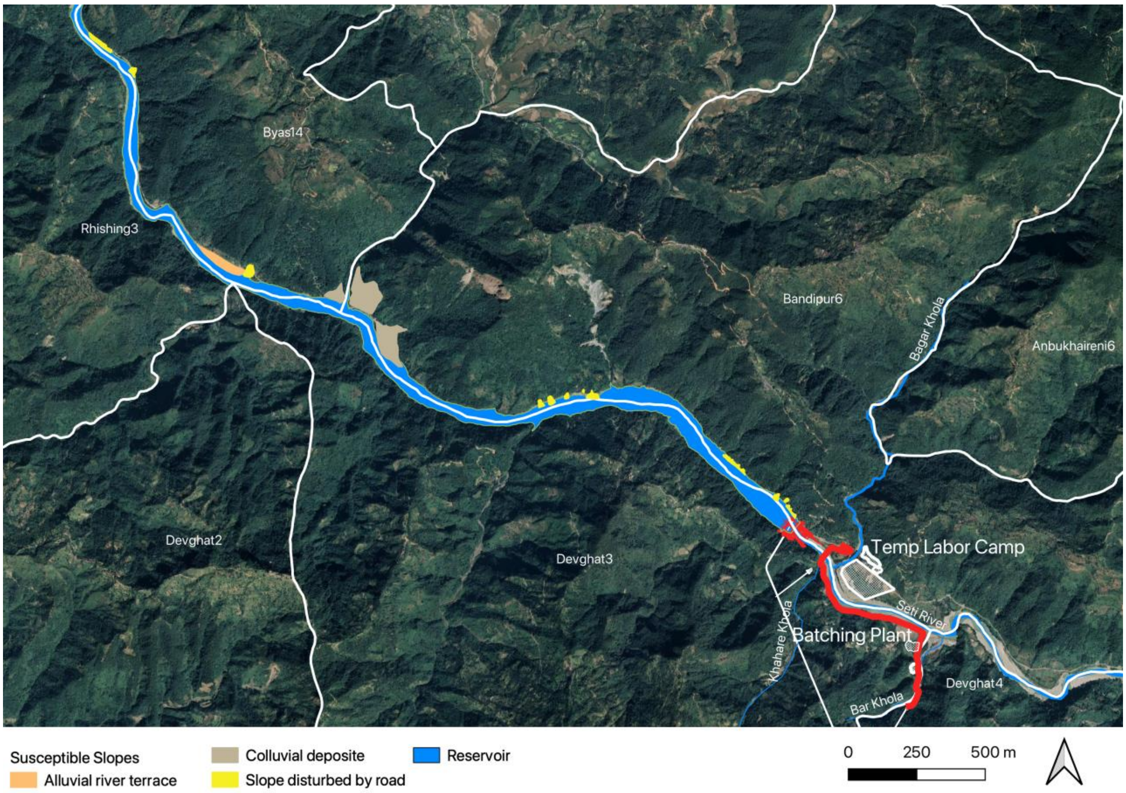


Figure 90: Susceptible slope (Source: Baseline Survey, EIA Study)

Based on site observation, several slopes on the left bank of the Seti River, specifically in the area designated for the reservoir, have been identified as susceptible to instability. The accompanying map illustrated the distribution of these slopes. Most of these unstable slopes can be attributed to the construction of the Buddhsingh Marga. Furthermore, these is one river terrace with alluvial deposits and two slopes with colluvial deposits that have been identified as potential vulnerabilities during the reservoir's operation. Therefore, it is necessary to stabilize these slopes before the reservoir is formed.
As a part of mitigation measure a buffer of 3 meters from the FSL of 275m to 278m is proposed. This is explained in detail in the mitigation measure chapter.

The magnitude of the impact is moderate, site specific in extent and long term in duration.

7.2.2.4 Environmental Flow

During the dry season, which extends from the end of October until the end of May, the average discharge in the river is 50 m^3/sec. However, during the monsoon season, there is a significant increase in the amount of water entering the river system due to rainfall. As a result, the discharge increases exponentially. The peak discharge, reaching approximately 630 m^3/sec, occur in July and August, after which it gradually decreases.

The design discharge of the TSHPP is 206.0 m^3/sec. This discharge is available in the river for about 5 months between June and October.

Considering the fluctuating water levels, the barrage associated with the TSHPP will need to store water during the monsoon season when there is excess water and release it gradually during the dry season when water resources are scare. The project has proposed 5.08 m^3/sec as the riparian discharge. This proposed rate aligns with the requirement set by the Government of Nepal which specifies releasing of a flow equivalent to 10% of the average monthly discharge observed during the driest period, specifically recorded during Jan and Feb.

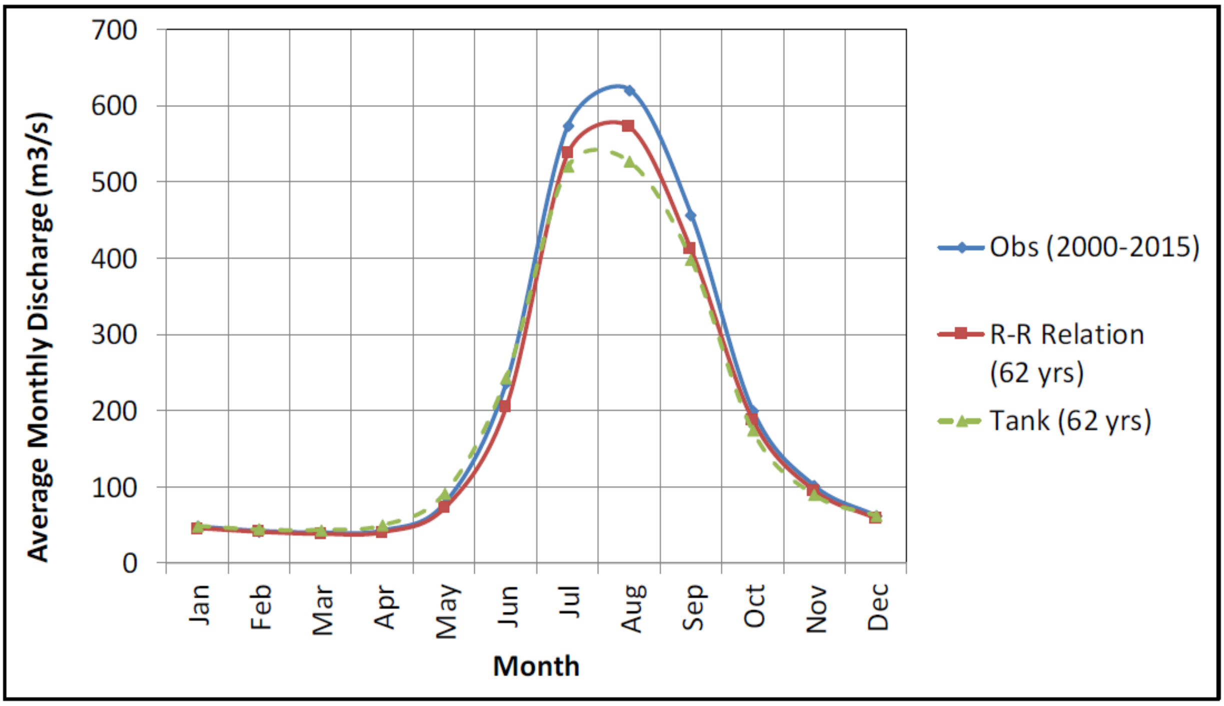


Figure 91: Long term monthly flow at TSHPP diversion barrage site by R-relation model

Due to the diversion of discharge from the Seti River, a section of approximately 11 km from the barrage to the point where it meets the Trishuli River will experience reduced flow. However, some replenishment of the discharge in this stretch will occur through the contribution of tributaries. During the field survey conducted In October of 2021, estimates were made regarding the discharge from these tributaries. It was estimated that the total contribution from the 6 tributaries to the Seti River was about 14 m^3/sec at that time, which was beginning of the dry season. Among these tributaries, the Bagar Khola and Bhut Khola were the two largest contributors in this stretch. Each of these tributaries provide around 4 m^3/sec of discharge to the Seti River. Eventually, the Seti River merges with the Trishuli River, which is a large river system. Considering the riparian flow of 5 m^3/sec and the contribution from the tributaries, it is estimated that a total discharge of approx. 19 m^3/sec might be available during the dry season.

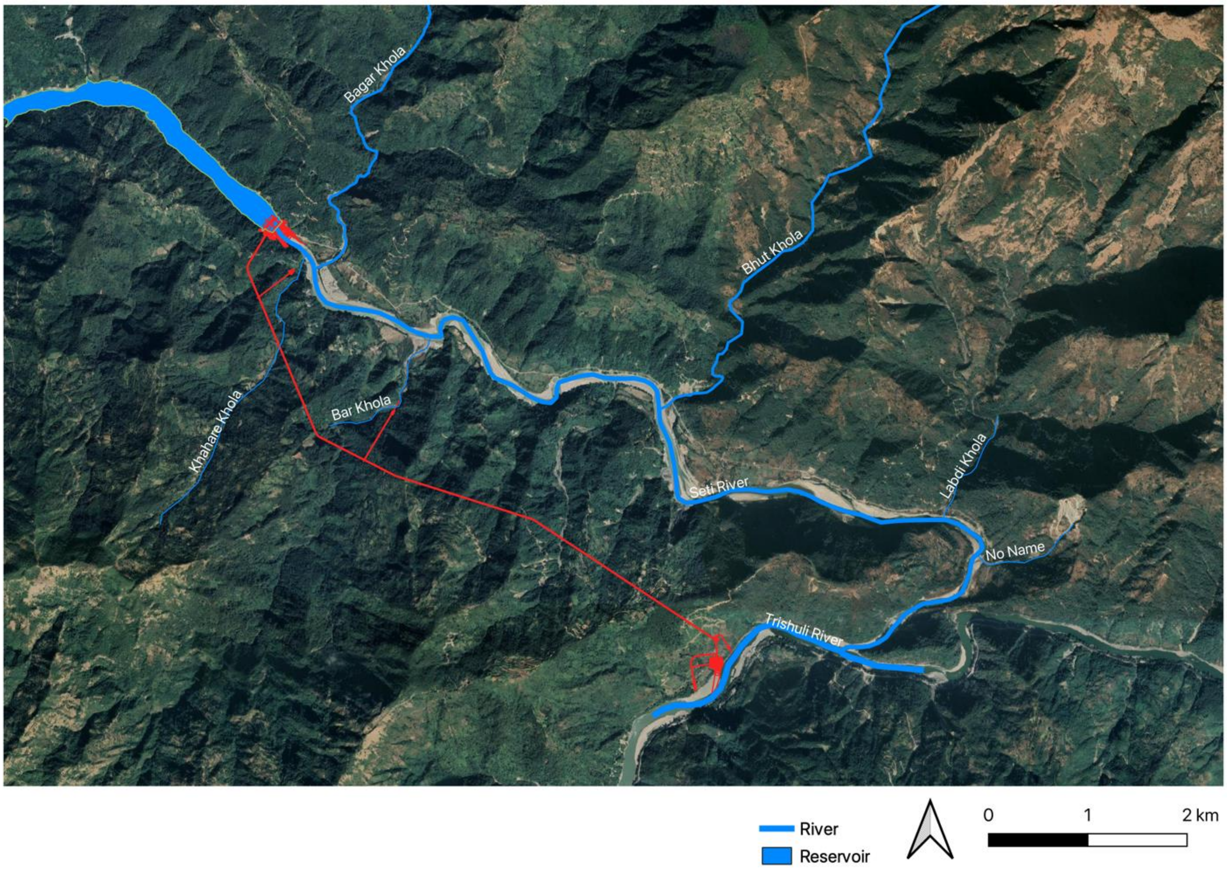


Figure 92: Tributaries of the Seti River in its reduced water stretch (Source: Baseline Survey, EIA Study)

Considering the natural dry season flow available in the Seti River, which is 50 m^3/sec. This means only 40% of the average dry season flow will be available during the project operation period. Therefore, the magnitude of the impact is considered high (H), extent local, and of long-term duration.

The decreased discharge in the affected stretch of the Seti River will have adverse consequences for sustaining the ecological balance, including aquatic life, riparian vegetation, and terrestrial wildlife.

- The barrage has incorporated the fish ladder for fishes to move upstream, however, this stretch of reduced discharge can add up as a barrier for the fishes to migrate upstream.
- Sediment is important for river ecosystems because it helps to maintain the riverbed and banks. It also provides a habitat for variety of organisms. Reduction in sediment transportation can lead to changes in riverbed and banks, compromising the possibility of spawning for the fishes.
- Terrestrial wildlife, such as birds, mammals, reptiles, also rely on rivers for food and water. When the discharge is reduced, these animals can lose their habitat and their food sources. This can lead to a decline in their populations.
- The social, cultural, and economic needs of the residents residing in this area may also be negatively affected by reduced discharge in the river. While the local population is not directly dependent of river for their livelihood, they do fish for

recreation, and personal consumption, and sometimes sell their catches for extra income. Additionally, the river is an important part of the local culture, as it is used for religious ceremonies, of which cremation of the dead and performance last rituals on the riverbanks is important.

To gain a comprehensive understanding of these impacts, it is crucial to conduct a detailed study using E-Flow modelling tools. These tools will facilitate an in-depth analysis of the ecological and socio-economic implications resulting from the reduced water flow, allowing for informed decision-making and the development of appropriate mitigation measures.

7.2.2.5 Impact of hydropeaking

The proposed project will be operated as a peaking reservoir project. It stores the water in the reservoir and releases it through turbine to generate electricity during peak demand period. The design discharge during peaking is 206 m^3/sec. This amount of water will be reintroduced into the Trishuli River through the tailrace during the peaking hour.

The Trishuli River, which become the Narayani River few km downstream from the tailrace. It is the major outlet of the Gandaki River basin, and one of the major contributors of the Ganges River System. Its discharge can be as high as 100,000 – 140,000 m^3/sec during the monsoon period, but it can come down to 3000 - 5000 m^3/sec during the dry season, particularly, in the months of January and February. While the addition of 206 m^3/sec may not appear significant in terms of volume, it can have implications for the water quality and ecological and social integrity of the river due to the release reservoir water as well as nature peaking release. Some studies (Puffer, Power, Bronte, & Thoms, 2015) (Graf, Thoms, Bronte, & Power, 2013) have been carried out on the impact of hydropeaking on river environment, which can be expected in this project and are discussed below:

- Changes water flow and quality - Hydropeaking can cause significant changes in the water flow and quality in immediate downstream of the tailrace in the Trishuli River. This disruption to the natural flow regime can have negative impacts on aquatic ecosystems.
- Degradation of habitat – Hydropeaking has the potential to degrade stream habitat by creating sediment plumes, which can smother aquatic vegetation and reduce oxygen levels in the water. This can result in the loss of habitat for fish and other aquatic organisms.
- Fragmentation of fish populations: Hydropeaking can fragment fish population by creating barriers to migration, thereby reducing reproductive success in fish by disruption spawning and rearing activities.

The anticipated impacts of the hydropeaking are expected to occur downstream of the tailrace. A more comprehensive understanding of these impacts can be gained by assessing the downstream area. At this level of study, the impacts are anticipated to be of low magnitude, considering that the peaking discharge constitutes a relatively small proportion (4-5%) of the Narayani River's drier monthly discharge. It is expected that the extent of these impacts will be localized as the additional water is assimilated into the flow of the Narayani River. However, it is important to note that these impacts may have long-term consequences.

7.3 Biological Impacts

7.3.1 Forest Vegetation

7.3.1.1 Construction Phase

7.3.1.1.1 Loss of forest (community and leasehold)

As a part of the site clearance for construction of the project components including formation of the reservoir, the trees and vegetation will be cleared. It is expected that a total of 19,115 tree belonging to 27 species (that includes both trees and poles) will be removed.

The summarized tree removal data is provided in the table below.

Table 7. 9: Trees removed from the project component site (Source: Baseline Survey, EIA Study)

SN	Project component	Permanent/ Temporary	Total Area [ha]	Forest Area [ha]	# tree	# poles	# Saplings	Total (Tree+Poles)
1	Reservoir	Permanent	157.45	30.29	5789	5116	3164	10,904
2	Clay Area	Temporary	6.81	6.81	1301	1150	711	2,452
3	Old Alluvial and Coarse Aggregates	Temporary	2.79	2.79	533	471	291	1,004
4	Intake	Permanent	8.63	3.19	610	539	333	1,148
5	Additional Dumping area at Intake	Temporary	2.91	0.23	44	39	24	83
6	Rock Quarry Area B	Temporary	5.37	5.37	1423	295	376	1,718
7	Batching Plant and Labortory for Tunnel B	Temporary	1.10	0.54	143	30	38	173
8	Temporary Labor Camp A	Temporary	1.40	0.25	66	14	18	80
9	Access Road to Adit 2	Temporary	1.06	1.06	281	58	74	339

SN	Project component	Permanent/ Temporary	Total Area [ha]	Forest Area [ha]	# tree	# poles	# Saplings	Total (Tree+Poles)
10	Batching Plant and Laboratory for Tunnel A	Temporary	0.52	0.49	130	27	34	157
11	Temporary Labor Camp B	Temporary	0.51	0.10	27	6	7	32
12	Powerhouse Area	Permanent	16.69	0.46	122	25	32	147
13	Dumping Area PH	Temporary	2.52	2.30	610	127	161	736
14	Dumping Area HWs	Temporary	6.88	0.44	117	24	31	141
	Total		214.64	54.32	11,195	7,920	5,294	19,115

The entire project footprint where forest clearance is required consists of 54.32 ha out of which 20.38 ha will be required temporarily for the undertaking of construction works and only 33.94 ha will be permanently utilized for project structures.

The impact will be direct in nature, moderate in magnitude, site specific in extent and long term in duration.

7.3.1.1.2 Loss of plant biodiversity due to loss of forest and vegetated area

The table below provides a summary of the loss of promising tree species in the project area. The largest proportion of trees to be felled, accounting for 17.36% belongs to the species Padke Siris (*Albizia lucidicor*). This is followed by Ram Rittha (*Trewia nudiflora*), 16.07%, Sal (*Shorea robusta*) 9.00%, Sindure (*Mallotus philippensis*) 9.64%, Khirro (*Falconeria insignis*) 7.07% and so on.

Additionally, the project area will experience a loss of shrub and herb species, which contributes to a substantial decrease in plant diversity. Among them, total number of shrubs (33 in number), herbs (109 in number) and climbers (15 in number) have been recorded and provided in detail in baseline section. Translocating these species is challenging, however, it is important to note that these species can be found in other natural forests within the project area. The loss of shrub and herbs with medicinal values is outlined in the baseline section.

The total number of trees expected to be lost, as mentioned earlier, is derived from the sample plot survey conducted in natural and semi-natural forest stands. For project sites where trees are sparsely distributed, tree enumeration has been carried out, and the findings from the sample plot survey are presented in ANNEX O.

The project sites contain a significant number of plant species of indigenous origin. These plant species play important role in maintaining ecosystem of the area, and they are essential part for mineral cycling after death and decay. They are manifested as varieties of plants, popularly known as biodiversity at a given condition. The loss of these plant species would have a significant negative impact on the ecosystem.

The impact of this loss would be direct, meaning it would directly affect the ecosystem. Although the magnitude of the impact would be moderate. The extent of the impact would be specific to the project site. Furthermore, the duration of the impact would be long term.

A study on the importance value has been presented below, which includes an analytical review and assessment of the significance of tree species found in the project sites, particularly in natural and semi-natural stands. The importance value is based on relative density, relative dominance, and relative frequency.

Table 7. 10: Importance value index of tree species of the project site (Source: Baseline Survey, EIA Study)

SN	Local name	Scientific name	Pole	Tree	Total	Volume (pole and Tree together) m3	Relative Density (RD)	Relative Dominance (RD)	Relative Frequency (RF)	Importance value Index (IVI) {RD+RD+RF}
1	Guyalo	*Callicarpa arborea*	0	1	1	0.8315849	0.32154341	0.2603238	0.8695652	1.45143243
2	Kyamuna	*Syzygium nervosum*	1	3	4	4.5571779	1.28617363	1.4266035	1.7391304	4.45190756
3	Kharane	*Symplocos sp.*	2	0	2	0.2139854	0.64308682	0.0669871	0.8695652	1.57963917
4	Payaar	*Buchanania latifolia*	1	0	1	0.3167942	0.32154341	0.099171	0.8695652	1.2902796
5	Lasune	*Dysoxylum sp.*	0	1	1	1.005696	0.32154341	0.3148285	0.8695652	0.6988719
6	Bel	*Aegle marmelos*	4	1	5	0.1140836	1.60771704	0.0357134	1.7391304	3.38256083
7	Taaki	*Bauhinia purpurea*	1	0	1	0.0709094	0.32154341	0.0221979	0.8695652	1.21330649
8	Bhayalo	*Semecarpus anacardium*	3	0	3	0.8636414	0.96463023	0.270359	2.6086957	4.53028038
9	Dumri	*Ficus racemosa*	0	1	1	0.494991	0.32154341	0.1549546	0.8695652	1.34606327
10	Bohori	*Cordia dichotoma*	3	0	3	0.2391278	0.96463023	0.0748579	1.7391304	2.77861851
11	Tiju	*Diospyrus melanoxylon*	2	0	2	0.4426634	0.64308682	0.1385737	0.8695652	1.65122576
12	Khayar	*Senegalia catechu*	3	2	5	1.9039082	1.60771704	0.5960097	2.6086957	4.81242238
13	Chhatiwon	*Alstonia scholaris*	2	1	3	1.3014728	0.96463023	0.40742	2.6086957	3.98074592

S N	Local name	Scientific name	Pole	Tree	Total	Volume (pole and Tree together) m3	Relative Density (RD)	Relative Dominance (RD)	Relative Frequency (RF)	Importance value Index (IVI) {RD+RD+RF}
14	Sindure	*Mallotus phlippensis*	27	3	30	8.2343324	9.64630225	2.5777198	6.9565217	19.1805437
15	Padke Siris	*Albizia lucidior*	34	20	54	58.813613	17.3633441	18.41133	8.6956522	44.4703262
16	Simal	*Bombax ceiba*	2	14	16	13.36673	5.14469453	4.1843932	8.6956522	18.0247399
17	Bot Dhayaro	*Lagestroemia parviflora*	6	7	13	72.180343	4.18006431	22.595723	9.5652174	36.3410049
18	Saaj	*Terminalia elliptica*	2	16	18	24.816924	5.78778135	7.7688234	6.9565217	20.5131265
19	Madane	*Acrocarpus fraxinifolius*	0	7	7	14.663755	2.25080386	4.5904208	2.6086957	9.44992026
20	Khirro	*Falconeria insignis*	17	5	22	6.8648573	7.07395498	2.1490119	6.9565217	16.1794886
21	Katus	*Castamopsis indica*	3	2	5	3.0593979	1.60771704	0.9577304	1.7391304	4.30457788
22	Chilaune	*Schima wallichii*	3	14	17	19.293492	5.46623794	6.0397386	4.3478261	15.8538027
23	Ram ritha	*Trewia nudiflora*	21	29	50	37.727199	16.0771704	11.810325	10.434783	38.3222784
24	Sigane	*Pterospermum lancifolium*	2	8	10	7.8956564	3.21543408	2.4716988	5.2173913	10.9045242
25	Saal	*Shorea robusta*	3	25	28	32.87632	9.00321543	10.29178	3.4782609	22.7732565
26	Karam	*Haldina cordifolia*	4	4	8	6.8934568	2.57234727	2.1579648	4.3478261	9.07813818

SN	Local name	Scientific name	Pole	Tree	Total	Volume (pole and Tree together) m3	Relative Density (RD)	Relative Dominance (RD)	Relative Frequency (RF)	Importance value Index (IVI) {RD+RD+RF}
27	Saadan	*Desmodium oojeinense*	1	0	1	0.4003927	0.32154341	0.1253411	0.8695652	1.31644972
			147	164	311	319.44251	100	100	100	299.879532

7.3.1.1.3 Loss of NTFPs and plants with ethno-botanical importance

The project area boasts a rich and diverse array of valuable plant species. These plants serve multiple purposes, including providing medicinal, aromatic, ornamental, and fiber-bearing properties, as well as holding religious, ethno-botanical, and ecological importance. Furthermore, these plant species play a crucial role in maintaining overall balance and functioning of the ecosystem of the area.

Some of the important NTFPs that can be affected by the project are Khayar (*Acacia catechu*), Peepal (*Ficus religiosa*), Amriso (*Thysanolaena maxima*), Badahar (*Atrocarpus lakoocha*), Simal (*Bombax ceiba*), Allo (*Girardinia diversifolia*), Amala (*Phyllanthus emblica*), Gittha (*Dioscorea bulbifera*), Batulpaate (*Cissampelos sp*.),Kurilo (*Asparagus racemosus*), Babiyo (*Eulaliopsis binata*), Ghodtapre (*Centella asiatica*), Vyakur (*Dioscorea deltoidea*) Chilaune (*Schima wallichii*), Khanayo (*Ficus cunia*), etc. Further detailed account is provided in the baseline chapter with their utility values.

However, with the commencement of the project, the clearance of the site becomes inevitable, leading to the destruction and loss of these invaluable plant species. The impact of this loss will be direct and have an impact of moderate (M) magnitude. Furthermore, the extent of the impact will be site-specific (SS) and long-term (LT) duration.

7.3.1.1.4 Threat to the plant species with conservation significance

The project area, particularly the reservoir area, will experience a large amount of vegetation loss because of inundation. The project area has plants species with conservation significance that could be lost in the because of the construction works. The species that may be affected are:

Shorea robusta – The *Shorea robust,* commonly known as the Sal tree, is a protected species in Nepal. An estimated number of 2,666 Sal trees are expected to be lost in which 1332 are in tree stage, 662 as poles, and 972 as saplings.

Dalbergia latifolia commonly known as Satisal. Sissoo is a valuable and highly sought-after timber species. It is listed as vulnerable in IUCN Red list as well as protected by the GoN. This species is not present in the directly project impact area but can be found in the vicinity of these impact areas.

The forest Act of Nepal strictly prohibits unauthorized felling, cutting, or destruction of these trees. The Department of Forests and Soil Conservation in Nepal is responsible for overseeing and authorizing tree felling activities based on the recommendation provided in the EIA report. To obtain permission, the project must undergo the process of inventory and assessment of these trees to be felled. This process involves determining the number, size, health, and location of the identified trees. Additionally, as part of the permission process, the project is required to undertake compensatory plantation and mitigation measures. These measures may include afforestation or reforestation plans aimed at replacing the felled Sal trees.

In Nepal, all orchids, including *Vanda sp.* and *Cymbidium aloifolium* are classified as protected according to the Forest Act and Rules (Subedi, et al., 2013). Unfortunately, the illicit trade of wild orchids poses a significant threat to their survival and conservation effort. *Cymbidium aloifolium*, commonly known as the Aloe-leaved Cymbidium or Jaalpakshi in Nepal is highly revered in Nepali culture. It is often used in religious ceremonies, festivals, and traditional rituals. *Vanda sp*., a genus of orchids that includes various species, which are protected under Appendix II of the CITES.

Dioscorea deltoides commonly known as Vyakur has been classified as threatened in the IUCN Red List. This species is not present in the directly project impact area but can be found in the vicinity of these impact areas and can be harvested during the construction activities.

The impact will be direct in nature, high in magnitude, site specific in extent and long term in duration.

7.3.1.1.5 Loss of government managed and community forests

A total of 15 Community Forests and 5 Leasehold Forests will be impacted by the project. The reservoir will submerge 2 CFs from Bandipur -6, Byas – 13, 3 CF from Byas-14, 1 CF from Devghat 2 & 4, 2 CF from Devghat 3 and 2 CF from Rishing 1,3. Other components, such as Barrage, Adit and disposal sites will also affect additional 5 Leasehold Forests. The details of the affected forests area presented in the table below.

Table 7. 11: Community forests affected by the project. (Source: Baseline Survey, EIA Study)

SN	Project component	Total land requirement for the project [ha]	Forest area required for the project [ha]	Project Municipality	Forest management (CF/ NF)	Remarks
1	Reservoir	157.45	30.29	Bandipur – 6	Siddhathani CF Bakhar Khola CF – Sarang Ghat	Left bank
				Byas 14	Rumsi CF Harkapur CF Bhoyeri CF – Masdi Ghat	Left bank
				Byas 13	Benikot CF – Koidium Ghat Chhap Danda CF – Kharaasdi Khola	Left bank
				Devghat 3	Sirchuli CF – Naldighat	Right bank
				Devghat 2	Chiuri Bhanjyang CF	Right bank

SN	Project component	Total land requirement for the project [ha]	Forest area required for the project [ha]	Project Municipality	Forest management (CF/ NF)	Remarks
				Rhishing 3	Solang CF, Todke CF	Right bank
				Rhishing 1	Koidium CF	Right bank
2	Intake	8.6	3.19	Bandipur - 6	Siddhathani CF Bakhar Khola CF – Sarang Ghat	Left bank
				Devghat 3	Sirchuli CF	Right bank
3	Adit 2	0.09	0.09	Devghat 3	Sirchuli CF	
4	Adit 3	0.07		Devghat 4	Janahit CF	
5	Adit 4	0.17		Devghat 4	Ghusitol Leasehold Forest Gotheri Leasehold Forest	
6	Dumping Area HW	6.88	NA	Devghat - 4	Ghusitol Leasehold Forest Gotheri Leasehold Forest	

The project study team has collected most of the information on the forest and its management through field observation and consultation with the local communities and member for CFUGs.

The impact of the project on the affected Community Forests (CFs) and Leasehold Forests (LFs) is high, site-specific in extent, and long-term in duration.

7.3.1.1.6 Illegal harvesting of timber and firewood by the workforce

Throughout the construction phase, a considerable workforce will be present at the project area. They will need a substantial amount of firewood for cooking and heating purposes. Based on a study conducted by Pokharel and Rijal (2020), which estimate an average daily consumption of 1.8 kg per capita for a rural household, it is projected that approximately 2.3 metric tons of firewood would be required daily to cater to a workforce of 1,293 individuals. This estimate might vary as running a mess and HH kitchen certainly are different, however, it gives an estimation. As there is a provision of kerosine and LPG as a substitute for firewood, this estimate may considerably decrease the consumption of firewood up to 50%.

Furthermore, the construction of access roads and construction roads grants improved forest accessibility, enabling deeper extraction of firewood from previously inaccessible areas. Additionally, as part of the proposed project, the construction of 3 temporary camps may necessitate the extraction of timber from the adjacent forest. The heightened resource demand associated with these activities poses a potential threat of degradation to the surrounding forest areas.

The impact is expected to be indirect in nature, medium in magnitude, local in extent and short term in duration.

7.3.1.1.7 Increased risk of forest fire

The project site, particularly, the reservoir area, is surrounded by a significant expanse of dense forest. These forested areas are vulnerable to forest fires. There are some studies carried out on forest fire in Tanahu District (Ghimire, Neupaneq, & KC, 2017) (Adhikari, Ghimire, & KC, 2018) (Ghimire, Adhikari, & KC, 2019) have found that the rate of forest fires in Tanahu District has been increasing in recent years. The main causes of forest fires in the district are human activities, such as careless disposal of cigarettes, open burning of agricultural waste, and logging. The project construction activities can further add to the possibility of forest fire.

The impact will be indirect in nature, low in magnitude, local in extent and short term in duration

7.3.1.1.8 Impacts on Ecosystem Services

Impact on Biotic Provisioning Ecosystem Services

The construction phases of the project will have considerable effects on the provision of biotic ecosystem services, particularly in relation to cultivated crops, livestock, fisheries, and wild flora and fauna. An estimated 14.23 hectares of cultivated land will be submerged, resulting in a significant loss of arable land that will disrupt local agricultural practices. Additionally, grazing areas for livestock will be impacted, either by being submerged by the reservoir or repurposed for project infrastructure. These changes will directly affect agricultural and livestock farming activities. Moreover, the removal of forested areas will lead to a notable decrease in the availability of timber, fuelwood, and wild plants and animals, which are traditionally used for food, energy, and cultural practices.

Impacts on Abiotic Provisioning Ecosystem Services

The construction phases will also notably affect abiotic ecosystem services, particularly groundwater resources. Field surveys have indicated that only a few households rely on surface river water for irrigation purposes. However, the creation of the reservoir may alter the groundwater table, potentially causing the drying up of springs that are vital for drinking water.

Impact on Biotic Regulation and Maintenance Ecosystem Services

The construction phases will significantly impact a range of biotic regulation and maintenance services, particularly those related to soil erosion control, landslide prevention, water flow regulation, pollination, seed dispersal, habitat provision, disease control, soil and organic matter maintenance, and climate regulation. These impacts arise from land clearance, construction activities, and changes to water dynamics within the project area. Specific impacts include:

Controlling Soil Erosion: Substantial vegetation clearance during construction will directly increase soil erosion, especially on steep slopes around the reservoir. The removal of natural vegetation and disturbance to the soil will reduce its ability to control erosion. Additionally, the creation of the reservoir will result in sedimentation, further exacerbating soil loss. This impact is severe, leading to long-term soil degradation and reduced stability.

Preventing Landslides: Clearing vegetation and altering the area's hydrology will disrupt natural processes that help prevent landslides. Seasonal water level fluctuations in the reservoir may destabilize slopes, increasing the risk of landslides, especially in areas already susceptible to slope failure. The magnitude of this impact is significant, as it will lead to substantial erosion and risk to the integrity of surrounding landscapes.

Regulating Water Flows: The diversion of water for power generation will significantly alter the river's natural flow regimes, affecting both upstream and downstream ecosystems. The removal of riparian vegetation to create the reservoir will further diminish the landscape's capacity to regulate water flows, potentially leading to downstream flooding and sedimentation. This impact is high, with long-term consequences for water regulation and related ecosystem functions.

Pollination Services: Habitat loss due to land clearing will reduce the availability of habitats for pollinators, particularly insects like butterflies and moths, which are essential for plant reproduction. The impact on pollination services is moderate, as mitigation measures such as reforestation could restore some of these services, though full recovery will take time.

Seed Dispersal: Construction activities will displace species critical for seed dispersal, such as mammals and birds. The destruction of habitats for these species, coupled with the overall reduction in biodiversity, will disrupt seed dispersal networks vital for ecosystem regeneration. This impact is moderate, with certain areas expected to recover through restoration efforts over time.

Habitat Provision: The creation of the reservoir will submerge vast areas of forest, agricultural land, and natural habitats, leading to the loss of essential ecosystems for both terrestrial and aquatic species. The disruption will have substantial long-term effects on habitat availability, affecting biodiversity and ecological balance. This impact is very high, with significant habitat loss, particularly for species dependent on forest and aquatic ecosystems.

Disease Control and Pest Regulation: Increased human activity and environmental changes may introduce new pests and diseases, disrupting the natural regulation of pests and disease vectors. This impact is considered moderate, as invasive species and disease outbreaks may be controlled through targeted interventions, but the initial effects could be significant.

Soil and Organic Matter Maintenance: The transition to a reservoir ecosystem will alter soil processes and reduce the natural decomposition of organic material. The loss of forested areas will decrease the input of organic matter into the soil, which will affect soil fertility. The magnitude of this impact is moderate, with long-term effects on soil health and fertility.

Climate Regulation: The destruction of forest cover will reduce the region's ability to sequester carbon, contributing to the project's overall carbon footprint. The loss of vegetation and changes in land use will diminish the area’s capacity to regulate the climate. The magnitude of this impact is high, with lasting consequences for climate regulation in the region.

Impacts on Biotic Cultural Ecosystem Services, Including Spiritual Significance, Cultural Identity, and Recreational Use

The construction phases of the project will result in substantial effects on various biotic cultural ecosystem services (ES), particularly in terms of recreational activities, cultural identity, spiritual value, and heritage. These impacts stem from significant changes in land use, such as the submerging of important areas and alterations to water flow dynamics. The specific impacts are outlined below:

Recreational Activities: During the construction phase, land clearance and the creation of a reservoir will lead to the loss of areas traditionally used for active recreation. Activities that rely on the inundated regions, such as physical engagement in these spaces, will be permanently removed. The magnitude of this impact is high, as it involves the long-term loss of recreational spaces. While some nearby areas may partially compensate for this loss, access to these spaces could be limited. This impact is expected to persist in the long run.

Spiritual Significance: The Seti riverbanks are home to Hindu cremation ghats, where water is essential for performing last rites, including the ritual washing away of ashes. Changes in water flow and availability caused by construction activities will heavily impact these spiritual practices. The magnitude of this impact is high, as the river's water plays a critical role in religious rituals. This effect will persist over the long term, and measures such as providing psychological support and facilitating a smooth resettlement process will be necessary to address these impacts.

Heritage and Bequest Values: The displacement of communities from ancestral lands can cause significant psychological distress, as people are emotionally attached to their ancestral homes and heritage. The magnitude of this impact is high, given the deep emotional and cultural connections people have to these areas. The impact is expected to be long-term, requiring interventions like psychological counseling and support for livelihoods to mitigate these effects.

The overall impact of the project on ecosystem services is considered **high** in magnitude, **local** in extent, and **long-term** in duration.

7.3.1.2 Operation Phase

7.3.1.2.1 Adverse impacts on the forest area resulting from enhanced accessibility

During the operation phase, the project area, particularly the sites near the construction areas, will be affected by improved accessibility resulting from the road construction. This heightened accessibility may attract local inhabitants and remaining project staff, leading to unauthorized activities such as time and firewood collection, as well as potential disturbance to wildlife species.

The impact of the project is considered “Indirect”, however, the impact magnitude will be moderate, local in extent, and long-term in duration.

7.3.1.2.2 Increased impact on vegetation of conservation significance

Within the project area, there exist rare, endangered, vulnerable, and protect species of flora, particularly Sal, Satisal and varieties of orchids. Enhancing access to the project area can lead to an upsurge in the potential for illegal collection and utilization of these species.

The impact of the project is considered “Indirect”; however, the impact magnitude will be moderate, local in extent, and long-term in duration.

7.3.2 Wildlife

7.3.2.1 Construction Phase

7.3.2.1.1 Habitat Loss and Degradation

It was observed that both herpetofauna and mammals in the project area utilize a range of local habitats including forests, agricultural land, wetlands, barren land as well as human settlement. However, most of them use forest habitats, employing them for various purposes. The project implementation, however, will either disturb the forest temporarily or permanently such as temporary camps, reservoir, and other project facilities. Site clearance will be necessary in all cases, which will compromise their habitat condition as well as area. Nevertheless, we can expect that wildlife will have the ability to relocate to other adjoining and/or available habitat in vicinity and adapt relatively well to minor changes.

The construction works are expected to have adverse impacts on the conditions of the wildlife habitat. The activities involved, such as vegetation removal, blasting, excavation, and disposal of muck and spoils, among others, are likely to contribute to the deterioration of the habitat. Several significant factors of disturbance have been identified, including increased sedimentation levels in the river system, elevated noise and vibration levels, disturbances to slopes, and loss of vegetation, which were discussed in the earlier sections.

These construction activities pose a potential threat to wildlife feeding grounds, shelters, and breeding grounds, which may result in habitat deterioration. The species at risk range from common to those classified as critically endangered, heightening concerns about the impact of the construction work on their survival and well-being with the project area.

Based on the referenced data, the area of habitat loss is home to various wildlife species, including the Elongated Turtle, Golder Monitor, Burmese Python, Irrawaddy Squirrel, both species of Porcupine, Small Indian Mongoose, Rhesus Macaque. Yellow-Throated Marten, and Barking Deer. These species primarily use the area for occasional passage, feeding, or stopover, rather than for breeding purposes.

This impact is expected to be direct, moderate in magnitude, local in extent (site specific) and long term in duration.

7.3.2.1.2 Disturbance on the movement of the wildlife

According to the project design, the construction phase of the project will engage many workers, leading to significant rise in anthropogenic activities across the entire project area. The increased movement of heavy vehicles, the utilization of explosives resulting in high noise levels, and a surge in human activities along regular routes and prime wildlife habitats are expected to restrict or interrupt the movement of wildlife within the project area. These factors pose potential challenges to the natural behaviors and movements of the local wildlife during the construction phase.

The wildlife faces the potential threat of road kills due to vehicular movement, which may result in fatalities and injuries. In addition, excavation works, blasting, operation of heavy machineries, crushing plant operations, quarry operations, and disposals, *etc.* will contribute to excessive noise and vibration, that can be extremely disturbing to wildlife. Moreover, the use of strong lightings during night shifts will further add disturbances, particularly to nocturnal wildlife such as Bats. Additionally, land clearing, excavation, grading, and filling activities will particularly affect less-mobile species like frogs, reptiles, and rodents. These species may face significant habitat loss and disruption of their natural environments due to these activities.

The wildlife that is sensitive to these changes will respond by either relocating to safer habitats or gradually adapting to the disturbed environment. Certain mammals may permanently leave their current habitat and seek refuge in adjacent areas. Overall, the disturbance caused by construction-related activities will result in a localized reduction in food and shelter for mammals, primarily confined to the project areas.

The sensitive wildlife to such change will either move to safer habitat or slowly adopt themselves in the disturbed environment. Some mammals will permanently leave their present habitats and take refuge to the adjacent habitats. However, it is important to closely monitor the process of adaptation and/or survive in these new habitats. At present, there is a lack of substantial data and comprehensive studies to definitively determine whether the wildlife will successfully adapt or survive as they move to different locations. More study and observations are necessary to better understand the outcomes of these potential habitat shifts.

The expected impact is direct, with low magnitude, limited to a local extent, and of short-term duration. Its significance will be relatively low, and it will diminish as the construction work at each site is completed.

7.3.2.1.3 Illegal Hunting and Wanton killing

It was reported that the locals in the project area engage in small-scale hunting for meat and financial gains, specifically targeting species like Barking Deer, Porcupine, and some edible frogs. There is a possibility that the labor force working on the project might also become involved in these hunting activities. The labor force could potentially introduce new hunting techniques, which may then be shared with local poachers.

Furthermore, the construction of access roads for the project may facilitate easier access for locals to prime wildlife habitats, expanding their hunting grounds. As the construction progresses and more people arrive in the project area, the demand for bush meat is likely to increase, leading to a surge in hunting activities. This heightened hunting pressure poses a significant threat to the local wildlife populations and their habitats.

Like many other parts of Nepal, this area is also characterized by a widespread fear of snakes, resulting in the belief that all snakes are venomous and should be killed immediately upon sight. Consequently, snakes and monitor lizards are both susceptible to indiscriminate killing due to fear and superstition.

Additionally, the construction activities in the area have the potential to disrupt and expose microhabitats, putting various snake and monitor lizard species at risk of being killed or harmed. The disturbance caused by construction work may pose a serious threat to these reptilian species and their habitats, potentially leading to a decline in their populations.

While rules and regulations are in place to prevent hunting and wanton killing of wildlife, their enforcement at the local level is often not 100% effective. As a result, these activities continue to cause a decline in the populations of various wild animals in the project area.

Among the most hunted animals in the region are the Indian Crested Porcupine, Malayan Porcupine, Indian Hare, Golden Jackal, Otter, Barking Deer, Common Goral, turtles, monitor lizards, and snakes. These species are particularly vulnerable to illegal hunting, and their populations may suffer consequently.

These activities are projected to have a direct impact, which is expected to be of low magnitude and significance, localized in extent, and short-term in duration. However, as the construction work at each site is finished, the impact is likely to gradually diminish, resulting in a relatively low overall significance.

7.3.2.1.4 Waste and Pollution impact on wildlife

A substantial amount of solid waste is expected to be generated from the temporary settlements, including camp sites, housing areas, office spaces, and vehicle garages. If not adequately managed, this waste can attract mammals that may scavenge on the dumps, potentially leading to health issues. Additionally, the improper disposal of solid waste can pollute the nearby river, posing a threat to aquatic fauna such as frogs, turtles, crocodiles, and otters, jeopardizing their well-being and survival. Proper waste management is essential to mitigate these environmental risks and protect the local wildlife and aquatic ecosystem.

The anticipated impact is direct, with a moderate magnitude, specific to the project site, and short-term in duration. Overall, this impact is deemed to be of low significance.

7.3.2.1.5 Illegal trade of Wildlife Trophy

The Environmental Impact Assessment (EIA) study has identified several noteworthy findings regarding wildlife in the project area. Specifically, two nationally protected priority species, one nationally Endangered species, and four nationally Vulnerable species have been recorded. Among the recorded fauna, one species is globally Critically Endangered, five are Vulnerable, eight are listed in CITES Appendix-I, and six are listed in CITES Appendix-II.

The illegal demand for trophies of some of these wildlife species is considerably high in the market. Notably, the critically endangered Elongated turtle's population is declining due to poaching within the country. This species has been recorded in only one area of the project, and despite being illegal, some individuals are kept as pets in private homes. The ease of locating and capturing this species, coupled with the exorbitant illegal market price, raises concerns about potential illegal trade of this and other local wildlife trophies.

The expected impact of these activities is direct, but it is of low magnitude, localized in extent, and short-term in duration. While this impact is recognized, it is deemed to be of low significance.

7.3.2.2 Operation Phase

7.3.2.2.1 Disturbances to the Wildlife

The operation of the hydropower plants, particularly, the barrage area and powerhouse sites, may cause disturbances to the wildlife. Notably, noise and constant lighting will be, particularly, a nuisance for the wildlife. The lighting necessary for operation and safety purposes at the project sites affects the nocturnal foraging behaviors and may also disrupt the sleep patterns of certain crepuscular species. These disturbances pose potential challenges to the natural behaviors and rhythms of the affected wildlife in the area.

During the winter season, the construction of reservoir above the dam site will obstruct the easy crossing of Seti river for wildlife. This change may lead to some disorientation among the local mammals in the area. Species such as monkeys, Leopards, Gorals, and Barking Deer might encounter negative impacts on their mobility due to the restricted access to their usual crossing points across the river.

The anticipated impact is direct, with a high magnitude, localized in extent, and long-term in duration. Despite these characteristics, the impact is of low significance.

7.3.2.2.2 Habitat Loss and Degradation

During the operation phase, significant alterations to the local wildlife habitats are expected to occur due to various activities. One major impact will arise from the formation of the reservoir, which will result in changes to the terrestrial habitat. While some areas will be compromised due to submergence, additional water areas will become available for the wildlife to utilize.

Furthermore, the creation of a low water zone downstream of the barrage will impact water availability for the wildlife in that specific region. However, it might also lead to enhanced river crossing opportunities for certain species. Moreover, the operation of the powerhouse and the water released from the tailrace will further modify the habitat conditions for the local terrestrial fauna.

The alterations in habitat can potentially lead to intra and interspecies competition among the local wildlife for food and space. With certain areas being compromised or lost due to the reservoir formation, some species might face challenges in finding suitable habitat. For example, the habitat for turtles, extending about 12 km upstream of the barrage, may be reduced, affecting their behaviors and population dynamics.

The combination of these habitat alterations can have complex and interrelated effects on the local wildlife. While some species may benefit from the new water areas, other may face challenges in adapting to the changes. Moreover, the increased competition for limited resources could lead to shifts in species distributions and dynamics within the ecosystem.

This impact is expected to be direct, moderate in magnitude, site specific in extent and long term in duration. This impact is of low significance.

7.3.2.2.3 Habitat degradation due to inadequate waste disposals

During the project's operational phase, solid waste will be generated from the camps and project sites, although the quantity will be significantly lower compared to the construction phase. Despite the reduced amount, inadequate management, and improper disposal of solid waste from camping locations can lead to the deterioration of soil and habitat quality, resulting in negative impacts on both terrestrial and aquatic fauna.

Furthermore, the discharge of wastewater into the streams without treatment might degrade the water quality affecting the overall biodiversity of the area. This can be especially detrimental to species like turtles, crocodiles, and otters, which rely on aquatic life for sustenance. A decrease in fish populations in the dewater zone below the dam may lead to a shortage of food for these aquatic-dependent animals.

Proper waste management and responsible disposal practices during the operational phase are vital to safeguard the ecological integrity of the region and mitigate potential negative impacts on wildlife and their habitats. Ensuring sound waste management practices will help preserve the soil quality, maintain biodiversity, and sustain the delicate balance of the ecosystem, benefiting both terrestrial and aquatic fauna in the project area.

The impact is expected to be direct, low in magnitude, site specific in extent, and long term in duration.

7.3.2.2.4 Illegal Hunting of the wildlife

The increased mobility of people in the project area, facilitated by enhanced road access and the development of growth centers, presents a potential concern for the hunting of mammals such as Barking deer and Goral for meat and financial gains. As people have better access to the area, there may be an increased incentive for hunting wildlife as a means of sustenance or income generation.

Furthermore, the local wildlife's ability to cross the 6km long stretch of the river below the dam (reduce water zone between *Dhaap* to *Ghumaaune*) could lead to conflicts with the local community. In cases where the wildlife raid crops and livestock, they may become easy targets for illegal hunting as a means of retaliation or protection of personal property.

While illegal hunting is likely to occur, it is expected to be less prevalent than during the construction phase of the project. However, it remains a concern that could impact the local wildlife populations, especially species targeted for their meat or perceived threat to human livelihoods.

The overall impact is direct, low in magnitude, site-specific in extent, and long-term in duration. Despite these factors, the impact is of low significance, which could be attributed to the relatively lower scale of illegal hunting compared to the construction phase. Nonetheless, proper monitoring and enforcement measures will be essential to mitigate potential adverse effects on the local wildlife and maintain the delicate ecological balance of the area.

7.3.3 Avifauna

7.3.3.1 Construction Phase

7.3.3.1.1 Habitat Loss and habitat fragmentation

During the construction phase of the project, there will be a need to clear the vegetation to make ways for the project components. Unfortunately, this action will result in habitat loss for various wildlife, including birds. The removal of trees and vegetation will lead to habitat fragmentation, meaning the natural environment will be broken up into smaller and isolated patches, which can disrupt the normal movement and behavior of avifauna.

Furthermore, the felling of trees and removal of vegetation will have several detrimental effects on the bird population. It will reduce the availability of nesting spaces, which are essential for birds to breed and raise their young. Additionally, birds often rely on certain trees or elevated perching and roosting sites as vantage points for feeding, resting, and social interactions. With these sites taken away, the avifauna will face challenges in finding suitable areas for these activities, impacting their overall well-being. For instance, the river stretch has several Simal trees (*Bombax ceiba*), also known as silk cotton trees, which play a crucial role in supporting vulture populations. These trees provide

(a) nesting sites, as their large, sturdy branches provide secure platforms for vultures to build their nest. Vultures are colonial breeders, meaning they often nest is large groups, and Simal trees can accommodate multiple nests, fostering thriving vulture colonies.
(b) Roosting sites – vulture require safe and elevated roosting sites where they can socialize and rest. The tall height and robust branches of Simal trees offer ideal roosting spots for vultures, allowing them to observe their surroundings and maintain a safe distance from potential ground-level threats.
(c) Perching site for scanning – vultures is expert scavengers that rely on their keen eyesight to spot carrion from great distances. Simal trees' elevated vantage points for vultures to scan the landscape for potential food sources.

The project's vegetation clearance, especially in the reservoir area, will significantly impact bird habitat, affecting important species. The extent of the impact can be local to regional, as the project area receives migratory birds, and during will be long-term, as most of vegetation removal will be permanent in nature.

7.3.3.1.2 Disorientation and displacement of avifauna

During the construction phase, various project activities like transporting construction materials, operating equipment. Vehicular mobility and muck disposal can have negative effects on avifauna in the project area. These effects can be attributed to several factors.

- Vehicular emission – The frequent movement of vehicles during construction can lead to increased vehicular emissions, which may affect the air quality. This can disorient and displace birds as they rely on clean air for navigation and may find it challenging to navigate through polluted areas.
- Increased noise levels – the use of blasting and operation of heavy machinery during construction can generate loud noises that disturb birds. Loud noise can startle birds and disrupt their normal activities, leading to displacement from their preferred locations.
- Disturbance of nocturnal birds – Nocturnal bird species, such as owls, are particularly sensitive to artificial light at night. The presence of bright lights during construction can distract and disorient these birds, interfering with their hunting and foraging behaviors. Prolonged exposure to such disturbances can lead to local extirpation, meaning the temporary or permanent disappearance of a bird population from a particular area.

These are the direct impact of the project on bird population. The magnitude can be high during the construction phase, and the extent can be local and short-term in duration.

7.3.3.1.3 Reduced food availability

During the construction, the project will be undertaking excavation, tunnelling, quarrying, and disposal of spoils and muck, all of which can result in increased sedimentation of the rivers. The increased turbidity can have significant implications for the local ecosystem, particularly for riparian birds that depend on these waters for their survival.

The turbid waters will negatively impact on the availability of food for riparian birds, such as fish and macroinvertebrates (insects and other smaller aquatic organisms). Reduced visibility in the water will make it harder for these birds to locate and catch their prey, leading to a decrease in their food resources. As a result, the population of riparian birds in the area may decline as they struggle to find enough food to sustain themselves.

Moreover, the unfavorable conditions caused by increased turbidity might force some riparian birds like Ruddy Shelduck (*Tadorna ferruginea*) to physically relocate to other areas with clearer. This relocation can disrupt their unusual nesting and foraging patterns and may result in reduced breeding success and overall survival.

The impact can be indirect; however, the magnitude of impact can be moderate, extent local and short-term in duration.

7.3.3.2 Operation Phase

7.3.3.2.1 Mortality of Eggs and Nestling

Reservoirs, despite offering appealing habitats for water birds, can have significant negative impacts on various bird species. When reservoirs are created, they often flood specific habitats and seasonal areas, which results in the loss of vital sites for reproduction, feeding, and resting for many bird species. The natural cycles of flooding and droughts, which serve as important cues for birds regarding food availability and migration paths in riverine regions, are disrupted by the presence of reservoir.

Furthermore, reservoirs led to the fragmentation of alluvial forests, which are crucial for maintaining bird diversity and supporting specific functional groups. The fragmentation of these habitats can limit bird populations and hinder their natural movement patterns, leading to potential declines in certain bird species.

Additionally, the formation of reservoir and sudden release of water from tailrace can cause the loss of bird population, particularly affecting species with reduced flight capabilities. The mortality of eggs and nestling is a significant concern, as these birds may not be able to escape rapidly rising water levels during these events.

The impact can be direct, low in magnitude, local in extent and long-term in duration.

7.3.3.2.2 Impact on reservoir filling on bird population

The formation of reservoir might have significant impact on resources availability and species interactions, which, in turn, impact the reproductive success and survival of bird populations. While some birds may return to the area, many might be forced to move away during reservoir filling phase. At the same time, opportunistic species, often predators that feed on fish and insects, are attracted to the newly available prey. The increase in opportunistic species near the reservoir can lead to more intense density-dependent processes, such as competition, predation, and parasitism, resulting in a restructuring of the bird communities.

During the period of community restructuring following the disturbance caused by dam flooding, known as the relaxation time, some bird populations may be locally extirpated, while other species colonize the newly formed environments. This restructuring process can lead to the loss of evolutionary lineages or relevant ecosystem functions, reducing the ecological stability of the bird communities.

For instance, aquatic bird species like herons, egrets, ducks, and cormorants many benefit from the reservoir filling, as it provides them with suitable habitats. However, large ground-dwelling bird species may be negatively impacted as their habitats are submerged.

To understand the changes in bird species composition after reservoir filling, it is essential to conduct regular monitoring of avian diversity across the project area. Monitoring helps in assessing the impact on different bird species, identifying potential shifts in the community structure, and informing conservation efforts to mitigate negative effects on bird populations.

The impact is direct, high in magnitude, local in extent and long term in duration.

7.3.3.2.3 Reduced Food Availability

The construction of the barrage on the Seti River, diverting water to the powerhouse, will result in formation of 13 km long reduced water zone downstream of the barrage up to the confluence of Seti with the Trishuli River. This reduced water zone will have a substantial impact on the natural flow of water downstream, reducing it to a level that can only sustain basic ecological flow for supporting aquatic biodiversity.

Riparian birds, which depend on the river's natural flow and associated habitats, will face significant challenges due to the reduced water flow. With the scarcity of suitable habitats in the reduced water zone, these birds will be forced to concentrate in areas where basic e-flow can still support their survival.

As the water flow diminishes in the reduced water zone, fish populations will likely decline, affecting the availability of food for fish-eating birds and other riparian bird species. This reduction in food resources can lead to increased competition among bird populations, and fish-eating birds may suffer as they lose their primary food source.

The overall consequence of these changes is that the population of riparian birds is expected to decrease in the affected areas. Some individuals may seek alternative habitats with better resources, physically relocating to other regions to meet their survival needs.

The impact is indirect, moderate in magnitude, local in extent and long-term in duration.

7.3.4 Aquatic Life

The project is going to significantly alter the natural flow of the Seti River, which is expected to have detrimental consequences on the aquatic ecosystem. These alterations affect flow patterns, sediment transport, and water quality, posing risks to aquatic life. Moreover, the project is anticipated to disrupt fish migration routes and cause destruction to spawning grounds, further threatening fish population's sustainability in the Seti River. Since the project is located near the draining out point of the Seti River, the effect of impact at this point is expected to be observed in the entire river system, making the impact magnitude highly significant. Thus, a thoughtful consideration and effective implementation of mitigation strategies to minimize negative effects on the river's ecosystem and ensure the long-term survival of fish population in this river system.

The prevailing fishing practices in the project area pose a significant threat to both the fishery and the aquatic balance of the Seti River, warranting attention and concern. Despite the regulations set forth by the Aquatic Animal Protection Act (1960), which strictly prohibit the use of electric current, explosive substances, or poisonous substances for catching and killing aquatic animals, illegal fishing practices involving electric current, and explosives are extensively observed. These reckless practices pose substantial risks to non-targeted aquatic animals, especially during critical early life stages such as eggs, embryos, fry, and fingerlings. The detrimental impacts of these practices are particularly intensified during the breeding season, further exacerbating their consequences on the delicate aquatic ecosystem.

The prevalence of these illegal fishing activities is more pronounced in specific regions, including the proposed reservoir area, lower reaches of the Seti River, and the Trishuli River downstream of the tailrace. These areas are particularly vulnerable to such illicit practices, which can lead to adverse consequences for aquatic life and disrupt the delicate balance of the aquatic ecosystem.

It is crucial to address and combat these illegal fishing practices effectively, as they not only violate regulations but also pose a serious threat to the sustainability and conservation of aquatic species in the project area. Strict enforcement and awareness of the existing laws are essential to ensure the protection and preservation of the aquatic environment and its diverse inhabitants.

7.3.4.1 Construction Phase

7.3.4.1.1 Obstacle to fish migration by diversion tunnel

During the initial phase of construction of the project, coffer dam will be constructed at the headworks to create a dry riverbed for building of the barrage. To maintain the connectivity of the river between upstream and downstream of the coffer dam, the river will be diverted through a diversion tunnel.

The diversion tunnel may pose challenges for migrating fishes attempting to pass through it. The tunnel's characteristics, such as variations in cross-section, substrate composition, depth, and flow regime, differ from those of the natural river channel. The baseline has reported the presence of 22 migratory fish species in the area.

The obstacles to fishes to migrate caused by the diversion tunnel can significantly impact their ability to carry out essential life processes, including spawning, rearing, feeding, and sheltering. The altered conditions within the tunnel might disrupt the natural behavior and life cycles of these fish species. Out of 68 species reported, 22 were migrant species. Furthermore, 4 species are long-distance migratory species (*Bagarius bagarius, Clupisoma sp., Tor putitora,* and *Tor tor.*) including Raj Bam (*Anguilla bengalensis*) which is catadromous fish, which means it migrated from freshwater to the seas to spawn.

However, there is a silver lining as well. The reduced discharge stretches of the Seti River, along with E-flow and the flow contributed by tributaries, can offer suitable breeding grounds for these migratory species in the long run. Despite the potential blockage, the reduced discharge stretch can create favorable conditions for spawning and other critical life stages of these fish species.

Migration of these fishes will be significantly affected by the project. This obstacle for migration becomes more critical because of the project's location at the entry point of the Seti River System, as it can block the migration of these species into the Seti River system all together. However, it should also be noted that the reduced discharge stretch of the Seti River with the E-flow and flow contributed by the tributaries can become a breeding ground for these species in the long run.

Additionally, during the construction phase, the workforce might engage in fishing activities in the dewatered stretch or at the intake and outlet points of the diversion tunnel. This fishing could further disturb the aquatic environment and exacerbate the impact on fish populations.

The impact on migrating fish at the entry point of the Seti River is of significant magnitude and is expected to have a regional extent. Moreover, this impact is projected to be long-term in duration. Even though the coffer dam will be removed after the construction phase, the disruption to fish migration will persist due to the installation of the barrage in the river. The presence of the barrage will continue to hinder the natural migration patterns of fish, affecting their ability to carry out crucial life processes. As a result, the long-term implications of this disruption on fish populations and the overall aquatic ecosystem need to be carefully considered and addressed through appropriate mitigation strategies.

7.3.4.1.2 Loss of Riparian Habitat, Soil Erosion, and Sediment Deposition into the River

Most of the construction works carried out in this project will locate in proximity with the river, thus, can significantly affect the morphology, water quality, as well as ecology of the Seti as well as Trishuli Rivers. The construction activities include river diversion, excavation works, mining, tunnel excavation, construction of roads, barrages, and others.

One major concern is the potential destruction of riparian habitats. Riparian zones are vital ecosystems that support a wide variety of plants and animals. When construction activities encroach upon these areas, the delicate balance of these habitats can be disrupted, leading to the loss of biodiversity and ecological functions.

Moreover, construction activities near rivers can result in soil erosion. The removal of vegetation and disturbance of natural land can leave the soil vulnerable to erosion. Therefore, sediment and waste materials can be washed into the river, degrading water quality and thus adversely affecting aquatic life.

Despite these potential environmental impacts, the overall significance of these effects is expected to be low. The magnitude of the impact is expected to be low, meaning that the total disturbance caused by the construction activities will be limited. The impact is also considered local, as the degradation of water quality might occur some distance downstream from the construction sites. Furthermore, the duration of the effects is projected to be short-term, as construction activities will eventually conclude, and natural recovery processes may begin.

7.3.4.1.3 Fish Stranding during the River Diversion

During the initial phase of river diversion, there is a potential risk of fish stranding in during the river diversion at the headwork area. Fish stranding happens when fish become trapped in isolated pools or sections of the river that have lost their normal water flow. This situation can be hazardous for the fish population for several reasons.

The reduced water flow in these isolated areas may result in lower oxygen levels, which are essential for fish survival. Without adequate oxygen, the stranded fish may face difficulties in breathing and can suffocate, leading to their death.

Fish stranding creates an opportunity for predators to concentrate in these isolated pools. Moreover, the construction workers and locals can also make use of the opportunity to collect the fishes. With limited escape routes and the fish in a weakened state due to adverse conditions, they become more susceptible to predation, further contributing to their decline.

While fish stranding during river diversion poses a risk to the local fish population, the overall impact is expected to be relatively low. The magnitude of the impact is likely to be low, as it only affects specific areas where river water is diverted. Additionally, the extent of the impact is site specific, confined to the isolated stretches of the river that have been dewatered. Furthermore, the duration of the impact is short-term, as the diversion process is typically temporary.

7.3.4.1.4 Fishing of stranded fishes by the workforce and locals

During the initial diversion phase of the Seti River, fish stranding might occur at certain areas of the river. This means that the water level is reduced suddenly yet temporarily, leaving the fishes stranded on dry land or isolated pools. Locals and construction worker might make use of this opportunity and may engage in fishing activities.

The overall impact of these activities is expected to be low in magnitude, meaning that it will not have significant effect on the fish population. The extent will likely be site specific, confined to the headworks. The duration of the impact is expected to be short-term since it is associated only during the construction period.

7.3.4.2 Operation phase

7.3.4.2.1 Sediment deposition in the reservoir

During the project operation, notable changes are expected in the sediment transport and deposition patterns of the Seti. The reservoir will receive majority of discharge from the tailrace of Tanahu HEP, which will trap most of the sediment that is currently carried by the Seti River, resulting in a reduction of sediment reaching the reservoir. Consequently, this will affect the deposition regime in the reservoir.

The sediment load of the reservoir will mainly be supplied by the Madi River, which is a tributary of the Seti River, known to carrying a substantial amount of sediment. This sediment from the Madi River will become the primary source of sediment for the reservoir. In addition to it, runoff from the immediate catchment area will also contribute to the sediment load of the reservoir. These combined factors will shape the new sediment transport and deposition regime of the reservoir.

As sediment begins to accumulate in the reservoir due to reduced flow downstream of the Barrage, it triggers several adverse effects on the river ecosystem. One significant consequence is the increase in turbidity caused by the elevated sediment transport. The suspended particles in the water reduce the penetration of light, leading to a reduction in primary productivity. This decrease in light availability negatively impacts aquatic plants and algae, which are essential for supporting the entire food chain in the river.

The elevated turbidity can have cascading effects on various organisms. The freshwater fish that are currently found in the river and other aquatic species that rely on clear water for their survival and reproduction might struggle to find suitable habitats and food sources. Additionally, spawners that lay their eggs in specific spawning beds may face difficulties. The fine sediment settling on these spawning beds can cover the eggs and the gills of the spawners, leading to suffocation and impaired reproductive success.

Moreover, the altered sediment transport can also impact the physical structure of the riverbed and its surrounding areas. Excessive sediment deposition can modify the river's morphology, potentially affecting the distribution of habitats and altering the dynamics of the river channel.

The predatory fish species that rely heavily on their visual senses to hunt for prey. The presence of suspended sediment particles reduces water clarity, creating visual impairment for the predators. As a result, their ability to locate and target prey becomes compromised, leading to disruptions in their feeding habits. This reduced hunting efficiency can negatively affect their growth, health, and overall population dynamics.

Furthermore, the increased movement of sediment in the river can significantly disrupt the habitat of macro-invertebrates. These organisms often seek stable refugia in the form of crevices, rocks, or submerged vegetation to protect themselves from predators and harsh environmental conditions. However, the constant shifting of sediment on the riverbed makes it challenging for them to find and maintain stable hiding places. This lack of refugia exposes them to increased predation risk and makes them more vulnerable to unfavorable conditions in the river.
Impact will be direct, high in magnitude, Site specific in duration and long term in duration.

7.3.4.2.2 Prevented sediment transport to the Reduced Water Zone

The river stretch, downstream of the Barrage up to the confluence of Seti River with the Trishuli River and up to the tailrace in the Trishuli River, will have lower discharge due to the project operation. This is about 14 km long stretch. This decreased flow contributes to the proliferation of vegetation along the riverbanks. Consequently, the river's course becomes more stable, which may lead to a reduction in lateral erosion and sediment transport in this stretch.

The reduced transport of sediment will compromise availability of food sources of the macro-invertebrates in the reduced water zone of the river, particularly the Seti River, where the discharge will be significantly lower. Many of these organisms depend on specific microhabitats or surface layers of sediment to find food, such as algae, organic matter, and detritus. The obstruction of the sediment transport downstream of the Barrage can disrupt the availability of these food sources, leading to potential food shortages for the macro-invertebrate populations. This, in turn, can have cascading effects on the entire river ecosystem, as these organisms serve as an essential food source for the fishes and to the birds.

Considering the overall impact, it is expected to be of medium magnitude. The extent of the impact is local, confined mainly to the reservoir area, tailrace, and the reduced water stretch of the river. Importantly, the duration of these impacts is long-term, meaning that they persist over an extended period.

7.3.4.2.3 Changes in the reservoir condition

The formation of the reservoir along the Seti River will result in the permanent transformation of a portion of its natural riverine habitat into a lacustrine habitat. This transformation will bring about significant changes to the river ecosystem, impacting various aspects of the aquatic environment. The accumulation of sediments in the reservoir. As settlement settle, they can alter the substrate composition on the reservoir's bed. This change in substrate composition can affect the availability and quality of habitats for various aquatic species. Some species may prefer specific types of substrates for spawning, shelter, or foraging, and these alterations may affect their ability to find suitable habitat.

Furthermore, the formation of the reservoir may lead to changes in water temperature and water level fluctuations. The impounded water can experience temperature variations, which can impact the metabolic rates and behavior of aquatic organisms. Additionally, water level fluctuations caused by the Barrage operations can further influence the availability of suitable habitats along the riverbanks, which can affect the reproductive success and survival of certain species.

The transition from a free-flowing river to a reservoir also influences light penetration into the water. The reduced flow and sediment accumulation can increase water turbidity, limiting the amount of light that reaches the deeper layers of the reservoir. This reduction in light availability can affect primary productivity and hinder the growth of aquatic plants and algae, which are essential for supporting the food chain and overall ecosystem health.

Another critical aspect affected by the reservoir is the accumulation of nutrients. The dam will trap nutrients from the upper reaches of the river and adjacent agricultural lands, leading to an increase in nutrient concentrations within the reservoir over time. This excessive nutrient buildup can cause eutrophication, leading to an overgrowth of algae and other aquatic plants. As these plants die and decompose, the process of respiration and bacterial decomposition consumes oxygen, which can deplete dissolved oxygen levels in the water.

Moreover, eutrophication can promote the production of toxic byproducts like CO_2, CH_4, N_2O, and possibly H_2S in deeper layers of the reservoir, leading to further deterioration of the physicochemical parameters. The lower stratum may become unsuitable for many aquatic species, potentially leading to a reduction in species diversity and alterations in species composition and dominance.

Therefore, the construction of the TSHPP dam and the subsequent formation of the reservoir will bring about significant changes to the Seti River ecosystem. The transition from a riverine to a lacustrine habitat will impact flow dynamics, light penetration, water temperature, dissolved oxygen levels, sediment deposition, and nutrient concentrations. These changes will have profound effects on the habitat suitability for various aquatic species, potentially altering the biodiversity and ecological dynamics of the river and reservoir ecosystem. Proper management and mitigation strategies will be essential to address these impacts and ensure the sustainable conservation of the aquatic life in the area.

The impact caused to the reservoir is significant with high magnitude, local in extent and long-term in duration.

7.3.4.2.4 Changes in the reduced discharge stretch of the River

The diversion of river discharge from the headworks to the powerhouse complex will result in reduced water flow along the Seti River and Trishuli river, spanning between the Barrage and the Tailrace. To mitigate the impact on the aquatic ecosystems, the project must ensure a E-Flow discharge in this section. Additionally, the presence of tributaries along this stretch may contribute to the overall discharge, but despite these conditions, the water availability in this area will still be lower than it was before the project's implementation. This alteration in water conditions will likely have consequences that will affect the aquatic ecosystems in the region.

Sediment transport and habitat quality – As discussed earlier, the natural flow patterns of river play a crucial role in sediment transport. However, one the barrage is constructed, it hinders the river's flow, causing sediment to accumulate in the reservoir, whereas the discharge will be significantly reduced downstream of the barrage, preventing sediment travel as well.

A significant concern arising from this alteration in sediment transport and deposition is its impact on aquatic life, particularly fish species. Most fish species require specific types of river bottom, typically gravel or rock, to successfully spawn. These substrates provide a secure environment for fish to lay their eggs. Unfortunately, the disruption caused by the dam's presence interferes with the availability of suitable spawning and residing habitats for aquatic life. Therefore, the fish populations and their ability to reproduce and thrive are jeopardized.

Nutrient Deposition and Fertility - Reservoir trap sediments and nutrient brought in by streams. As a result, the outflow water from the dam has low turbidity and lacks nutrient-rich sediment deposition downstream. As a result, the outflow water from the dam has low turbidity and lacks nutrient-rich sediment deposition downstream. This can reduce the fertility and productivity of downstream aquatic environments, impacting the entire food chain and ecosystem dynamics.

Human activities – In a reduced water stretch, human activities, both legal and illegal fishing, become more accessible. Overfishing or increased predation of fish predators can disrupt the balance of the aquatic community, leading to further stress on certain species and potential ecological imbalances.

Impact of fish species – Migratory fish species, such as *Neolissochilus hexagonolepis*, *Garra sp.*, and *Tor putitora*, will be directly affected by the reduction in their existing habitat as their migration to the upper reaches will be obstructed by the dam. This might affect their migration and spawning behavior that can have potential consequences on population dynamics. While some fish species might suffer, the reduce discharge stretch can provide additional spawning habitats for fish species that prefer warm, slow-running riffle and pool habitats in small tributaries. For instance, the Golden Mahseer (*Tor putitora*) is of the fish species can benefits from this environment. During the spawning season, which typically occurs from June to September, adult Mahseer migrate upstream to suitable spawning grounds. These fish prefer areas with slow-flowing water and pools, which provide ideal conditions for them to lay their eggs. The eggs are usually laid in shallow areas with clean gravel or rocky substrates. These species may find suitable conditions in this modified environment.

The impact of the dam on the downstream ecosystem is described as high in magnitude, regional in extent (covering a significant portion of the river's course), and long-term in duration. This highlights the severity and long-lasting nature of the ecological changes caused by the dam.

7.3.4.2.5 Loss and degradation of spawning grounds

The reservoir's creation may lead to the submergence and loss of important spawning and nursing areas for fish. The still waters of the reservoir can cause fish eggs to sink to the bottom, making it difficult for larvae to reach the surface and survive.

Studies have shown varying effects on different fish species in lacustrine habitats of reservoirs. Some species like *Puntius sp., Glyptothorax sp., Psilorhynchus pseudecheneis, Anguilla bengalensis, and Schizothorax richardsonii* might experience abrupt declines due to the reservoir's conditions. On the other hand, species like *Neolissocheilus hexagonolepis, Barilius bendelensis, Nemacheilus sp., and Garra gotyla* may remain unaffected in these altered environments.

Fish in the reservoir may also face challenges such as shoreline erosion and rapid drawdown, which can impact spawning and egg incubation.
Conversely, the reservoir's formation could have significant beneficial impacts on aquatic birds, as it provides a new habitat upstream of the dam. Additionally, the project can create job opportunities for local fishermen and communities through fish trapping, hauling, and tourism development.

Overall, the impact of the project will be considerable, affecting the aquatic ecosystem at a regional scale and with long-term consequences of high significance. As such, it is crucial to consider and manage these effects to ensure the preservation of the ecosystem's health and balance.

7.3.4.2.6 Migration barrier by barrage

The TSHPP involves the construction of a barrage over the Seti River, which will act as a physical barrier obstructing fish migration. Fish migration is crucial for accessing suitable feeding and spawning grounds. If fish spawn in unsuitable water conditions, their reproductive success may decrease, and the fry or fingerlings could suffer from a lack of food or predation.

After the main dam's construction, migratory fishes that reach the Trishuli-Seti River confluence during their upstream migration will have two options. They can either continue further upstream in the Trishuli River, which offers higher discharge, greater productivity, and no barriers for migration, thus providing abundant habitat choices for spawning in its tributaries. Alternatively, they may move into the Seti River's Reduced water stretch, which is expected to have lower discharge and productivity due to the trapping of drifting macroinvertebrates, plankton, and organic matter by the barrage. The presence of the barrage in the Seti River makes it a less favorable option for migratory fish, leading to the likelihood that most of them will migrate along the Trishuli River.

Migratory fish that naturally spawn in tributaries within the Reduced water stretch are likely to continue doing so. However, those fish that migrate to spawn in tributaries or river stretches located upstream of the barrage will be blocked by the barrage. How these fish will respond to the blockage is currently unknown. They may wait below the barrier each year, never successfully reproducing again, as observed in the KuriChu Dam in Bhutan. Alternatively, they may move to a nearby tributary and attempt to spawn there, or they may search for other suitable spawning habitats through a different route. Each of these scenarios has different long-term consequences for fish production in the project area.

The impact of these changes will be significant in magnitude, regional in extent, long-term in duration, and of high significance. It is essential to carefully consider and manage the consequences of the barrage on fish migration and spawning to ensure the conservation of the aquatic ecosystem and sustainable fish populations in the project area.

7.3.4.2.7 Peaking mode of operations

Downstream to the tailrace and all the way to the confluence with the Kaligandaki River, the flow will reach a minimum level daily when the power is shut down due to peaking operations. This peaking operation is anticipated to have various impacts on the aquatic ecosystem.

The sudden surge in flow during peaking hours can disrupt fish growth, production, and habitat use. It can also affect the composition and density of benthic fauna, leading to changes in the ecosystem dynamics. Spawning activities may be disturbed, and young fish, egg spawns, and invertebrates downstream of the tailrace might be displaced from their spawning and nursing grounds.

Furthermore, the abrupt reduction in flow downstream during the peaking season may result in fish and aquatic life getting stranded. The inability to shift laterally quickly enough with the sudden sinking of water levels can have a significant impact on fish populations. This, in turn, may affect water quality and nutrient cycling, further influencing the overall health of the ecosystem.

The mode of operation, particularly the ramping rate, plays a role in stranding events. Higher ramping rates can increase stranding occurrences and disrupt fish migration, potentially stranding them or their food organisms downstream of the tailrace.

Moreover, the deep-water outlets from the dam release colder water temperatures downstream of the tailrace, which may not naturally occur. This can hinder the spawning and hatching of fish eggs that require specific temperature thresholds. The cold bottom water released from dams may also contain dissolved gases and toxic redox products, further impacting aquatic life.

The temperature fluctuations caused by thermopeaking can disrupt the synchrony between environmental cues, such as water temperature, day length, food production, etc., which are essential for fish migration. As a result, thermopeaking can act as an additional stressor on river biota, affecting their growth, reproduction, migration, and physiological processes.

Considering the various impacts, the overall effect of the peaking operation and thermopeaking will be of moderate-high magnitude, regional in extent, long-term in duration, and of high significance. Proper management strategies and monitoring efforts are necessary to minimize these impacts and ensure the sustainability of the river ecosystem and its inhabitants.

7.3.4.2.8 Fish entrained or impinged

As fish move downstream, there is a risk of them being drawn into the power plant along with the intake flow, a phenomenon known as entrainment. This can result in fish passing through the turbine, exposing them to various physical stresses such as pressure changes, shear, turbulence, and strikes. These stresses can cause disorientation, physiological stress, injuries, or even mortality to the entrained fish.

Additionally, fish may also be impinged, meaning they get trapped against the structures of the power plant, particularly at the intake screens. This can lead to direct injuries and mortality for the impinged fish.
Both entrainment and impingement pose significant challenges to fish populations, especially migratory species. These impacts can disrupt fish movements and migration patterns, affecting their ability to access suitable habitats for feeding, spawning, and other essential life stages. Furthermore, the stress and injuries caused by entrainment and impingement can have negative consequences on fish health and reproduction, leading to reduced population numbers in the long term.

Considering the potential impacts on fish populations, the overall effect of entrainment and impingement is assessed to be of low magnitude, local in extent (limited to the area around the power plant), and long-term in duration, as the effects may persist as long as the power plant operates. However, despite the low magnitude, the significance of these impacts is of medium level, as they can have considerable consequences on fish populations and aquatic ecosystems in the affected area.

To mitigate the effects of entrainment and impingement, fish-friendly technologies and measures can be implemented at the power plant, such as fish screens, bypass channels, and improved turbine designs. These measures aim to reduce fish entrainment and impingement, thereby contributing to the preservation of fish populations and the overall health of the aquatic environment.

7.3.4.2.9 Cumulative impact of water diversion projects adjacent to TSHPP

The reduction in fish and other aquatic organism production caused by the TSHPP can have far-reaching consequences on the entire ecosystem. Animals inhabiting riparian areas that depend on fish and other aquatic organisms as their primary food source, such as otters, kingfishers, cormorants, and other aquatic birds, may face a decline in population numbers due to a decrease in available prey.

Moreover, the reduced riverine fisheries resulting from the TSHPP's impact can directly affect the livelihoods of the fishing community residing near the dam area, as well as other communities that rely on fishing as a part-time means of subsistence. This can lead to economic hardships for these communities and may disrupt their traditional way of life.

In addition to the TSHPP, several water diversion projects are planned upstream and downstream in the Seti and Trishuli rivers. The cumulative impacts of these projects may further degrade the ecological integrity of the rivers. Barriers created by these projects can impede the migration of fish, alter the natural flow regimes, and affect physicochemical parameters and nutrient cycling within the rivers. These alterations can ultimately reduce the abundance of migratory fish and other forms of aquatic life within the TSHPP's vicinity.

Considering the wide-ranging consequences on both aquatic and terrestrial ecosystems, the overall impact of the TSHPP and the cumulative effects of other planned projects is expected to be of high magnitude. These impacts are regional in extent, affecting the larger riverine system, and are likely to be long-term in duration, persisting as long as the projects operate. The significance of these impacts is of high significance, given the potential disruptions to ecosystems, livelihoods, and biodiversity.

To mitigate these adverse effects, comprehensive environmental management and conservation strategies need to be implemented, including measures to protect and restore fish habitats, manage water flow, and support the livelihoods of local communities dependent on fishing. The sustainable development and operation of hydropower projects necessitate careful planning and monitoring to safeguard the delicate balance of aquatic and terrestrial ecosystems in the region.

7.4 Socio-Economic Environment

This section identifies and evaluates potential project risks and impacts to the social environment.
This section assesses the predicted social environmental impacts, both positive and negative, associated with the project.

The project will cause a range of pre-construction, construction and operation phase impacts that will affect people living in the project impact area, which includes both the direct and indirect impact areas.

7.4.1 Construction Phase

7.4.1.1 Land acquisition and displacement

Any development projects that lead to involuntary displacement of people can have significant and far-reaching impacts on the environment, society, and economy. Such displacements often give rise to a host of challenges and issues that need to be carefully addressed. When people are relocated to areas where their skills may be less relevant and where competition for resources is higher, it can result in difficulties for their livelihoods and overall well-being.

The process of involuntary displacement can weaken community structures and social networks, leading to the dispersion of kin groups. This dispersion can result in a loss of cultural identity, traditional authority, and the potential for mutual assistance within the community, which are the strong traits of the Nepali society. Moreover, production systems might also break down, and people may lose their productive assets and source of income, further exacerbating their vulnerability.

Resettlement, whether voluntary or involuntary, can have long-term negative consequences if proper mitigation measures are not thoroughly planned and executed. Without effective strategies to address the challenges posed by displacement, communities may face long-term hardship and impoverishment. Additionally, inadequate planning and implementation can result in environmental damage and degradation.

The proposed TSHPP necessitates the acquisition of a significant land area, specifically around 271.45 ha. Among this, 210.30 ha will be permanently acquired for the hydropower facility and its ancillary structures, while 61.15 ha will be temporarily acquired during the construction period.

7.4.1.2 Permanent acquisition of land

This land acquisition will directly affect at least 437 land parcels, encompassing a total land area of about 271.45 ha (210.30 permanently, 61.15 ha temporarily). Among these parcels 355 parcels are private (30:Resort, 1:School, 324:Individual), 62 parcels are government, 8 parcels are public lands, and 12 parcels are unidentifiable. 355 privately owned parcels accounts for 17.95% of the total land requirement. Even if the total number of privately owned parcels is higher, the area occupied by these parcels is less than the public parcels. These land parcels belong to various individuals or entities, and their use will be affected due to the project. In some cases, a minor amount of additional land acquisition might be carried out, especially in situations where the residual land area after the primary acquisition is too small for practical economic use for the owner. In such instances, landowners may prefer to have the residual land acquired by the project as well.

The table below provides the total number of parcels and subsequent land area required for establishing various project components permanently as well as temporarily.

Table 7. 12: Number of Parcels required for the project components (Source: Caadastral Survey, 2023)

SN	Project Component	Municipality/ Ward	Area [ha]	Land Type [ha]		No of Parcels	Acquisition Type
				Private	Public		
1	Intake Area	RB: Devghat-3, LB: Bandipur-6	8.63		8.63	-	Permanent
2	Reservoir FSL 275m	LB: Bandipur-6, Byas-14, Byas-13 RB: Devghat 2, 3; Rhising 1, 3	157.45	14.23	143.22	128	Permanent
3	Reservoir Buffer 278m	LB: Bandipur-6, Byas-14, Byas-13 RB: Devghat 2, 3; Rhising 1, 3	23.95		23.95	168	Permanent
4	Permanent Camp Area-A	Bandipur-6	0.44	0.44		3	Permanent
5	Employer Camp Alternative-2	Devghat-4	2.28	2.28		13	Permanent
6	Powerhouse Area	Devghat-4	16.69	6.3	10.39	46	Permanent
7	Surge Shaft	Devghat-4	0.86	0.08	0.78	3	Permanent
Total Area (Ha)			210.30	23.33	186.97	361	

The impact is of high magnitude, site-specific in extent and long-term in duration.

7.4.1.3 Temporary acquisition of land

The project will also require securing temporary land access agreements for an area of 61.15 ha. These agreements are essential to facilitate the construction works. These lands will be used for construction purposes, such as setting up construction camps, stockpiling, quarrying, disposal, and other activities. Once the construction is completed, the land will be restored to its original condition and use. The restoration process will be crucial in determining the extent of the impact on the temporarily acquired land. If the restoration is carefully planned and executed, the impact on the land can be minimized, and it can be reverted to its previous state, allowing it to resume its original purpose or use.

Table 7. 13: Land for temporary acquisition (Source: Caadastral Survey, 2023)

SN	Project Component	Municipality/ Ward	Area [ha]	Land Type		No of Parcels	Acquisition Type
				Private	Public		
1	Explosive Store House/Barrack	Bandipur-6	0.41	0.41	0	7	Temporary
2	Access Road to Adit 2	Devghat-4	1.06		1.06		Temporary
3	Batching Plant and Laboratory A	Bandipur-6	0.52		0.52	2	Temporary
4	Batching Plant and Laboratory for Tunnel B	Devghat-3	1.1	0.54	0.56	8	Temporary
5	Clay Area Private Land	Byas-14	6.81		6.81	1	Temporary
6	Dumping Area-HW	Bandipur-6	6.88		6.88	-	Temporary
7	Additional Dumping Area at Intake	Devghat-3	2.91		2.91		Temporary
8	Dumping Area-PH	Devghat-4	2.52	0.22	2.3	4	Temporary
9	Temporary Labor Camp A	Bandipur-6	1.4	0.82	0.33	7	Temporary
10	Temporary Labor Camp B	Devghat-4	0.51		0.51	-	Temporary
11	Temporary Labor Camp C	Devghat-4	1.15	1.15		5	Temporary
12	Old Alluvial Deposits and Coarse Aggregate	Bandipur-6	2.79		2.79	-	Temporary
13	Adit-2	Devghat-4	0.09		0.09		Temporary
14	Adit-3	Devghat-4	0.07	0.03	0.04	4	Temporary
15	Adit-4	Devghat-4	0.16		0.16	5	Temporary
16	Access Road to Surge Shaft Adit 4 & Adit 3	Devghat-4	2.05	0.9	1.14	32	Temporary
17	RBM-1		5.54		5.54		Temporary

SN	Project Component	Municipality/ Ward	Area [ha]	Land Type		No of Parcels	Acquisition Type
				Private	Public		
18	RBM-2		7.34		7.34		Temporary
19	RBM-3		6.28		6.28		Temporary
20	RBM-4		3.91		3.91	1	Temporary
21	RBM-5		2.28		2.28		Temporary
22	Rock Quarry - B		5.37		5.37		Temporary
Total Area (Ha)			61.15	4.07	56.82	76	

Proper restoration of the temporarily acquired land involves activities like removing construction equipment, restoring of the natural landscape, and rehabilitation of any disturbed areas. The goal is to leave the land in a condition like its pre-construction state, ensuring that any disruption caused during the construction phase are mitigated as much as possible.

The impact is predicted to be high in magnitude, site-specific in extent and short-term in duration.

7.4.1.4 Affected HH by acquisition

The process of land acquisition will have significant implications for HHs. It can result in two types of displacements:

- Physical displacement – this occurs when HHs are required to vacate their current residence or land to make way to the development. The land acquired by the project might be where these HHs have been living for generations, and they will be compelled to relocated to a different area. Physical displacement can uproot families from their familiar surroundings, disrupt established social networks, and lead to the loss of community ties and cultural heritage.
- Economic displacement – it refers to the impact on HHs' livelihoods and income sources due to the land acquisition process. When land is acquired, it can result in the loss of productive assets and sources of income that were dependent on the land. For example, if the land was used for agriculture or other income-generating activities, the loss of land can lead to economic hardships and challenges for the affected HHs.

7.4.1.4.1 Affected HHs

The project implementation is expected to affect a total of 285 HHs, both permanently and temporarily. Here are the details of affected HHs:

- The project will acquire single parcel of land from 261 HHs, and more than one parcel from 24 HHs.
- From 261 HHs (single parcel HHs), land from 123 HHs will be acquired temporarily, while land from 138 HHs will be acquired permanently.
- From 24 HHs (more than 1 parcel HHs), 49 parcels will be acquired temporarily and 47 parcels will be acquired permanently.

Table 7. 14: Affected HHs by Municipality

Municipality/Ward	Number of Affected HHs
Bandipur-6	133
Byas-14	75
Devghat-3	17
Devghat-4	44
Total HHs	269

7.4.1.4.2 Affected Business (Resort)

In addition to HHs, other institutions will also be impacted by the land acquisition. The project will permanently acquire land from a private resort called "Care and Downey", totaling 0.95 ha across 30 parcels. The cadastral maps and details of ownership can be found in Annex J and Annex K respectively.

Figure 93: Photograph of Care & Downey Resort

7.4.1.4.3 Affected Government-owned land

Government-owned land will be subject to acquisition, both permanently and temporarily. A total of 13.82 ha of land, which comprises of 62 parcels will be acquired permanently, and 36.30 ha of land (13 parcels) will be acquired temporarily. Moreover, 9.90 ha of public lands (6 parcels) will be acquired permanently.

7.4.1.4.4 Unidentified Parcels

During the study, a total of 12 parcels were not initially identified. These parcels collectively amount to 1.25 ha of land that the project needs to acquire. Within this, 0.99 ha of land will be acquired permanently, while 0.25 ha of land will be acquired temporarily.

The identification of these parcels occurred during the commencement of fieldwork. While the locations of these parcels have been pinpointed, there's a notable absence of owners or stakeholders associated with these properties. This issue of absentee ownership will be tackled during the process of land acquisition, and the approach involves coordination with the Land Revenue Office Tanahu.

To resolve the complication arising from absent owners, legal notifications will be employed. These notifications serve as formal announcements or notices issued by the concerned authorities to alert absentee owners or stakeholders about the impending acquisition, or any necessary actions related to their properties. This process is conducted in accordance with legal procedures to ensure that all relevant parties are duly informed and given the opportunity to participate or respond as required by law.

Coordinating with the Land Revenue Office Tanahu indicates a structured and regulated approach to resolving the issue, likely ensuring compliance with legal norms and facilitating the acquisition process by addressing the challenge of absentee ownership through the appropriate legal channels.

Unidentified parcels which will be identified later will be treated as PAFs during project operation.

7.4.1.4.5 Non-acquisition displacement

In addition to the displacements resulted by land acquisition, some HHs may be displaced, not because of land acquisition, but rather due to the presence of nuisance. These nuisances might include adverse effects on HHs, such as pollution, noise and disturbances caused by the construction due to their proximity to project constructions. These negative impacts can make it untenable for some HHs to continue living in their current locations, prompting them to seek alternative places to reside. This situation might occur prevalently at Gai Ghat for construction of the powerhouse complex.

Table 7. 15: HHs displacement estimate due to Project Nuisance (Baseline Survey 2022, EIA Study)

SN	Project component	Municipality/ Ward	No of HH
1.	Powerhouse	Devghat-4	23
2.	Headworks	Bandipur-6	4

7.4.1.4.6 Consequences of acquisition and displacement

Based on the consultations with the local community, it has been indicated that land acquisition and displacement can have multi-faceted and far-reaching consequences on their lives, which are summarized below:

- Loss of residential structures, leaving HHs without a place to live and disrupting their sense of security and stability.
- Loss of productive structures such as cattle sheds, shops, etc resulting in the loss of livelihood opportunities.
- Loss of other structures such as schools, shops, Ghats, temples, *etc*. leading to disruption of essential services.
- Loss of agricultural land and preferred livelihoods.
- Loss of community cohesion and social ties by scattering their community members, thus, breaking up social bonds and community cohesion.
- Loss of access to the natural resources – Land acquisition might restrict access to forests, rivers, grazing land, and other natural resources that community have been relying on.
- In some cases, displaced individuals might receive inadequate compensation or resettlement options, leading to the creation of stranded or residual land plots that are not economically viable.
- In some cases, even if HHs aren't entirely displaced, they may lose parts of their land to the project resulting in fragmented and less productive plots.
- Displacement can disrupt small businesses located in the project area, causing financial losses and challenges in reestablishing elsewhere.
- For many indigenous and traditional communities, land holds spiritual significance and cultural heritage. Displacement can lead to the loss or disruption of these vital connections.
- Loss of community cohesion

- Displacement can disproportionately affect women, who may face increased vulnerability due to loss of income, disruption of social networks, and challenges in accessing resources.

The anticipated impact of land acquisition and displacement is significant and direct. The project is going to affect many HHs thus the magnitude is "high". However, it should be noted that the number of HHs affected by this project is lower if compared with the displacement caused by the hydropower projects of similar scale. The extent of impact will be site specific as HHs located within the project structures and activities will be affected. The displacement will mainly be permanent in nature; thus, the duration of impact is "long-term".

7.4.1.5 Impacts associated with loss of standing crops and agricultural productivity.

The project necessitates the acquisition of privately-owned agriculture lands, which could result in the loss of the productive land as well as the standing crops in these lands, which will decline agricultural productivity of the project area. Such consequences could have significant ramifications, affecting both the local communities and the broader agricultural sector. The ensuing list outlines the key impacts associated with this loss:

- ***Economic loss*** – Land is often an asset for most of the residents of the project area, serving as a significant source of economic security. When land is taken away for the project, it can seriously compromise the financial stability and opportunities that land ownership provides to its rightful owners. The loss of land may mean a loss of potential income from farming or other land-based activities, thereby affecting the livelihoods of those who depended on it.
- ***Loss of agricultural productivity*** – Apart from the direct loss of land, the destruction of standing crops in the field inflicts additional economic setbacks upon farmers in the project area. These farmers rely heavily on agriculture as their primary source of income and invest significant resources, such as time, labor, money, and effort, to cultivate crop throughout the season. When the project disrupts their agricultural activities, particularly if the affected crops are near harvest, it can lead to substantial financial losses. The investments in terms of seeds, fertilizers, irrigation, and other farming inputs may all go to waste, result in severe economic hardships. This impact becomes even more severe when they cannot recoup these investments. Given that majority of locals is engaged either full-time or part-time in agriculture, the loss of agricultural productivity can be significant and widespread across the community.
- ***Food security***: Agriculture plays a crucial role in ensuring food security within the project area. Most locals, particularly small landholders, rely on subsistence farming. The loss of standing crops not only impacts the local economy but also severely disrupts the food supply chain, leading to food shortages and increased prices. As a result, this directly affects the food security and nutrition of local communities, especially those heavily dependent on subsistence farming for their sustenance.
- ***Livelihood Disruption:*** Farmers who experience crop losses may encounter either temporary or long-term disruptions to their livelihoods. The financial recovery process can be challenging, and finding alternative sources of income might prove

difficult, resulting in heightened poverty levels and socio-economic challenges within the affected communities.

- ***Increased dependency on imports***: A significant decline in local agricultural productivity can lead to an increased dependence on imported food to meet the demand.

In total 40.069 ha (21.632 ha permanently and 18.437 ha temporarily) of agricultural land will be acquired during the construction phase and during creation of reservoir. These lands are currently utilized for cultivating cereal crops such as wheat, maize, buckwheat, paddy, and others. Consequently, the area will experience a significant long-term loss of production due to the land acquisition.

Considering the annual crop losses, the acquisition of land for the project structures and ancillary facilities results in the loss of about 50.5896 MT of cereal crop from permanent land and 43.1176 MT from temporary land.

Table 7. 16: Crops lost due to project

Major Crops	**Total Production (MT)**	**Total Production (MT)**
	Permanent Land	**Temporary Land**
Rice	22.8851	19.505
Maize	24.5377	20.9136
Wheat	1.24092	1.05764
Millet	1.88131	1.60344
Buckwheat	0.04458	0.038
Total	**50.5896**	**43.1176**

The total income loss per year from acquiring the lands temporarily accounts for NPR 16,14,739.61 and permanently accounts for 18,94,562.42 totaling to NPR 35,09,302.03 per year.

Most anticipated agricultural loss is expected to be direct consequences of the project. It is however, of moderate magnitude considering the consequences on the locals, particularly the small landholding and vulnerable families. The extent will be site specific as it limits within the project sites. Most of the agricultural losses will be of long term as recovery back will be difficult.

7.4.1.6 Project-induced in-migration

The commencement of the project is anticipated to lead to in-migration into the project area. Contracted workers and officials will naturally relocate to the area to carry out their roles. Additionally, the project's allure will attract job seekers seeking employment opportunities within the project. Moreover, as the project creates business opportunities for goods and services to facilitate its operations, this could further fuel an influx of people moving into the vicinity.

During the peak construction period, which is expected to span five years, a total of 1293 workers, encompassing both skilled and unskilled labor, will be required to fulfill the project's demands.

Most of the project activities will be concentrated around the headworks site, where construction of the barrage, intake, and HRT will take place at Sarang Ghat, and the powerhouse complex at Gai Ghat. Considering this distribution of activities, the plan has included to provide appropriate accommodations at these two convenient locations.

While efforts will be made to prioritize local employment, it is anticipated that a significant portion of skilled and semi-skilled positions will be filled by workers from regions outside of the project districts.

Infrastructure projects of this magnitude tend to draw economic migrants in search of direct or indirect employment opportunities linked to the project. This phenomenon is commonly referred to as the influx population.

Below, we delve into several impacts associated with in-migration and, to a lesser extent, the population influx of economic migrants seeking employment opportunities:

- ***Increased Demand and Competition for Local Public Services***: The rising population puts additional strain on local public services such as healthcare, education, transportation, and utilities, resulting in potential service quality issues.
- ***Increased Pressure on Accommodation and Rents***: The influx of people seeking housing can lead to a surge in demand, driving up rents and making housing less affordable for both locals and newcomers.
- ***Local Inflation of Prices and Crowding Out of Local Consumers***: With a higher population, demand for goods and services rises, potentially causing local inflation and limiting access for existing residents.
- ***Gender-Based Violence***: Influx populations can exacerbate gender-based violence, including cases of sexual harassment, child abuse, and exploitations, which require attention and preventive measures.
- ***Substance Abuse and Criminal Behavior***: The stresses of migration and economic hardship may lead to increased instances of substance abuse and criminal activities in the affected area.
- ***Increased Stress on Public Protective Services***: The rise in population places added pressure on law enforcement and emergency services, necessitating additional resources to maintain safety and order.
- ***Increased Incidences of Prostitution and Casual Sexual Relations***: In some cases, the influx of people can lead to a rise in informal sex work and casual sexual relationships, posing risks to public health and community dynamics.
- ***Conflict between Local Community and Migrant Workers***: Tensions may arise between the local community and migrant workers, particularly if there are perceived threats to local job opportunities or cultural clashes.
- ***Conflict between Local Community and the Project***: The project itself may encounter opposition or conflict from the local community due to concerns related to its impact on the area and its resources.

It is crucial for project planners and local authorities to address these potential impacts proactively, taking appropriate measures to mitigate negative consequences and foster a harmonious coexistence between the influx population and the existing community. Community engagement, support programs, and proper planning are vital in managing these challenges effectively.

The impacts associated with the in-migration is the direct consequences of the project. It is however, of moderate magnitude considering the consequences on the locals. The extent will be local, and of short-term duration.

7.4.1.7 Acquisition of Privately Owned Structures

Privately owned structures comprise a diverse range of buildings, including residential and commercial properties, as well as facilities like bathrooms, toilets, safety tanks, taps, water tanks, storage houses, kitchens, animal sheds, dining halls, chicken coops, fishponds, and others. In total 248 privately built structures on titled land are set to be impacted by the project.

Table 7. 17: List of Privately Owned Structure

SN	Structure Type	Numbers
1	Bathroom	5
2	Campfire Place	2
3	Church	1
4	Dining Hall	2
5	Dipping Pool	1
6	Fish Farm	7
7	Generator Place	1
8	House	52
9	House and Commercial	15
10	Kitchen	19
11	Only Commercial House	2
12	Poultry Farm	1
13	Public Structure	7
14	Safety Tank	5
15	Shed	63
16	Store House	5
17	Tap	22
18	Temporary House	1
19	Toilet	31
20	Waiting Room	1
21	Washing Room	1
22	Water Tank	4
	Total	248

Additionally, there are certain land with structures on them that lack formal titles. Among these, 22 non-titled owners have been identified whose structures lie within the project's footprint. These individuals may face unique challenges due to the absence of formal land ownership documentation.

	
Picture: Residential House	Picture: Commercial and Residential House
	
Picture: Water tank	Picture: Toilet
	
Picture: Fish Farm	Picture: Polutry Farm

	
Picture: Animal Shed	Picture: Private Tap

Figure 94: Some of the affected structures

The impact is high in magnitude, site-specific in extent, and long-term in duration.

7.4.1.8 Displacement of Janata Primary School for Tailrace Construction

The construction of the powerhouse complex, particularly the tailrace component, will also have an impact on Shree Janata Primary School located in Gai Ghat, Devghat-3 of Tanahu district. Established in 2046 BS, the school, named Shree Janata Primary School, offers education from Class 1 to Class 5. Currently, the school enrolls 18 students, overseen by a staff of 3 teachers. The school premises span a total area of 0.051 ha and are equipped with essential amenities including classrooms, a computer lab, library, temple, electricity, drinking water, internet access, toilets, and playgrounds. The project's development will necessitate considerations for the school's continuity and well-being, given its role in local education and community life.

Figure 95: Janata Primary School

The displacement of Janata Primary School will compromise access to education for the local population. The school has been serving local students the opportunity to receive primary education at home. Displacing the school will disrupt the convenience and accessibility that the locals are enjoying now. Students and their families will potentially face challenges in accessing alternative educational facilities, which could result in dropout rates.

This displacement underscores the importance of considering alternative solutions and mitigation strategies to ensure that the education needs of the local population are adequately addressed during the construction of the powerhouse complex. The impact will be Moderate in magnitude, site-specific in extent and short-term in duration.

7.4.1.9 Displacement of Shops from Gai Ghat

Construction of the Powerhouse Complex at the Gai Ghat will necessitate the displacement of two local shops owned by the residents. Notably, Gai Ghat holds significant importance as the starting point for Jeep Transportation, drawing a considerable influx of customers, particularly to the shop located near the suspension bridge. These establishments serve as both grocery stores and tea stalls, fulfilling essential local needs.

7.4.1.10 Displacement of the Community Hall of Gai Ghat

The construction of the Powerhouse Complex will involve the removal of the Community Hall situated in the Gai Ghat belonging to Ward No 3, Dev Ghat Municipality. This Hall is located adjoining the Janata Primary School. It has a small building covering an area of about 150 sq m. Currently, the Community Hall is a tin-roofed shed with a stage, and open from 3 sides except on a side with small stage. It also has toilet facilities for Gents and Ladies separately.

Figure 96: Picture of the Community Hall in Gaighat

7.4.1.11 Impacts Associated with transmission of diseases.

The construction of the Tallo Seti (Tanahun) Hydropower Project (TSHPP) is expected to attract a considerable influx of workers and individuals seeking employment opportunities, both directly and indirectly related to the project. While this migration can boost economic activities in the region, it also brings the risk of introducing or increasing the transmission of communicable diseases. The concentration of people in construction sites and nearby areas creates an environment conducive to the spread of diseases due to increased contact and interactions.

One significant concern related to hydropower projects like TSHPP is the formation of vector habitats during construction and possibly even during operation. Vector-borne diseases are transmitted to humans and animals through the bites of infected vectors, such as mosquitoes, ticks, and flies. The modifications made to the environment during construction can lead to the creation of new breeding grounds for these vectors. For example, standing water associated with the reservoir can provide ideal breeding sites for mosquitoes, leading to a potential increase in mosquito-borne diseases like malaria and dengue.

The presence of construction sites and changes to the natural landscape can also facilitate the proliferation of disease vectors. Excavation activities, construction debris, and changes in vegetation can create additional opportunities for vectors to thrive. Moreover, the influx of people from different regions can introduce new strains of diseases, potentially impacting the local population.

During the construction of the hydropower project, external workers will settle in temporary camps located close to existing settlements. This proximity between the incoming workforce and the local communities creates a situation where interactions are likely to occur. However, this interaction also brings the potential risk of increased transmission of communicable diseases between the two groups.

As the external workers arrive from different regions or even countries, they may bring with them infectious diseases that are not endemic to the local area. Additionally, these workers may meet residents, leading to the possibility of disease transmission. In some cases, the external workforce might introduce a new disease to the community that was not previously present in the region. This can happen through direct contact with infected individuals or indirectly through the exchange of contaminated items.

Furthermore, the close interaction between the external workers and the local population can also lead to the spread of more virulent strains of existing diseases. If the external workers carry strains of diseases that are different from those already present in the area, there is a chance that these new strains could mix with the local strains, potentially leading to the emergence of more dangerous and resistant variants.

Moreover, overcrowding and living in close quarters within the worker's camp, along with inadequate hygiene and sanitation facilities, and improper management of solid and liquid waste, can create conditions conducive to the spread of communicable diseases. These factors can lead to an increased prevalence of pests, attracted to improperly stored food and waste, further contributing to disease transmission.

The combination of these factors could have both short-term and long-term impacts on the health and well-being of the community. The temporary influx of workers and the resulting living conditions can lead to immediate health risks, such as outbreaks of infectious diseases. Additionally, the inadequate waste management and pest proliferation may have prolonged effects on public health, with the potential for disease transmission to persist even after the construction phase is completed.

These are the indirect impact of the project. The magnitude of these impact can be high, with local extent, and yet short-term in duration.

7.4.1.12 Impacts on public services and local infrastructures.

The influx of migrant workers and individuals settling in the area in search of employment opportunities with the project or other economic prospects can lead to an increased demand on local services and existing infrastructure. These external arrivals may utilize community facilities such as health facilities, drinking water sources, public toilets, and other essential services available in the area.

As more people come to the region, the existing infrastructure may experience strain and might struggle to meet the increased demands. For instance, local health facilities may face a higher patient load, leading to longer waiting times and potential challenges in providing quality healthcare services. Similarly, the demand for clean drinking water may rise, putting pressure on the existing water supply systems, which could result in water scarcity or decreased water quality.

The increased usage of public toilets and other amenities can also lead to overuse and may require more frequent maintenance and upkeep. Additionally, the surge in population might lead to overcrowding in public spaces and transportation facilities, affecting the overall efficiency and comfort of these services.

The rise in population due to the project might increase demand for services, which can put significant pressure on existing infrastructure and service facilities, potentially overcrowding and inadequate provision of essential services. For instance, if there is an outbreak of communicable diseases, the demand for healthcare services may escalate rapidly, overwhelming healthcare facilities and healthcare professionals. Similarly, an increase in accidents, possibly due to the influx of workers or changes in the local environment, can lead to a higher number of emergency cases requiring immediate medical attention.

Furthermore, according to the estimates, the project is expected to bring in about 1200 people during the construction period. This influx of new residents will necessitate a stable water supply and proper sewage management. During the construction phase, the water supply and sewage requirements are proposed to be met by utilizing nearby Nalas/streams, using gravity flow, and implementing a water treatment plant and overhead storage tanks. The estimated domestic water requirement for everyone is 70 liters per capita per day (lpcd), resulting in a total daily water requirement of 84,000 liters. It is anticipated that approximately 80% of the water supplied will be generated as sewage. Consequently, the total amount of sewage generated is expected to be around 67,200 liters per day. However, during the operation phase, the sources and causes of water will likely differ significantly from the construction phase.

The impact is expected to be direct. The magnitude of the impact is moderate, local in extent and short-term in duration.

7.4.1.13 Occupational health, community health and accidental risks

The construction of hydropower projects is a demanding and intricate undertaking that exposes workers to numerous occupational hazards and risks. Working in dynamic and constantly evolving environments can lead to unexpected dangers. Some of these hazards include working in confined spaces like tunnels, being exposed to blasting during excavation, dealing with unstable slopes, operating heavy machinery that is prone to accidents, exposure to loud noises, polluted air, hazardous chemicals, and other potential risks.

The possible occupational health risks consist of:

- Workers might be exposed to physical hazards such as heavy machinery, electrical equipment, and confined spaces such as tunnels, increasing the risk of injuries or accidents.
- Construction materials, fuels, and other chemicals can expose workers to harmful substances if not handled properly, leading to respiratory issues or other health concerns.
- Continuous exposure to high noise levels and vibrations from machinery can result in hearing impairment and musculoskeletal disorders.
- Repetitive tasks in construction and operation can cause musculoskeletal disorders and ergonomic issues.

The possible community health risks:

- Construction activities can release dust and pollutants into the air and water, potentially affecting the health of locals.
- The project might necessitate the displacement of local, impacting their physical and mental well-being.
- Changes in water flow and standing water from the project could increase the risk of vector-borne diseases like malaria and dengue.
- Increased population due to the project can strain local healthcare facilities and resources.

The possible emergency situations:

- The seismic activities can lead to earthquakes, landslides, and flood, posing a significant threat to the project's infrastructure and the safety of workers and nearby community.
- Machinery failures, construction accidents, or dam breaches can result in emergencies requiring swift and coordinated response plans.
- Inadequate sanitation and living conditions in temporary worker camps could lead to disease outbreak, necessitating immediate medical interventions.

These are the direct impacts of the project, with high magnitude, site-specific in extent and short-term in duration.

7.4.1.14 Gender discrimination and violence against women

Over the course of time, gender status and roles in Nepal have undergone considerable changes. Historically, Nepal was characterized as a patriarchal society, where men held dominant positions in the society. However, significant strides have been made in promoting gender equality and women's rights in the country.

The Constitution of Nepal played pivotal role in advancing gender equality. It guarantees equal rights and opportunities for men and women, acknowledging the importance of gender parity and empowering women in all spheres of life. Moreover, the Constitution reserves a certain percentage of seats for women in Federal, Provincial, and Local Government bodies.

This affirmative action ensures women's participation in decision-making processes at all levels of governance.

Despite the progress, challenges in achieving full gender equality persist, and gender-based discrimination is still observed in some areas. Cultural norms and practices deeply ingrained in society can perpetuate gender disparities, creating obstacles for women, particularly those residing in rural areas, marginalized communities, and indigenous populations like those found in the project area. Some of the gender discrimination that may occur in the project area during the project construction are:

Preference to male workers - The project construction can attract workforce predominantly male workers, a trend that might also be encouraged by the project itself. Since, much of the construction work requires physical strength, the project may prioritize hiring men in its workforce, inadvertently limiting opportunities for women. Additionally, there could be a perception that men are more effective, leading to them receiving full wages for their contributions, while women may receive reduced wages if recruited for project activities.

Gender insensitivity and exclusion of women in the workspace - Addressing gender sensitivity and inclusivity in the project's working environment is important to ensure fair employment opportunities for women. Instances have been observed where the project sites and labor camps lack provisions for women, such as separate toilets and showers. A lack of gender-sensitive facilities not only disregards the dignity and privacy of female workers but also creates barriers to their participation.

Gender-based violence becomes a concerning issue in and around hydropower projects due to the presence of a large male workforce. This situation increases the risk of women and girls facing various forms of violence, including sexual harassment, assault, and exploitation. Factors such as increased alcohol consumption, cultural differences, and inadequate protective mechanisms can contribute to creating an unsafe environment for them.
Factors such as increased alcohol consumption and the mixing of cultures and languages among the diverse workforce can further contribute to an unsafe environment, making women more susceptible violence.

Trafficking - While the project construction can uplift economic opportunities in the project areas, it can also create conditions conducive to trafficking in persons, particularly vulnerable individuals. Women and children are often at a higher risk of being trafficked as they may face greater vulnerabilities. The presence of a large male workforce in the project area can create environment where exploitation and abuse may occur, including instances of sexual harassment, assault and forced labor.

Female-Headed Households' Vulnerability to Displacement - Displacement and resettlement can pose specific challenges for women, especially those in female-headed households. During the resettlement process, women may encounter difficulties, including loss of land tenure, limited access to livelihood opportunities, and increased vulnerability to poverty. These challenges can disproportionately affect women, making it essential to address their specific needs and empower them during the resettlement process to ensure their well-being and long-term sustainability.

The impact is direct, moderate in magnitude, local in extent and short-term in duration.

7.4.1.15 Impacts associated with Nuisances.

The construction of the project is expected to bring about several nuisances impacts on the local communities, particularly in the villages of Sarang Ghat, Masdi, and Gai Ghat, which are located adjecent to the construction sites. As construction activities take place either through or near these villages, residents may experience significant increase in noise levels, vibration, and fugitive dust.

- ***Noise*** generated from construction machinery, equipment, and other activities can be disruptive and cause discomfort for the people living in these areas. The constant presence of heavy machinery and construction activities can lead to prolonged noise exposure, affecting the overall quality of life and creating potential health concerns for the residents.

- ***Vibrations*** resulting from various construction activities including blasting can also be felt in the surrounding areas. These vibrations may affect nearby structures and buildings, potentially leading to concerns about structural integrity and safety for the residents.

- ***Fugitive dust***, a type of airborne particulate matter released during construction, can become a major concern for the local communities. It can cause respiratory issues and exacerbate existing health conditions, especially for vulnerable populations such as children, elderly, and those with pre-existing respiratory problems.

The villages of Saran Ghat, Masdi, and Gai Ghat, being near the construction activities, are likely to bear the brunt of these nuisance impacts. It is crucial for the project authorities to take measures to mitigate these impacts and ensure the well-being and comfort of the affected communities. Implementing effective dust control measures, managing construction schedules to minimize noise during sensitive hours, and adhering to appropriate guidelines can help address these nuisance impacts and foster a more harmonious coexistence between the project and the locals. Effective communication and engagement with the communities can also play a crucial role in understanding their concerns and incorporating their feedback to minimize the disruptions caused by construction activities.

The impact is direct, high in magnitude, local in extent and short-term in duration.

7.4.1.16 Cultural Heritages

A social and cultural baseline survey was conducted to assess the presence of potential cultural heritage sites within the project footprint area. The survey results indicated that no cultural heritage sites were identified in the project footprint area.

However, it is essential to remain vigilant during the construction phase, as activities like ground clearance and excavation works will be frequent. There is a possibility of discovering previously unknown materials with cultural heritage significance, such as grave sites, archaeological artifacts, and other historical remnants.

While the immediate impact on cultural heritage is considered low during the construction phase, it is crucial to acknowledge that the potential impact on cultural heritage may become more relevant during the operation phase. The implications related to cultural heritage during the operation phase will be discussed in the next section. As the project progresses, ongoing monitoring and adherence to cultural heritage preservation protocols will be important to safeguard any cultural heritage that might be discovered or impacted during the construction and operation of the project.

7.4.2 Operation Phase

7.4.2.1 Impacts on Built-up structures and infrastructures

During the operation phase, the creation of reservoir will inundate various private and community structures.

7.4.2.1.1 Private Structure

The reservoir will inundate a total of 157.45 ha (14.23 ha private) of land accounting for 128 land parcels. Within this reservoir, various private lands and structures within these lands will be inundated. Land parcels of 116 HHs will be inundated by the reservoir.

The reservoir will inundate the currently existing Care & Downey resort. The total area that will be inundated is 0.96 ha of land comprising of 30 parcels.

Furthermore, a reservoir buffer of 3meters will be acquired which will require additional area of 23.95 ha of land oweing to 168 parcels.

7.4.2.1.2 Cultural and religious structure – Cremation Site and Temples

In the designated project area, several riverside cremation sites, referred to as ghats, have been documented. These ghats, including notable ones like Masdighat, Mayagaun, Khahare Tar/Kahare Ghat, Nalbung, Lungri, Dagara, Koithim, Benikot, Rumse, Harkapur, Najung, Govantal, Solang, and Kharibhitta, hold significant importance for the local community as sites where cremation ceremonies are commonly conducted.

Through the fieldwork process, the investigative team was able to validate that these ghats remain unadorned by any constructed edifices. This serves to underscore their central function as spaces exclusively designated for the performance of cremation rituals along the river's edge. The absence of man-made structures at these ghats accentuates their profound purpose, highlighting their role as solemn locations woven into the fabric of the local community's cultural and spiritual practices.

The creation of the reservoir brings about a transformation in the landscape, leading to the water level encroaching upon the vicinity of certain temples. These temples, constructed adjacent to the cliffs that line the riverbank, have evolved as integral elements of the cultural and spiritual tapestry of the area. Among these significant structures, a careful assessment conducted as part of the study pinpointed three specific temples that will bear the consequences of the project's impact.

Figure 97: One of the cremation sites in the project area

Namely, the temples identified are the Saraswati Temple, Nam Devi Temple, the Jhakrithan Temple, and the Gorkha Kalika Temple. Situated in close proximity to the area that will experience inundation, these temples occupy a zone that is poised to be indirectly affected by the impending changes. The ramifications of this impact are primarily centered on the accessibility of these temples for the local population.

Figure 98: Saraswoti temple to be impacted indirectly by project

The temples' positioning along the cliffs exemplifies their historical alignment with the riverbank, further underscoring their historical and spiritual significance. The impending increase in water levels due to the reservoir formation introduces a complex scenario where these temples, although not submerged, will nonetheless find themselves in close quarters with the changing aquatic environment.

As a result, the accessibility of these temples, crucial for the community's spiritual practices and connections, is expected to be indirectly influenced. Pilgrims, devotees, and visitors who have historically frequented these temples might face challenges in reaching them due to the changing landscape and potential alterations in the route.

It is within this context that the potential impact on these temples assumes importance. Preserving not only the structural integrity but also the cultural and religious value of these temples demands thoughtful consideration and mitigation efforts that go beyond the physical alterations in the environment.

Table 7. 18: Ghats and temples affected by the project (Baseline Survey 2022, EIA Study)

SN	Project component	Cultural and religious structure
1.	Reservoir	All the cremation sites in the reservoir stretch

2.	Fringes of the reservoir	Nam Devi temple Jhakrithan temple Gorkha Kalika temple

7.4.2.1.3 Inundation of the Motorable Road

Buddha Singh Marga serves as a vital motorable road that connects the project area with the Damauli Bazar. This road is yet to be the road spans 24 km, starting from Damauli Bazar and extending to Ghumaune on the right bank of the Trishuli River. A bridge was planned over the Trishuli River, and construction commenced, though it is yet to be completed. Once finished, this bridge would have provided a direct connection between the project area and the Tribhuwan Highway, significantly reducing travel time, and enhancing accessibility to the project area, and Damauli. At present, there exists a suspension bridge at this location, serving as a crossing point for locals on foot and motorcycles to traverse the river.

The road has been playing a significant role in facilitating the transportation of goods and people of the project area. Locals are utilizing this road on their motorcycles to access the Tribhuwan Highway across the Trishuli River, which provides connection to Bharatpur, Chitwan, and Kathmandu. Additionally, adjoining settlements of Bandipur, Rishing, Vyas, Devghat, and Aanbu Khaireni are linked to Buddha Singh Marga though connecting roads. This extensive network facilitated by the Buddha Singh Marga has made it a crucial lifeline for the local communities, allowing them to access essential resources, services, and market from the surrounding areas.

The construction of the Buddha Singh Marga remains incomplete, as it lacks essential elements that would make it an all-weather road. Although the alignment appears to be established, crucial ancillary structures, including bridges, culverts, road drains, shoulders, and most importantly, bitumen application to the road surface, have not been implemented. As a result, the road’s service gets disrupted during the rainy season, making it impassable and unsuitable for use.

The projected extent of inundation is substantial, with a total of 7.28 km of the Buddha Sing Marga is expected to be submerged. It is important to note that while the reservoir won’t significantly raise the water level along the river valley, the road will still be affected at multiple points, totaling 7.28 km. The road, in fact, frequently descends close to the Seti River at several location, making it susceptible to floodings. These vulnerable sections are the ones expected to be submerged by the reservoir. To mitigate the impact, it becomes crucial to reroute these portions of the road to higher ground. Additionally, implementing flood protection structures can provide further safeguarding.

Given the road’s high significance and the need to ensure uninterrupted access, the project must take necessary measures to prevent any disruptions. This may involve careful planning and engineering to reroute vulnerable sections, fortifying flood protection measures, and incorporating resilient infrastructure to maintain the road’s functionality despite the reservoir’s presence. By proactively addressing these challenges, the project can secure a reliable and accessible transportation route for the benefit of the locals as well as for the project itself as well.

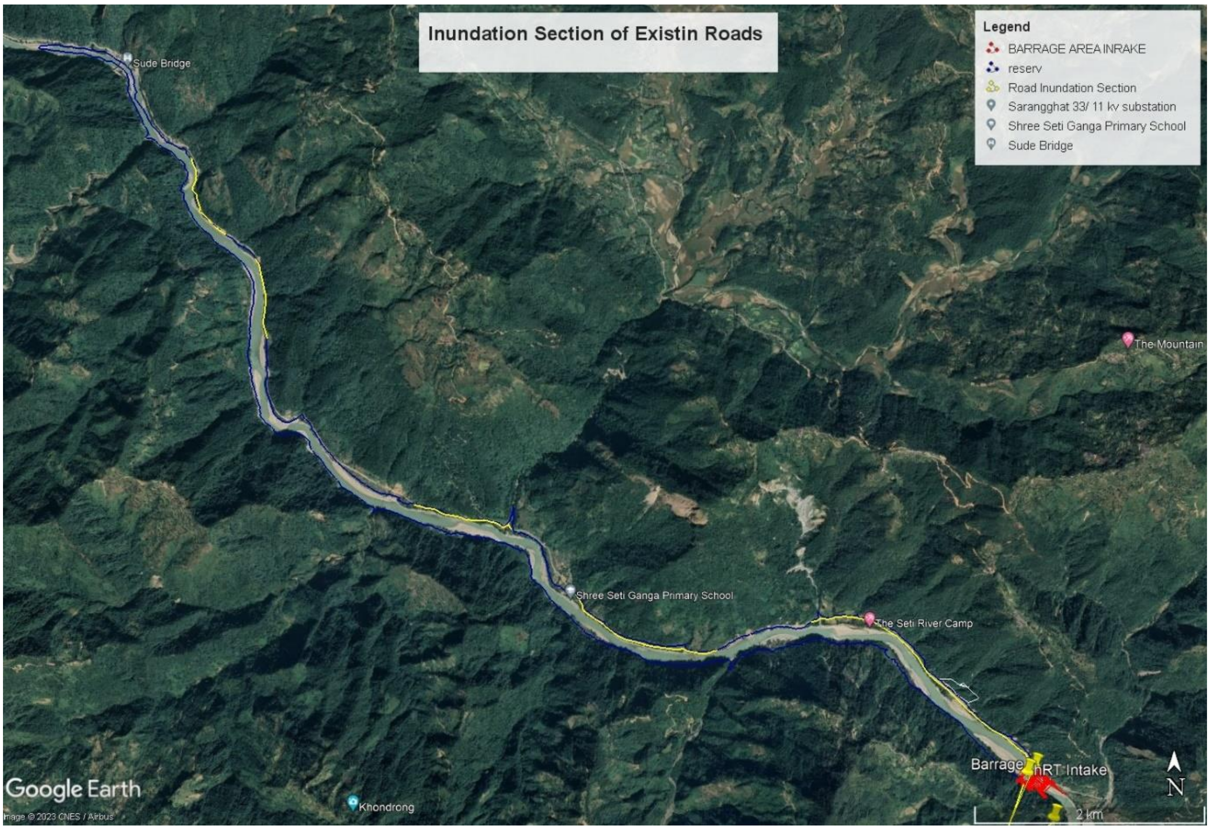


Figure 99: Location of inundated roads due to the reservoir.

The impact is expected to be "high" as will result in disconnection a large population from the project area. This is expected to be "local" extend as its consequences will be felt by entire population living in the project area and beyond. The duration will be "long-term" as the reservoir will remain permanently once filled.

7.4.2.2 Suspension Bridge

The inundation of suspension bridges is expected to have a profound impact on the daily lives of the local communities residing on both sides of the Seti River. These suspension bridges play a crucial role in facilitating transportation and communication, serving as lifelines for the locals. Consequently, their submergence due to the reservoir's filling would pose significant challenges to the communities' mobility and connectivity.

One of the affected bridges is the suspension bridge located next to the Shree Seti ganga Primary School, which serves as a vital link between Bandipur-6 and Devghat-3. This bridge is an essential conduit for the locals, providing them with access to educational facilities, health services, markets, and other amenities available in both settlements.

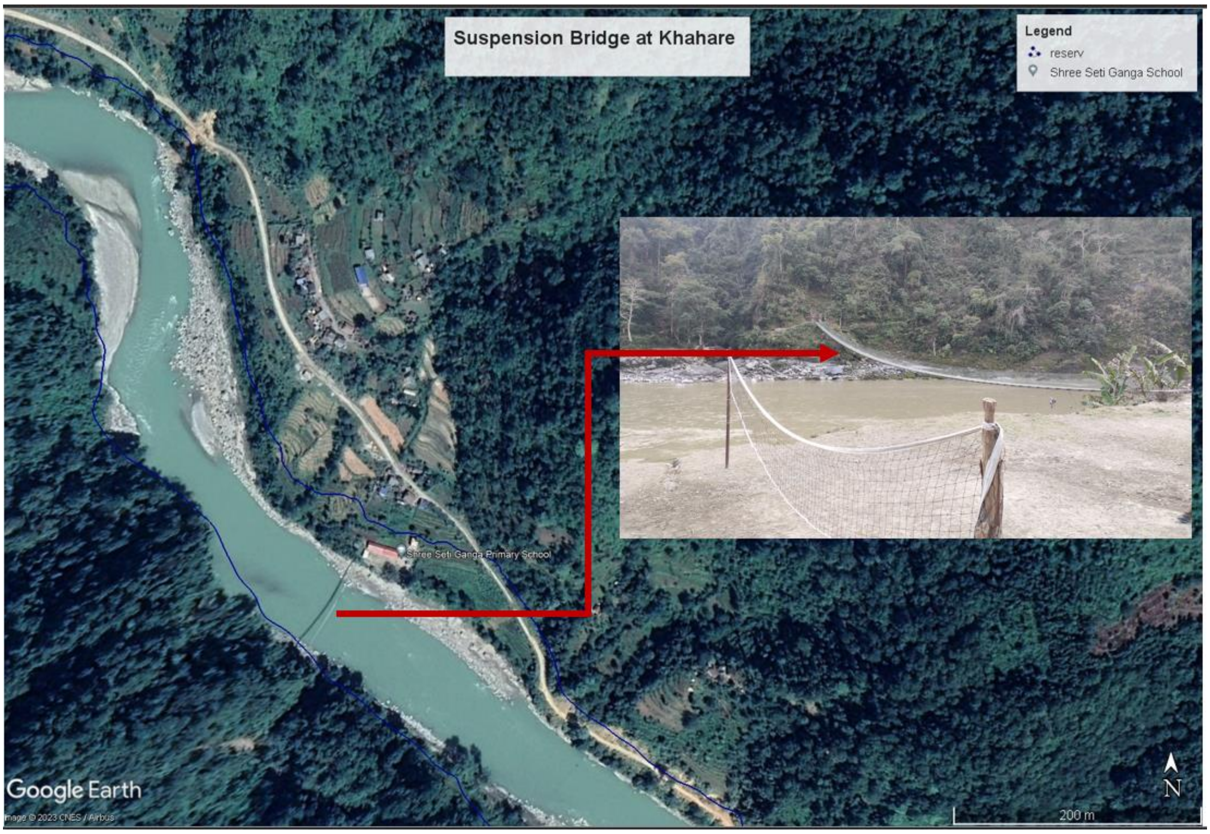


Figure 100: Suspension Bridge at Khahare, bandipur-6

7.4.2.3 Inundation of a school

The formation of reservoir will lead to submersion of the school – Shree Seti Ganga Basic School – located at Kharaetar, Bandipur – 6. This school was established in 2044 BS, catering to students from Playgroup to Class 8. Currently the school has a total of 72 students. The Teaching staff comprises of total of 13 teachers, with 4 being employed from private sources.

The school's premises spans 0.07 ha and include classrooms, a computer lab, toilets, a playground, drinking water, electricity, and internet connectivity for students.

Figure 101: Affected School Building

The impact is direct, high in magnitude, local in extent and long term in duration.

7.4.2.4 Compromise in the River Use

The project operation will include the creation of a 12.7 km long reservoir upstream of the barrage, which will affect the condition of the river in this area. One of the primary effects will be the conversion of the flowing water into a stagnant body of water for much of the year. Unlike the natural flow of the river, which varies with seasons and weather, the reservoir will hold a relatively constant water level, resulting in stagnant conditions. One of the prominent changes that may be observed in change in water quality as the river gradually converts into the lacustrine ecosystem.

Similarly, diverting the river flow from the reservoir to the powerhouse will have impact downstream of the barrage as well. It will result in a reduction or potential stoppage of water flow downstream of the barrage up to the S/T confluence. This effect will be more pronounced during the dry season, when the water needs to be stored in the reservoir. As a result, the natural flow conditions in this section of the Seti River will be significantly altered. Similarly, the Trishuli River stretch between the S/T confluence and the tailrace outlet from the powerhouse will also be affected, but the impact will be less significant compared to the Seti River upstream of the S/T confluence. This is because the Trishuli River is a larger river with a substantial discharge, which partially compensates for the reduced contribution from the Seti River.

The change in the river flow is expected to impact the water use at different sections of the river in different ways, some of which are discussed below:

7.4.2.4.1 Water supply and irrigation potential will be compromised

The reduced discharge stretch of the Seti River and the changes in water flow pattern may have implications for the water supply. Currently in this stretch, neither water supply scheme nor irrigation scheme exists, thus, no impact is expected at this moment. However, the potential use of water for these purposes in the future will be compromised.

7.4.2.4.2 Fishing in the river

The project area, particularly at Sarang Ghat and Gai Ghat, is home to the Majhi and Bote Communities. Historically, these communities provided river crossing services to the locals when bridges were not available, but these practices have ceased in recent times. Additionally, fishing has been a significant livelihood activity for these communities, although it has undergone changes over the years. At present, the current Bote and Majhi communities are partially engaged in agriculture, labor work, and business, with fishing serving as a supplementary occupation. Moreover, other communities from the project were also found to engage in fishing, either for recreation or as a supplementary source of income.

The project implementation is anticipated to have a notable impact on fishing activities in both the reservoir and the reduced flow stretch of the river. The reduced water flow in the stretch can disrupt fish migration due to limited discharge available in this section. Additionally, the construction of the barrage will act as an obstacle for fish trying to migrate

upstream into the reservoir area, further affecting fish populations. As a result, the overall fish population is expected to decrease significantly.
In the reservoir, the conditions will change into a lacustrine ecosystem, which may not be conducive to the survival of freshwater fish species, even if they manage to cross the barrier of the barrage. Consequently, the reservoir's environment will not support the same variety of fish as the natural river stretch did before the project.

The combination of these impacts on both the reservoir and the reduced flow stretch will significantly influence fishing practices in the area. The changes in fishing opportunities and the transformation of the river ecosystem will also have social and economic implications for the communities reliant on fishing for their livelihoods.

7.4.2.4.3 Cultural and Religious Practices

The Seti River holds significant cultural and religious value for several ethnic groups in the region. The river is used for various cultural ceremonies, religious rituals, and cremations. The regulation of water flow can impact the accessibility and suitability of the river for these practices, potentially affecting the cultural heritage and spiritual significance of the river to local communities.

7.4.2.4.4 Rafting and Tourism

Rafting is a major recreational activity in the Seti River, attracting tourists and contributing to the local economy. The changes in flow conditions, particularly the creation of low flow downstream of the dam, can have a significant impact on commercial rafting activities. The reduced water flow may affect the quality and feasibility of rafting experiences, potentially leading to economic consequences for the tourism sector. A privately owned resort "Care and Downey" is running the rafting activities in the Seti river.

The impacts are direct in nature, high in magnitude, local in extent, and long-term in duration.

7.4.2.5 Decline in economic activities raised in construction phase

Upon the completion of the construction phase, the demand for a large workforce, heavy machinery, and construction-related services may diminish as the focus of the hydropower project shifts to electricity generation and distribution. The operational phase brings forth different economic activities, potentially leading to a decline in employment opportunities and the previous construction-related economic activities.
During the construction phase, there might have been a reliance on local resources like construction materials and transportation services. However, once the construction is finalized, the demand for these resources may decrease significantly.

It is essential to recognize that while there might be a decline in economic activities associated with the construction phase, the operational phase of the hydropower project can present new economic opportunities. These opportunities may include maintenance and monitoring services, tourism related to the project site, and other revenue-generating activities.

The shift from construction to operation marks a transition in the economic landscape, and it is crucial for local communities and stakeholders to adapt and explore the potential benefits that arise during the operational phase. Developing a sustainable approach to harnessing these opportunities can foster long-term economic growth and community development in the region. By effectively managing the transition and identifying new economic avenues, the hydropower project can continue to contribute positively to the local economy and livelihoods even after the construction phase has been completed.

The impact is direct in nature, high in magnitude, local in extent and long term in duration.

7.4.2.6 Impacts on Ecosystem services

The project implementation will result in the compromise of ecosystem services, and a significant aspect is the potential loss of forest resources that have long been managed and utilized by the Community Forest User Groups (CFUGs). These CFUGs have played a crucial role in managing these forested areas, ensuring sustainable resource utilization, and benefiting the local communities. The loss of these resources could have far-reaching consequences.

The details of community and leasehold forest are provided in table below.

Table 7. 19: Details of community and leasehold forest impacted by project

S. N	Name of CF/LF	Address	H H No	Female Population	Male Population	Total Population	Area
1	Rumsi CF		NA	NA	NA	NA	NA
2	Kocho CF	Rhising-1	55	165	166	331	154.41
3	Harkapur		NA	NA	NA	NA	NA
4	Bhoyeri		NA	NA	NA	NA	NA
5	Chap Danda		NA	NA	NA	NA	NA
6	Benikot		NA	NA	NA	NA	NA
7	Sidhhadhani	Bandipur-6	109	296	302	518	315.45
8	Bagarkhola		NA	NA	NA	NA	NA
9	Todke		NA	NA	NA	NA	NA
10	Solung	Rhising-3	74	330	337	667	176.59
11	Koidim CF	Rhising - 1	83	242	228	470	327.1
12	Janahit	Devghat-4	97	310	332	642	152.25
13	Sirchuli	Devghat-3	52	217	206	423	280.73
14	Manakamana	Devghat-3	49	163	208	371	180

S. N	Name of CF/LF	Address	H H No	Female Population	Male Population	Total Population	Area
15	Chuiri Bhanjyang	Devghat-2	26	106	111	217	70.67
16	Ghisitol	Devghat-4	NA	22	24	46	4.50 Ha
17	Gotheri LF	Devghat-4	NA	30	31	61	4.25 Ha
18	Beldanda	Devghat-4	NA	39	60	99	7.15 ha
19	Chidepani	Devghat-4	NA	38	37	75	9.2 Ha
20	Kanera	Devghat-4	NA	31	38	69	6.2 Ha

The impact will be direct in nature, Moderate in magnitude, local in extent and long-term in duration.

7.4.2.7 Impact of sudden water release downstream of the barrage on safety of people

The design team has considered an ecological flow of 4.65 m^3/s, which amounts to 10% of the minimum monthly flow. Consequently, during operation, the project will release 10% of water into the dewatered zone. However, in case of project shutdown or sudden increases in river water, there could be an abrupt release of water from the weir gate or spillway. This sudden and rapid release may generate strong currents and unpredictable water flow patterns downstream, posing risks to individuals residing or working near the water bodies. Activities such as swimming, fishing, or engaging in recreational pursuits in the affected area could become particularly hazardous.

Moreover, the sudden release of water can have adverse effects on the natural ecosystem. It may disturb the habitats of wildlife downstream, leading to displacement and potential disruption of nesting areas, breeding grounds, and feeding sites. Additionally, the rapid rise in water levels can stir up sediments, pollutants, and other substances present in the riverbed, resulting in a degradation of water quality downstream.

These potential consequences highlight the importance of implementing proper measures to manage water releases and ensure the safety of both people and wildlife in the area. Careful planning, monitoring, and adherence to environmental protocols can help mitigate the impacts of sudden water releases and safeguard the well-being of the local ecosystem and communities.

This impact will be of direct, low in magnitude, local in extent and short-term in duration.

Table 7. 20: Impact Matrix

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	Magnitude	Extent	Duration	Total	Total Score/Significance
Construction Phase									
Physio-Chemical Environment									
C1	Construction of Barrage, Camps, Powerhouse & roads. Excavation, Earthworks & Blasting	Project Sites	Land use Change	D	M (20)	L (20)	LT (20)	60	Moderately Significant
C2	Excavation, tunneling and modification of existing terrain	Project SItes	Land Instability	D	M (20)	SS (10)	ST (05)	35	Low Significance
C3	Excavation activities, land clearing, earthmoving operations, spillage of oils and chemicals, release of solid and liquid wastes into river	Construction sites and labor camps	River water quality	D	H (60)	L (20)	ST (05)	85	Highly Significant
C4	Tunnel excavation, Blasting	HRT	Drying of Spring Sources	D	L (10)	SS (10)	ST (05)	25	Low Significant
C5	Exavation, Earthmoving, Transportation, Blasting, Operation of machinary	Openings of tunnels, Roads, Construction sites	Deteroriation of air quality	D	H (60)	L (20)	ST (05)	85	Highly Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	Magnitude	Extent	Duration	Total	Total Score/Significance
C6	Camp activities, Construction works, Excavation, Use of machines	Camps & Disposal Sites	Generation of Solid waste	D	H (60)	SS (10)	ST (05)	75	Highly Significant
C7	Excavation, Construction, Blasting, Transportation Machinary, Night-shifts	Roads, Tunnels and other Construction Areas/Sites	Noise, Vibration and Light Pollution	I	M (20)	SS (10)	ST (05)	35	Low Significant
Biological Environment									
Forest									
C8	Clearance of vegetation	Project Sites	Loss of forest (Community and Leasehold)	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
C9			Loss of plant biodiversity	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
C10			Loss of NTFPs and plants with ethno-botanical importance	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
C11			Threat to plant species with conservation significance	D	H (60)	SS (10)	LT (20)	90	Highly Significant
C12		Project Sites	Loss of government managed and community forests	D	H (60)	SS (10)	LT (20)	90	Highly Significant
C13		Forest areas near Labor camps	Illegal harvesting of timber and firewood	I	M (20)	L (20)	ST (05)	45	Moderately Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi.	Magnitude	Extent	Duration	Total	Total Score/Significance
C14	Improved forest accessibility to workers and locals		Increased risk of forest fire	I	L (10)	L (20)	ST (05)	35	Insignificant
	Wildlife								
C15	Vegetation removal, Blasting, Excavation, Disposal of Muck and Spoils	Project sites	Habitat loss and degradation	D	M (20)	L (20)	LT (20)	60	Moderately Significant
C16	Movement of heavy vehicles, high noise levels, surge in human activities	Project sites	Disturbance on movement of wildlife	D	L (10)	L (20)	ST (05)	35	Low Significant
C17	Improved access for labours, population influx	Project Sites	Illegal hunting and wanton killing	D	L (10)	L (20)	ST (05)	35	Low Significant
C18	Establishment of camp sites and influx of workers	Project Camp Sites	Impact of waste and pollution on wildlife	D	M (20)	SS (10)	ST (05)	35	Low significant
C19	Population influx, Migrant workers, Improved forest access	Project sites	Illegal trade for wildlife trophy	D	L (10)	SS (10)	ST (05)	25	Low significant
	Avifauna								
C20	Removal of trees and vegetation	Project Sites	Habitat loss and habitat fragmentation	D	H (60)	L (20)	LT (20)	100	Highly Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	Magnitude	Extent	Duration	Total	Total Score/Significance
C21	Transporting construction materials, operating equipments, vehicular movement	Project sites	Disorientation and displacement of avifauna	D	H (60)	L (20)	ST (05)	85	Highly Significant
C22	Increased turbidity of river due to construction activities	Seti river	Reduced food availability	I	M (20)	L (20)	ST (05)	45	Moderatelyt significant
Aquatic Life									
C23	River diversion for building barrage	Barrage area	Obstacle to fish migration	D	H (60)	R (60)	LT (20)	140	Highly Significant
C24	Construction activities such as river diversion, excavation works, mining, tunnel excavation	Project sites	Loss of riparian habitat, soil erosion and sediment deposition	D	L (10)	L (20)	ST (05)	35	Low significant
C25	River diversion for building barrage	Barrage area	Fish Stranding	D	L (10)	SS (10)	ST (05)	25	Low significant
C25			Fishing of stranded fish by workforce and locals	D	L (10)	SS (10)	ST (05)	25	Low significant
Socio-economic Environment									
C27	Construction of permanent project components	Project area	Permanent acquisition of land	D	H (60)	SS (10)	LT (20)	90	Highly Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	Magnitude	Extent	Duration	Total	Total Score/Significance
C28	Construction of temporary project components	Project area	Temporary acquisition of land	D	H (60)	SS (10)	ST (05)	75	Moderately Significant
C29	Construction of project components	Project area	Acquisiton and displacement of HHs	D	H (60)	SS (10)	LT (20)	90	Highly Significant
C30	Acquisiton of agricultural lands	Private land pacels	Loss of standing crops and agricultural productivity	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
C31	Project construction	Overall project area	Project inducted in-migration	D	M (20)	L (20)	ST (05)	45	Moderately Significant
C32	Land acquisition for construction	Overall project area	Acquisition of privately owned structures	D	H (60)	SS (10)	LT (20)	90	Highly Significant
C33	Construction of PH complex	PH area	Displacement of Janata Primary School	D	M (20)	SS (10)	ST (05)	35	Low Significant
C34	Population influx, formation of vector habitats, closed labor camps	Project area	Transmission of diseases	I	H (60)	L (20)	ST (05)	85	High Significant
C35	Population influx	Project area	Impacts on public services and local infrastructres	D	M (20)	L (20)	ST (05)	45	Moderately Significant
C36	Working condition, exposure to work hazards	Project construction sites	Occupational health, community health, and accidential risks	D	H (60)	SS (10)	ST (05)	75	Moderately Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact: Direct/Indi.	Magnitude	Extent	Duration	Total	Total Score/Significance
C37	Employment of workers of different cultural background	Project area	Gender discrimination and violence against women	D	M (20)	L (20)	ST (05)	45	Moderately Significant
C38	Construction works around settlements	Project construction sites	Impacts associated with Nuisances	D	H (60)	L (20)	ST (05)	85	Highly Significant
Operation Phase									
Physio-chemical Environment									
O1	Formation of Reservoir	Reservoir area	Land Use Change	D	M (20)	L (20)	LT (20)	60	Moderately Significant
O2	Operation of Barrage	All project area	Sediment Deposition U/S of reservoir	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
O3	Flactuation in Water level of reservior	Reservoir area	Slope Instability around reservoir	I	M (20)	SS (10)	LT (20)	50	Moderately Significant
O4	Operation of Barrage	Dewatered section of seti river	Environmental Flow	D	H (60)	L (20)	LT (20)	100	High Significant
O5	Tailrace releases	Downstream of Tailrace	Impact of Hydropeaking	D	L (10)	L (20)	LT (20)	50	Moderately Significant
Biological Environment									
	Forest								
O6	Improved access to nearby forests	Forests near project sites	Impact on forest area	I	M (20)	L (20)	LT (20)	60	Moderately Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	Magnitude	Extent	Duration	Total	Total Score/Significance
O7			Impact on vegetation of conservation significance	I	M (20)	L (20)	LT (20)	60	Moderately Significant
	Wildlife								
O8	Surge in human activities, lighting in project areas, Creation of reservoir	Project sites and reservoir	Disturbances to wildlife	D	H (60)	L (20)	LT (20)	100	Highly significant
O9	Formation of reservoir, Dewater zone	Reservoir and dewatered zone	Habitat loss and degradation	D	M (20)	SS (10)	LT (20)	50	Moderately Significant
O10	Increased mobility in the project area, enhanced road access	Project sites	Illegal hunting of the wildlife	D	L (10)	SS (10)	LT (20)	40	Low significant
	Avifauna								
O11	Formation of reservoir, sudden release of water from tailrace	Reservoir and D/S of tailrace	Mortality of eggs and nesting	D	L (10)	L (20)	LT (20)	50	Moderately significant
O12	Formation of reservoir	Reservoir	Reservoir filling on bird population	D	H (60)	L (20)	LT (20)	100	Highly Significant
O14	Formation of reduced water zone	Dewatered section of seti river	Reduced food availability	I	M (20)	L (20)	LT (20)	60	Moderately Significant
	Aquatic life								
O14	Construction of Barrage	Reservoir area	Sediment deposition in the reservoir	D	H (60)	L (20)	LT (20)	100	Highly Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi.	Magnitude	Extent	Duration	Total	Total Score/Significance
O15		Dewatered section of seti river	Prevented sediment transport in the reduced water zone	D	M (20)	L (20)	LT (20)	60	Moderately Significant
O16	Formation of reservoir	Reservoir area	Changes in reservoir condition	D	H (60)	L (20)	LT (20)	100	Highly Significant
O17	Construction of Barrage	Dewatered section of seti river	Changes in reduced discharge stretch of the river	D	H (60)	R (60)	LT (20)	140	Highly Significant
O18	Formation of Reservoir	Reservoir area	Loss and degradation of spawning grounds	D	H (60)	R (60)	LT (20)	140	Highly Significant
O19	Construction of Barrage	Seti river	Migration barrier	D	H (60)	R (60)	LT (20)	140	Highly Significant
O20	Operation of Barrage and HRT and PH	Barrage, PH	Fish entrained or impinged	D	L (10)	L (20)	LT (20)	50	Moderately Significant
O21	Project operation	All project area	Cumulative impact of water diversion projects	D/I	H (60)	R (60)	LT (20)	140	Highly Significant
	Socio-economic Environment								
O22	Operation of project	All project area	Impact on Bulit-up structures and infrastructures	D	H (60)	L (20)	LT (20)	100	Highly Significant
O23	Creation of reservoir and dewatered section	Seti river	Compromise in river use	D	H (60)	L (20)	LT (20)	100	Highly Significant
O24	End of construction phase and start of project operation	All project area	Decline in economic activities raised in construction phase	D	H (60)	L (20)	LT (20)	100	Highly Significant

SN	Project Activity	Project Location	Potential Impact	Type of Impact					
				Direct/Indi	**Magnitude**	**Extent**	**Duration**	**Total**	**Total Score/Significance**
O25	Operation of project	All project area	Impacts on ecosystem services	D	M (20)	L (20)	LT (20)	60	Moderately Significant
O26	Downstream releases from the barrage	D/S of the barrage	Impact of sudden water release downstream of the barrage on safety of people	D	L (10)	L (20)	ST (05)	35	Low significance

Magnitude	Extent	Duration
High/Major = 60	Regional = 60	Long Term = 20
Moderate = 20	Local = 20	Medium Term = 10
Low = 10	Site specific =10	Short Term = 05

A sum of the impact values for magnitude, extent, duration provides a maximum of 140 and a minimum of 25

Above 75	= High Significant
Between 45 - 75	= Moderately Significant
Below 45	= Low or Insignificant

8 Mitigation and Enhancement Measure

8.1 Physical Environment – Construction phase

8.1.1 Mitigation for land use change

Mitigation for land use change is an essential aspect of the project implementation. As highlighted in the impact assessment chapter, section 7.2.1.1, the project involves both permanent and temporary land use changes to establish its structures and components, such as reservoir, dams, powerhouse, surge tank, adit sites, roads, and permanent camps. However, certain project activities will require land temporarily only during the construction phase, such as disposal sites, quarries, temporary camps, and others.

To address the potential adverse impacts on land use, the project will adopt 3 mitigation principles:

8.1.1.1 Minimize land use change and ensure environmental integrity of the sites:

The project will strictly limit construction activities within designated sites by creating discrete compound walls around these areas, ensuring that project works do not spill over.

Sites used by the project, whether temporarily or permanently, will be utilized without compromising their integrity. Measures will be taken to prevent pollution, soil degradations, preservation of topsoil, minimal vegetation removal, and maintenance of slope stability, which can include but not limited to:

- ***Erosion and sediment control*** – implement erosion control measures such as silt fences, sediment basins, and erosion-resistant covers to prevent soil erosion and sediment run-off from the construction sites.
- ***Stormwater management*** – design and construct proper stormwater management systems to collect and treat run-off from construction activities, preventing the discharge of pollutants into nearby water bodies.
- ***Construction site layout*** – Optimize the layout of the construction site to minimize disturbance to natural terrain and vegetation. Avoid steep slopes.
- ***Soil stabilization*** – use appropriate stabilization techniques such as mulching, seeding, or geotextiles to prevent soil erosion and maintain soil structure.
- ***Vegetation protection*** – establish buffer zones and protective barriers around existing vegetation to minimize removal and damage. Replant vegetation in disturbed areas after construction in completed.
- ***Waste management*** – implement a comprehensive waste management plan to handle construction debris, chemicals, and hazardous materials responsibly, reducing the risk of pollution.
- ***Regular inspections*** – conduct regular inspections of the construction sites to ensure that pollution prevention measures are implemented effectively.
- ***Preserving the topsoil*** – The topsoil is a valuable resource, especially when the construction site is situated in cultivated lands. To ensure its preservation, the topsoil

shall be carefully removed from the site and stored for future use. This stored topsoil can then be utilized for the rehabilitation of the construction site.

8.1.1.2 Compensate land use change

The project also must permanently acquire lands for its permanent structures as discussed above. These changes in land cover and use cannot be avoided, and these are the residual impact. Compensation for these losses, therefore, becomes inevitable. The just compensations shall be provided for the loss of this lands.

- In case the land is private property, compensation shall be provided to the landowners. However, in some cases, though local HHs are using the land though they do not possess legal ownership over the land – nontitle holders. However, the project should find a solution through the discussion in the “Compensation Fixation Committee (discussed in social mitigation measures section of this report)” to provide compensation to these HHs so that their livelihoods are not compromised. This issue was heatedly debated at the Public Hearing.
- Lastly, if the land belongs to the Government, primarily the forested lands, the use of the land and land area itself shall also be compensated. This is discussed in detail in the section of mitigating forest resources of this report.

8.1.1.3 Restoration of land use change

The project will have to ensure that the sites used by the project during the construction phase, particularly the ones used on temporary basis, are rehabilitated. The rehabilitation shall be carried out to bring the condition of the sites to the previous level, and/or better condition. The measures for site rehabilitation might include but not limited to are:

- Erosion Control and Revegetation: Implement erosion control measures such as terracing, mulching, and erosion control blankets to stabilize the soil. Introduce native plant species to revegetate the site, which helps prevent further erosion and restores the ecological balance.
- Soil Amendments: Use soil amendments like organic matter, compost, or green manure to improve soil fertility and structure. This helps in the re-establishment of healthy vegetation. The topsoil that was stored could be reapplied to ensure soil fertility.
- Reforestation and Afforestation: If the construction led to deforestation, initiate reforestation programs by planting trees and afforestation to establish new forest areas, promoting biodiversity and reducing soil erosion.
- Wetland Restoration: If wetlands were affected, restore them to their original condition by removing fill material, re-establishing wetland vegetation, and promoting appropriate hydrology.
- Stormwater Management: Implement effective stormwater management systems to control runoff and prevent sediment and pollutants from entering nearby water bodies.
- Habitat Restoration: Identify and restore habitats for local wildlife, including the establishment of wildlife corridors to promote ecological connectivity.
- Removal of Temporary Structures: Ensure that any temporary structures or facilities used during construction are removed, and the land is rehabilitated to its original state.

- Monitoring and Maintenance: Conduct regular monitoring to assess the success of rehabilitation efforts and ensure that the restored sites continue to thrive. Perform ongoing maintenance to address any issues and prevent deterioration.
- Invasive Species Control: If invasive plant species have colonized the site, implement measures to control and remove them to promote the growth of native vegetation.
- Contouring and Grading: Adjust the topography of the site through contouring and grading to restore natural drainage patterns and prevent erosion.

By combining these methods and tailoring them to the specific conditions of the construction site, the rehabilitation process can be effective in restoring the ecosystem's health and promoting sustainability in the area surrounding the hydropower project.

8.1.2 Slope stabilization and erosion control

Ensuring the stability and integrity of slopes around the reservoir and immediate catchment area is of utmost importance for human safety, maintaining the stability of upland land-use, and mitigation potential landslides. Given the substantial investment involved in constructing a hydroelectric project, the project's longevity relies on securing slopes, minimizing erosion, and preventing landslides to the best possible extent.

All efforts made to secure slopes and construct various project facilities, including rig areas, roads, and labor camps, directly or indirectly contribute to the conservation of natural resources and arable lands in the project's vicinity. This, in turn, enhances the well-being of local communities. Moreover, conserving the immediate catchment area plays a significant role in stabilizing watersheds and maintaining the overall ecosystem functioning.

The geological investigations on slope stability and risk assessments recommend detailed mitigation techniques for the high-risk slopes. The various mitigation techniques to be considered for the slope reinforcement which are summarized in the following table, which can be divided into 4 main categories: (a) modification of slope geometry, (b) drainage, (c) retaining structures, and (d) internal slope reinforcement.

Modification of slope geometry Modification of slope geometry is a crucial slope reinforcement technique aimed at reducing the risk of landslides and improving overall stability. Here is an elaboration on each of the mentioned techniques: ● ***Removing Materials from the Landslide Area***: This technique involves identifying unstable or vulnerable areas within the slope that could potentially trigger landslides. Materials that contribute to instability, such as loose soil, rocks, or debris, are carefully removed from these areas. Additionally, lightweight fill materials may be used to replace the removed materials, creating a more stable and controlled slope profile. The goal is to decrease the weight and pressure on the slope, minimizing the risk of failure. ● ***Adding Material to Maintain Stability***: In some cases, a slope may lack sufficient material to maintain stability, or its natural balance may be disturbed due to construction activities or natural processes. To counteract this, engineers can add material to the slope, such as counterweight or berm fill. Counterweight involves

placing a mass of suitable material on the upper part of the slope, exerting additional pressure that opposes the destabilizing forces acting on the slope. Berm fill refers to creating a raised, horizontal platform on the slope, providing additional support, and helping to redistribute the forces and pressures.

- ***Reducing the General Slope Angle***: Slopes with steep angles are more prone to instability and failure due to gravitational forces. By reducing the general slope angle, the gravitational forces acting on the slope are mitigated. This can be achieved by cutting back the slope face to a gentler angle or creating terraces or benches at regular intervals. Reducing the slope angle improves the overall stability and decreases the risk of landslides.

Combining these techniques with other slope reinforcement methods, such as retaining structures and drainage systems, provides a comprehensive approach to slope stability and landslide prevention. Properly executed slope geometry modifications help to create safer and more reliable slopes, particularly in areas prone to landslides or in regions with challenging geological conditions. Expert analysis, careful planning, and suitable engineering measures are essential to ensure the success and long-term effectiveness of these slope reinforcement techniques.

2. Drainage:

The mitigation techniques for drainage in slope reinforcement are vital for effectively managing water flow and preventing water-induced instability. Here is an elaboration on each technique:

- ***Surface Drains***: Surface drains are designed to divert water away from the slide area and prevent it from accumulating on the slope surface. This involves the installation of collecting ditches and pipes strategically placed to channel water to safe locations, reducing the risk of soil erosion and slope failure.
- ***Shallow or Deep Trench Drains***: These drains are constructed within the slope to intercept and collect water. They are filled with free draining geomaterials, such as coarse granular fills and geosynthetics, which allow water to flow freely while preventing soil clogging. Shallow trench drains are suitable for surface water management, while deep trench drains handle deeper water infiltration.
- ***Buttress Counterforts***: Buttress counterforts are supporting structures built on the backside of retaining walls or slopes. They utilize coarse-grained materials to take advantage of the hydrological effects, redistributing loads and enhancing slope stability through the drainage of excess water.
- ***Vertical Boreholes***: Vertical boreholes, with either small or large diameters, are drilled into the slope. The smaller diameter boreholes can be equipped with pumping systems or designed for self-draining, effectively removing water from the slope to reduce pore pressure and enhance stability. Larger diameter wells rely on gravity drainage to drain water from deeper areas of the slope.
- ***sub horizontal or Subvertical Boreholes***: These boreholes are strategically placed to facilitate efficient drainage within the slope. They intercept water at various depths, providing multiple pathways for water removal and preventing the buildup of excess water pressure.
- ***Drainage Tunnels, Galleries, or Adits***: In cases of high-water flow, drainage tunnels, galleries, or adits are used to manage water runoff and control water flow. These

structures provide a more comprehensive and controlled drainage system, particularly for areas with heavy rainfall or high-water infiltration.

- ***Vacuum Dewatering***: Vacuum dewatering methods are employed to remove excess water from the slope efficiently. These techniques utilize vacuum pumps to decrease water pressure and accelerate drainage, enhancing the stability of the slope.
- ***Drainage by Siphoning***: Siphoning techniques involve using a vacuum or pressure differential to draw water from the slope to a lower elevation, maintaining a consistent water flow and reducing water saturation.
- ***Electro-Osmotic Dewatering***: Electro-osmotic dewatering processes use an electric field to promote water movement away from the slope, reducing water content and increasing soil strength.

Vegetation Planting: Vegetation planting is a natural approach to enhance drainage and slope stability. Plants help absorb excess water, prevent soil erosion, and provide root reinforcement, contributing to a more stable slope.

Each of these drainage techniques can be tailored to suit specific slope conditions, ensuring the effective removal of water and the enhancement of slope stability, reducing the risk of landslides and soil failures.

3. Retaining structures

Retaining structures are essential for slope reinforcements to stabilize and support unstable slopes. Various types of retaining structures can be employed based on the specific characteristics of the slope and the desired level of reinforcement. Here are some elaborations on the mentioned retaining structures:

- ***Gravity retaining walls:*** these structures use their own weight and mass to resist lateral pressure from the soil behind them. They are typically made of concrete or masonry and rely on their weight to maintain stability.
- ***Crib-Block Walls***: These are modular retaining walls made from interlocking concrete or timber blocks. They are versatile and can be used in various configurations to accommodate different slopes.
- ***Gabion Walls***: Gabions are wire mesh cages filled with rocks or stones. They provide a flexible and permeable retaining solution, allowing water to pass through while effectively stabilizing the slope.
- ***Passive Piles, Piers, and Caissons***: These deep foundation elements are driven or drilled into the ground to provide lateral support to the slope. They transfer the loads to more stable layers beneath the slope.
- ***Cast In-Situ Reinforced Concrete Walls***: These walls are constructed on-site using reinforced concrete to resist the lateral earth pressure and maintain slope stability.
- ***Reinforced Earth Retaining Structures***: These structures utilize strip, sheet-polymer, or metallic reinforcement elements to enhance the bearing capacity of the soil. They combine reinforcement with granular backfill materials to create stable retaining walls.
- ***Buttress Counterforts***: These are supporting structures built on the backside of the retaining wall to increase stability through the mechanical effect of distributing loads.
- ***Retention Nets for Rock Slope Faces***: These nets are installed on rock slopes to prevent rockfall and improve safety. They catch falling debris and reduce potential hazards.

- ***Rockfall Attenuation or Stopping Systems***: These systems incorporate various protective measures, such as rock trap ditches, benches, fences, and walls, to control and mitigate the impact of rockfall on slopes.
- ***Protective Rock/Concrete Blocks Against Erosion***: These blocks are placed on slopes to protect them from erosion caused by water flow, ice, or other factors.

Each type of retaining structure offers specific advantages and is selected based on factors like the slope's geometry, soil properties, environmental considerations, and project requirements. The choice of the appropriate retaining structure is critical to ensuring the long-term stability and safety of the slope.

4. Internal slope reinforcement

Internal slope reinforcement techniques are essential for enhancing the stability and integrity of slopes. These methods involve adding reinforcement elements within the slope itself to increase its strength and resistance to sliding or failure. Here's an elaboration on each of the mentioned techniques:

- ***Rock Bolts***: Rock bolts are long, steel rods inserted into pre-drilled holes in the rock or unstable slope material. These bolts provide additional support by anchoring the rock layers together and increasing their cohesion. Rock bolts are commonly used in rock slopes to prevent rockfalls and improve stability.
- ***Micropiles***: Micropiles are small-diameter, high-strength piles that are installed into the slope to transfer the loads to deeper, more stable soil layers. They offer additional resistance against sliding forces and are suitable for slopes with limited access or space constraints.
- ***Soil Nailing***: Soil nailing is a technique where reinforcing elements, usually steel bars or nails, are inserted into pre-drilled holes in the slope's surface. These nails are then grouted, forming a reinforced zone within the soil. Soil nailing provides lateral support and increases the shear strength of the slope, making it more stable.
- ***Anchors (Prestressed or Not)***: Anchors are tensioned elements, such as cables or rods, that are installed into the slope and anchored to stable areas or structures. Prestressed anchors are tensioned before being anchored, providing continuous support to the slope. Both types of anchors increase the stability of the slope by counteracting the forces that may cause sliding or failure.
- ***Grouting***: Grouting involves injecting a cement or chemical mixture into the soil or rock mass to improve its properties, such as strength and permeability. Grouting can be used to stabilize loose or weathered rock layers or to fill voids in the soil, enhancing the overall stability of the slope.
- ***Stone or Lime/Cement Columns***: Stone or lime/cement columns are installed by drilling holes into the slope and filling them with compacted stone or lime/cement materials. These columns increase the bearing capacity of the slope, making it more resistant to deformation and failure.
- ***Heat Treatment***: Heat treatment involves applying controlled heat to the slope material, such as soil or rock, to improve its strength and shear resistance. This technique can be used in frozen or weak materials to increase their stability and reduce the risk of instability.
- ***Electro-Osmotic Anchors***: Electro-osmotic anchors use an electric field to promote water movement away from the slope, reducing water content and increasing the

stability of the slope. This technique is particularly useful in water-saturated or soft soils.

- ***Vegetation Planting (Root Strength Mechanical Effect)***: Planting vegetation on the slope helps stabilize it by creating a network of roots that improve soil cohesion and provide mechanical reinforcement. The roots of the plants bind the soil particles together, reducing erosion and increasing the slope's overall strength.

Slope stabilization measures

Considering both technical and economic aspects of the project, the following mitigation measures appear most plausible at this stage:

- ***Toe embankments and/or toe buttressing and/or slope angle reduction***: These techniques involve reinforcing the base of the slope to improve stability, either by constructing embankments at the slope toe, installing buttressing structures, or reducing the slope angle.
- ***Drainage galleries/tunnels and/or sub horizontal drains***: Implementing drainage systems such as galleries, tunnels, or sub horizontal drains will help lower the groundwater level, reducing the potential for water-induced instability.
- ***Removal of potential slides***: This measure entails removing potential unstable sections of the slope either through excavation or controlled triggering, especially during reservoir filling, to minimize the risk of sudden failures.
- ***Erosion protection measures***: To counteract erosion, protective measures like rip rap in water fluctuation zones and drainage trenches and vegetation planting upslope can be applied to enhance slope stability and prevent soil loss.
- ***Soil nailing / ground anchors***: These techniques involve installing reinforcing elements within the slope to increase its strength and resistance to sliding.

While these are the primary mitigation measures being considered, other techniques mentioned in the tables may be examined more closely during the pre-construction phase when slope stability is assessed in greater detail. The final selection of mitigation techniques will be part of the detailed design phase.

Vegetation of the immediate catchment area

Beyond stabilizing the slopes, enhancing the vegetation quality in the immediate catchment area of the reservoir is equally important to minimize erosion and promote sediment infiltration before the run-off flows into the reservoir. To achieve this goal, the project will collaborate with existing community forest user groups, leasehold forestry groups and the Divisional Forest Office. These stakeholders possess valuable knowledge and experience in forest management and conservation, making their involvement essential for the successful implementation of the measures.

Part of the project’s compensatory plantation work will be focused on these immediate catchment areas. By strategically planting trees and vegetation, erosion can be mitigated, and water retention capacity can be improved. Such plantations will help create a “green buffer” around the reservoir, acting as. Natural filter to improve water quality and reduce sediment runoff.

Furthermore, the project might also encourage local farmers to switch from seasonal cropping to perennial cropping. Perennial crops, such as fodder, fruit, and medicinal plants, offer numerous benefits. They require less frequent cultivation, reducing soil disturbance and erosion. Additionally, perennial crops contribute to biodiversity conservation and provide economic opportunities for local communities through the sale of fruit, medical herbs, and livestock feed.

Through a collaborative effort with local stakeholders, the project aims to establish a holistic approach to catchment management. By combining slope stabilization, vegetation enhancement, and agricultural transition, the immediate catchment area will be better equipped to support the reservoir's water quality, ecosystem health, and the overall sustainability of the project.

8.1.3 Prevent water pollution during the construction phase

The construction work for the project poses a potential risk to the water quality of nearby water bodies. The water flowing from the construction sites into these water bodies may contain sediment loads, construction debris (such as cement and concrete), concrete washouts, minerals (possibly washed out from the tunnels), spilled chemicals, oils, lubricants, and construction wastes (like discarded materials and packaging). These materials can degrade the water quality and habitat for aquatic animals. To address this issue, it is crucial to implement proper erosion and sediment control measures, stormwater management practices, and pollution prevention strategies. The following are the measures to prevent water pollution during the construction phase:

Sediment trapping

- Sediment basins - Construction of sediment basins or settling ponds to capture and retain sediment-laden runoff before it is discharged into the river. These basins allow sediment to settle, preventing its entry into the river.
- Silt fences and erosion control mats – Install silt fences and erosion control mats along the construction site's perimeter to prevent sediment-laden runoff from leaving the site.

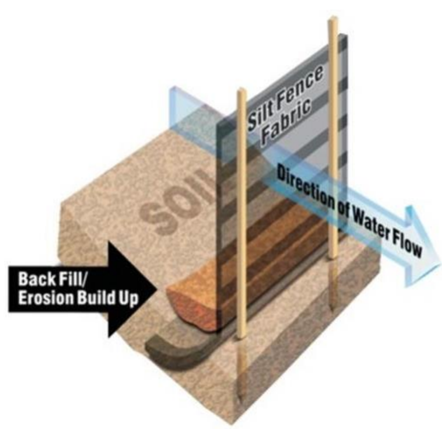


Figure 102: Silt fences and erosion control mats

Vegetation and re-vegetation – Establish and maintain vegetation on bare or disturbed areas to stabilize the soil and reduce erosion caused by rainfall or water flow.
Soil stabilization techniques – Employ techniques like terracing, contour plowing, or hydroseeding to stabilize slopes and prevent erosion.

Stormwater management
Implement effective stormwater management systems to control and treat runoff from the construction site before discharging it into the river.
Schedule construction activities during dry weather periods when the risk of erosion and sediment runoff is lower.

Site Inspection and Monitoring
Regularly inspect the construction site to identify erosion-prone areas and implement immediate corrective actions.
Monitor sediment levels in the river to assess the effectiveness of mitigation measures and adjust strategies if needed.

Contractor Training

- Provide training to construction personnel on sediment control practices and the importance of proper erosion control measures.

- Control of Oil, Chemicals, and Other Substance Spillage
- To ensure the prevention of water contamination from spillage, stringent measures will be implemented to handle oil, chemicals, and other substances responsibly. Storage areas for these materials will be strategically located at a safe distance from water bodies, minimizing the risk of accidental spills. Additionally, during refueling of heavy machinery, service vehicles will be utilized to reduce the likelihood of spillage incidents.
- Workshop facilities will be positioned at least 100 meters away from water sources to mitigate potential hazards. Inside the workshop, specialized oil and grease trapping systems will be installed to capture any spills that might occur. Regular maintenance and cleaning of these systems will be carried out to ensure that no contaminated runoff enters nearby water courses.
- Furthermore, a proactive approach will be taken through routine maintenance of vehicles and equipment to identify and address any potential leakages in fuel tanks. This preventive measure aims to safeguard the environment and prevent any adverse impacts on water quality and surrounding ecosystems.

8.1.4 Preserving springs during the tunnel construction

The examination of the presence of spring water sources along the tunnel alignment is an essential step in the planning phase of any tunnel construction project. In this specific case, it was observed that there were no spring sources within a 100-meter buffer of the tunnel alignment. As a result, it was initially concluded that the impact on springs is not anticipated in the current project. However, to ensure a thorough understanding and preparedness, it is recommended to conduct a more detailed investigation during the construction phase. The proposed activities aim to mitigate any potential impacts on springs and ensure the sustainable management of water resources in the area. Let's elaborate on each of the proposed activities:

Conducting a Comprehensive Hydrogeological Survey
This activity involves conducting a detailed hydrogeological survey of the entire project area before initiating tunnel excavation. The survey will focus on understanding the groundwater flow patterns, identifying the exact locations of springs, and mapping their recharge areas. This information will provide valuable insights into the hydrological dynamics and help assess the potential impact of tunnel construction on springs.

Continuous Monitoring of Water Levels
Throughout the construction process, it is crucial to continuously monitor the water levels of the springs and nearby wells. Regular monitoring will enable the project team to detect any significant changes in water levels promptly. If there are any unexpected impacts on springs, immediate actions can be taken to mitigate the effects.

Grouting and Waterproofing Techniques
Implementing grouting and waterproofing techniques is an essential preventive measure. By sealing the tunnel walls effectively, the chances of water infiltration into the tunnel are minimized. This not only ensures the safety and stability of the tunnel but also reduces the risk of affecting nearby springs by maintaining the natural flow of groundwater.

Scheduling Tunnel Construction with Consideration to Groundwater Levels
Planning the construction schedule to coincide with wetter seasons when groundwater levels are naturally higher can help minimize potential impacts on springs. Tunnel construction during drier seasons may lead to a higher demand for dewatering, which could impact local water sources.

Contingency Plans for Water Supply
If springs on which local communities depend for their water supply are adversely affected, it is essential to have well-thought-out contingency plans. These plans should include alternatives for supplying water to households, such as piped water systems or other sustainable sources. Ensuring access to water for affected communities is vital for their well-being and livelihoods.

8.1.5 Mitigating air pollution in the construction sites

Construction works involving excavation, earthmoving, and material transportation can lead to the generation of dust and particulate matter, especially in dry and windy conditions. To mitigate air pollution at construction sites, the following measures will be implemented:

- ***Dust Suppression***: Water spraying systems or sprinklers will be used during excavation and earthmoving operations to suppress dust. Regular site watering and maintenance will be conducted to keep the dust settled and prevent it from becoming airborne. Roads, equipment, and stockpiles will be cleaned to prevent dust from being carried away by wind or traffic.

- ***Windbreaks and Barriers***: Temporary fencing or walls will be installed around the construction site to reduce the impact of wind on dust dispersion.

Figure 103: Wind breaks to prevent air pollution coming out of the construction sites.

- ***Enclosures and Dust Collectors***: Dusty operations will be enclosed, and dust collectors will be used on equipment like crushers and conveyors to capture airborne particles. Stockpiles will be stored in enclosed premises or kept covered with tarpaulins.
- ***Waste Management***: Burning of waste will be strictly prohibited to prevent harmful pollutants from being released into the air. Proper waste management practices such as recycling, reusing, or proper disposal will be implemented.
- ***Distance from Residential Areas***: Stockpiles will be located at least 500 meters away from residential areas whenever possible.
- ***Compliance with Air Quality Regulations***: Local air quality regulations and standards will be strictly followed. Regular air quality monitoring will be conducted to ensure compliance.

Table 8. 1: Ambient air quality standards to be followed by the project.

Parameter	**Averaging period [1]**	**NAAQ, 2012[2] [μg/m^3]**	**WHO air quality guidelines (2021)**	**Standard value to be followed by the project**
TSP	Annual	-	-	-
	24 hours	230	-	230
PM_{10}	Annual	-	20	20
	24 hours	120	50	50
$PM_{2.5}$	Annual	-	10	10

	24 hours	-	25	25
SO_2	Annual	50	-	50
	24 hours	70		20
	10 min	-	500	500
NO_2	Annual	40		40
	24 hours	80	-	80
	1 hour	-	200	200
CO	8 hours	10,000	10	10,000
	15 min	-	100	100,000
	1 hour		35	35
Pb	Annual	0.5	-	0.5
Benzene	Annual	5	-	5

- ***Use of Cleaner Technology***: Low-emission or cleaner technologies that meet national emission standards will be used. Construction equipment and vehicles will be regularly checked and maintained according to the manufacturer's specifications.
- ***Distance from Sensitive Receptors***: Stationary emission sources will be kept at a safe distance from sensitive receptors like houses, schools, clinics, and temples.
- ***Covered Trucks***: Trucks transporting construction materials will have covers to prevent the dispersal of dust. They will also comply with emission standards and undergo regular servicing.
- ***Paved Surfaces and Stabilization***: Paved surfaces will be used whenever possible to reduce dust generation during transportation activities. Unpaved roads and stockpiles will be stabilized with environmentally friendly binders to limit dust emissions.
- ***Operational Health and Safety***: Workers near exhausts from vehicles and equipment or involved in earthworks will be provided with clean N95 dust masks to protect against inhalation of particulate matter and other pollutants.

Additional measures include enforcing speed limits for vehicles and machinery on construction sites, providing training and awareness to workers and contractors about dust control and air pollution prevention, monitoring weather conditions, and planning construction activities accordingly to avoid major earthmoving during periods of high wind and extremely dry weather.

The project has allocated a budget of USD 100,000 for air pollution management. This budget encompasses USD 50,000 designated for installing crucial equipment and materials like windbreakers, dust suppressors, and enclosures for stockpiling, among others. Additionally, an annual allocation of USD 10,000 for the next 5 years has been designated to cover the running expenses related to air pollution management. These measures underscore the project's dedication to improving air quality responsibly throughout its operational phase.

8.1.6 Solid waste management

The project construction will involve a sizable workforce of approximately 1200 workers, leading to the generation of around 450 kg of solid waste per day. This substantial waste output necessitates a comprehensive waste management approach to uphold sanitation standards and control pollution levels at the project sites. To achieve effective solid waste management, the following measures will be implemented:

- ***Waste Collection and Segregation***: A robust waste segregation system will be put in place, educating workers on the proper separation of recyclable materials, organic waste, and non-recyclables right at the source. The use of color-coded bins and clear signage will facilitate correct waste disposal.
- ***Waste Reduction Measures***: Workers will be encouraged to adopt reusable or refillable containers for food and beverages, thereby minimizing single-use packaging waste. The concept of "reduce, reuse, and recycle" will be actively promoted among the workforces.
- ***Recycling***: Dedicated facilities that segregate the materials like paper, cardboard, plastic, and metal waste from the waste. These segregated scraps will be periodically auctioned off to relevant buyers or recyclers "*kwadis*".
- ***Incineration of Waste***: On-site incineration units will be constructed to manage waste that cannot be disposed of, recycled, or reused. The incinerators will be designed to optimize residence time and temperatures, minimizing incomplete combustion, and reducing the volume of solid waste that needs to be removed off-site. However, open burning of waste will be strictly prohibited to prevent harmful emissions.
- ***Composting***: On-site composting of food waste may be permitted, provided that enclosed composting facilities are designed away from accommodations and properties outside the site boundary. This controlled approach will help avoid odors and pests during composting.
- ***Responsible Purchasing***: Collaborating with suppliers and vendors will prioritize products with minimal packaging or made from recyclable or biodegradable materials, reducing waste at the source.
- ***Waste Audits***: Regular waste audits will be conducted to assess the types and quantities of waste generated. Analyzing this data will identify opportunities for further waste reduction and optimization.
- ***Training and Awareness***: Training sessions and awareness programs will be conducted for workers, emphasizing proper waste management practices and the vital role they play in waste reduction and environmental preservation.
- ***On-Site Waste Treatment***: Exploring the implementation of on-site waste treatment technologies, such as compactors or shredders, will reduce the volume of solid waste before disposal.
- ***Collaboration with Local Authorities***: Collaborating with local waste management authorities will ensure compliance with waste disposal regulations and explore

opportunities for waste collection and processing services. Any waste sent for disposal will be done responsibly, adhering to all environmental guidelines and regulations.

By implementing these comprehensive measures, the construction project will efficiently manage its solid waste, promoting environmental sustainability and contributing to pollution control at the project sites.

The project has set aside a budget for solid waste management, totaling USD 100,000. This allocation includes USD 50,000 for the installation of essential infrastructure such as an incinerator, composting plant, segregation station, and collection bins. Additionally, the project will allocate USD 10,000 annually for the next 5 years to cover the running expenses associated with solid waste management. These measures demonstrate the project's commitment to responsible waste disposal and environmental sustainability throughout its operational phase.

8.2 Physical Environment - Operation Phase

8.2.1 Mitigating the land use change

The operation of the project will involve the creation of a 12.7 km long reservoir, starting from the barrage and extending up to a bridge located at Hattisundhe. This reservoir will result in permanent inundation of land on the banks of the Seti River. As mentioned in section 8.1.1, the project recognizes the need to provide compensation to the affected HHs whose structure, land, and crops, and other properties will be inundated by the reservoir.

The compensation process will also extend to the forested land belonging to the GoN and under the management of community forests that will be inundated by the reservoir. This includes compensating for the trees and vegetation present within these forested areas.

The compensation process and mechanisms are discussed in detail in the social mitigation plan presented later in this report that ensures that affected HHs and GoN receive fair and appropriate compensation for their losses.

8.2.2 Erosion control and soil conservation

The reservoir is expecting to receive sediment coming in from the Madi River and smaller tributaries in the reservoir area. The Madi River Confluence is located about 25 km upstream from the reservoir, however, the smaller tributaries in the reservoir area can bring in alluvial deposits throughout the year, especially during the monsoon season. The control of sedimentation coming in from the immediate catchment area, the following measures are proposed:

The sedimentation coming in from the immediate catchment area can significantly reduce the life period of the reservoir and reduce water storage capacity, increased maintenance, and compromise electricity generation capacity. Therefore, erosion control and soil conservation become crucial for the hydropower on one hand, on the other hand, it is also important to ensure safety of the land and properties located adjoining to the reservoir. The techniques to be used are:

- ***Terracing***: Terracing involves creating level platforms on slopes to reduce the speed and impact of water runoff. This technique prevents erosion by facilitating water infiltration into the soil instead of allowing direct surface flow, which could carry sediments into the reservoir. Terracing also aids in retaining moisture in the soil, fostering vegetation growth, and providing additional stability to the terrain.
- ***Contour plowing***: Contour plowing is a farming practice wherein furrows are made along the natural contours of the land. This method effectively slows down water flow, diminishes erosion, and prevents sediments from being washed away. In the project area, where sloping land is prevalent and water runoff is significant, contour plowing proves particularly effective.
- ***Vegetation cover***: Maintaining natural vegetation cover in the catchment area stands as one of the most potent erosion control methods. The project will prioritize minimizing vegetation removal while also emphasizing compensatory plantation in the reservoir area.
- ***Sediment retention structures***: Constructing small sediment retention structures, such as check dams or silt fences, plays a crucial role in capturing sediment-laden runoff and preventing it from reaching the reservoir. These structures slow down water flow, allowing sediments to settle out before the water continues downstream.
- ***Reservoir buffer and Buddha Singh Marg***: The project will give priority to maintaining a buffer around the reservoir and the Buddha Singh Marg, ensuring the areas are vegetated to serve as barriers, preventing sediment from entering the reservoir.
- ***Regular maintenance***: Ensuring the regular maintenance and repair of erosion control structures and vegetation cover in these areas, especially the buffer zone, is vital for the long-term effectiveness of these measures. Continuous maintenance will sustain their efficiency and benefits over time.
- ***Sediment Monitoring***: Establish a sediment monitoring program to track sediment loads and deposition rates in the reservoir. This data will help assess the effectiveness of mitigation measures and inform any necessary adjustments.

8.2.3 Slope stabilization in the riparian areas of the reservoir

Implementing slope stabilization measures for the riparian areas of the reservoir is crucial to preserve slope stability and safeguard adjoining land and properties to the reservoir. Due to the fluctuation of the water level in the reservoir, certain slopes can become vulnerable to slope failure. To address this, the following measures will be implemented:

- Conduct mapping to identify vulnerable slopes in the reservoir area that require targeted slope stabilization measures.
- Employ bioengineering techniques using live plants to stabilize the identified vulnerable slopes. This may involve planting native vegetation with deep root systems, such as grasses, shrubs, and trees, to anchor the soil effectively.
- Utilize riprap and gabion walls in areas where slopes are particularly susceptible to erosion, providing additional protection and stability.
- Implement effective stormwater management practices to minimize the impact of heavy rainfall events on the riparian slopes. Well-designed drainage systems can effectively control runoff and prevent erosion.

- In conjunction with the erosion control measures discussed in section 8.2.2, incorporate terracing, vegetation, and riparian buffers along with the Buddha Singh Marga to enhance slope stability and protect the riparian area.

8.2.4 Environmental Flow

Considering the fluctuating water levels, the barrage associated with the TSHPP will need to store water during the monsoon season when there is excess water and release it gradually during the dry season when water resources are scarce. Due to the diversion of discharge from the Seti River, a section of approximately 11 km from the barrage to the point where it meets the Trishuli River will experience reduced flow.

It important to release a discharge from downstream of the barrage that is sufficient to maintain ecological health, water use demand of locals, and overall integrity of the Seti River in its stretch which experience reduced flow during the project operation. The project has proposed 5.08 m^3/sec as the E-flow. In addition to the E-flow release, this stretch is also expected to receive discharges from several of its tributaries. During the field survey conducted In October of 2021, estimates were made regarding the discharge from these tributaries. It was estimated that the total contribution from the 6 tributaries to the Seti River was about 14 m^3/sec at that time, which was the beginning of the dry season. Among these tributaries, the Bagar Khola and Bhut Khola were the two largest contributors in this stretch. Each of these tributaries provide around 4 m^3/sec of discharge to the Seti River. Eventually, the Seti River merges with the Trishuli River, which is a large river system. Considering the riparian flow of 5 m^3/sec and the contribution from the tributaries, it is estimated that a total discharge of approx. 19 m^3/sec might be available during the dry season.

To ensure the ecological health of the aquatic and riparian ecosystems downstream of the reduced flow stretch, a detailed Environmental Flow (E-Flow) modeling is strongly recommended. This modeling will help determine the required discharge to maintain the existing ecosystem adequately. The E-Flow should adhere to the following criteria:

a) ***Natural Flow Regime***: The E-Flow should aim to mimic the natural flow regime of the river. This involves releasing sufficient water downstream to support the ecological health of aquatic and riparian ecosystems, including critical habitats for fish, plants, and other aquatic organisms.
b) ***Downstream Impacts:*** The operation of the barrage is expected to alter the natural flow patterns of the Seti River, leading to changes in sediment transport and aquatic habitats. The E-Flow assessment should consider these downstream impacts to mitigate potential adverse effects.
c) ***Flow Components:*** The E-Flow assessment should encompass various flow components. This includes determining the base flow, which represents the minimum flow required to sustain ecosystems during dry periods. Additionally, it should consider high flows to mimic natural flood events and seasonal flows to support specific life stages of aquatic species.
d) ***Reservoir Operations***: The E-Flow should also consider the optimization of reservoir operations. This involves releasing water in a manner that benefits downstream ecosystems while simultaneously meeting the requirements for energy generation.

By adhering to these E-Flow criteria, the project can ensure that the reduced flow stretch supports the ecological balance of the river system and preserves the health of the aquatic and riparian ecosystems downstream. The modeling process will provide valuable insights into the appropriate discharge needed to sustain the natural functions of the river and its associated habitats.

8.2.5 Mitigating impacts of hydropeaking

The operation of TSHPP is projected to release approximately 206 m^3/s of water into the Trishuli River. While the Trishuli River has an average discharge of 5000 m^3/s, this additional discharge may seem insignificant, but it can still impact the quantity and velocity of the river downstream of the tailrace. To address these potential effects, the following mitigation measures will be implemented:

- ***Flow Regulation***: Implement flow regulation strategies to manage the release of water from the hydropower plant. This will help control the quantity and velocity of the water being discharged into the Trishuli River, reducing the potential impacts downstream.
- ***Velocity Dissipation Structures***: Install velocity dissipation structures downstream of the tailrace to reduce the speed and force of the released water. These structures help dissipate energy and prevent excessive erosion and habitat disturbance.
- ***Monitoring and Adaptation***: Regularly monitor the downstream conditions, water flow, and ecological responses to assess the effectiveness of the mitigation measures. Adopt an adaptive management approach to make necessary adjustments based on monitoring results and changing environmental conditions.
- ***Public Awareness and Stakeholder Engagement***: Engage with local communities, environmental organizations, and relevant authorities to raise awareness about the potential impacts of the increased discharge. Involve stakeholders in the decision-making process and gather their feedback to improve the effectiveness of the mitigation measures.
- ***Water Quality Monitoring***: Monitor the water quality downstream of the tailrace to ensure that the increased discharge does not negatively affect water quality parameters.
- ***Warning system***: The project will implement a siren system that will serve as a crucial warning sign to alert individuals about the incoming discharge from the tailrace. This measure is put in place to prevent accidents and ensure the safety of all personnel in the vicinity.

8.3 Biological Mitigation Measure

8.3.1 Forest Mitigation – Construction phase

8.3.1.1 Compensation for removal of trees and vegetation and lost forest area

8.3.1.1.1 Estimate of compensation

The commencement of the construction works will involve the clearance of trees and vegetation from the construction sites. As mentioned in the impact assessment section, a total of 19,115 trees and poles are expected to be removed. Among these, 10,904 trees and poles will be removed from the reservoir area before its operation. Additionally, the construction of the intake and powerhouse complex will permanently require the removal of approximately 1,296 trees, while the remaining trees will be temporarily removed from sites such as quarries, borrow areas, clay areas, temporary camps, and dumping areas.

Although the removal of these trees and vegetation is unavoidable, the primary focus of mitigating the impact lies in compensatory plantation. However, the project will also integrate design and construction practices to minimize vegetation removal and incorporate conservation efforts.

To address the unavoidable loss of forest due to the project, compensatory measures, such as plantation activities, are essential. These efforts will be carried out simultaneously with conservation practices in the remaining forest areas. The project, in collaboration with the proponent and the contractor, will prepare a forest reforestation plan with the objective of achieving "no net loss of biodiversity." As per Forest Regulations 2079, compensatory plantations are mandatory and must be carried out at a ratio of 1:10, meaning that for every felled tree, 10 saplings will be planted. Therefore, to compensate for the loss of 19,115 trees, a total of 1,91,150 new trees will be planted.

The project will follow the guidelines provided in the Forest Products Collection, Sale, and Distribution Directives 2075 to clear the forest and stockpile the materials. Subsequently, the materials will be handed over to the respective owners.

The forest will only be cleared after a joint inspection and documentation of the trees to be felled, involving the forest authority. The proponent will bear the expenses associated with the government and community authority's participation in the inspection, including the costs related to tree felling and management of stockpiles.

Besides tree removal, the project will also be required to compensate for the loss of forested land. The acquisition of forest land for the project footprint will adhere to the Rule 91 of Regulations 2079 and Standards and Work Procedures for Utilization of National Forest Areas for Projects of National Priority, 2076. As indicated in the impact assessment section, the project requires 54.32 hectares of forested land, with 33.94 hectares being permanently allocated for project structures, and the remaining 20.38 hectares being temporarily used for construction activities. Thus, the project will need to compensate for the loss of 54.32 hectares of forest area by carrying out compensatory plantation on designated compensated land. Wherever feasible, the project will allocate an equivalent amount of land to the Government of Nepal.

Alternatively, according to Rule 92 of the Forest Regulations 2079, if the land acquistion committee (as per Rule 91, sub-rule 9) determines that the such land is unavailable, monetary compensation will be provided to the GoN based on specific rates for different land types outlined in Rule 93 of Forest Regulation 2079 and as stipulated in Section 10 of the Standards and Work Procedures for the Utilization of National Forest Areas for Projects of National Priority 2076. Furthermore, following forest regulations and the plantation rate of 1600 saplings per hectare, a total of 1,91,150 saplings must be planted to rehabilitate the 54.32 hectares of compensated land.

The reforestation will aim to plant a standard of 1600 seedlings per hectare. However, adjustments to this ratio may be made based on recommendations from the DFO and user groups, considering local site conditions or specific requirements. The selection of plantation sites will be done in consultation with the respective DFO and user groups, with preference given to sites with similar climate range and soil types as the deforested areas. Proximity to existing forest areas will also be considered to extend the range of species habitats. The immediate catchment area of the reservoir will be prioritized for reforestation, as suggested by the soil conservation and slope stability measures discussed earlier.

The species composition of the reforested areas will consist of locally native species, reflecting the composition of the corresponding deforested sections under the project. The preferences of user groups will also be considered in the selection of species, with an emphasis on selecting trees that provide suitable habitat for fauna, particularly vultures and other wildlife.

All expenses related to cutting, stockpiling, and transportation of the trees will be borne by the proponent.

8.3.1.1.2 Marking and felling of the trees

Before starting any work in forested areas, it is essential to obtain forest clearance permission.

During the project implementation, any clearance of forest vegetation will strictly adhere to the requirements specified for the project footprint only. Prior to felling any trees, a comprehensive marking and documentation process will be carried out through a joint inspection involving representatives from the forest authority, community forest, leasehold forestry, and relevant stakeholders.

The joint inspection serves to identify and document the specific trees that need to be cleared for the project footprint. This collaborative approach ensures transparency and accountability, as all parties involved can verify and agree upon the trees that will be affected.

Before clearance, the ecological importance of the forest will be assessed, along with verification of the number of trees to be cleared and documentation of the fauna in the study area. If tall trees valuable to vultures, high-quality forest habitat with a density of over 200 trees/ha, or other significant natural habitats are identified to be impacted, the contractor will actively seek ways to minimize tree and habitat loss through design reconsiderations. This may involve realigning the route or implementing alternative construction methods to reduce the impact on the identified areas of importance.

The proponent of the project will bear the responsibility for remunerating both government authorities and the community during the inspection. This includes covering the costs associated with felling the marked trees as well as managing the stockpile of cleared trees.

By following these procedures, the project ensures that the forest clearing is carried out in a controlled and responsible manner.

Selective felling of trees will be conducted meticulously, with careful identification and confirmation of the target trees. The species and location of the trees will be verified, and they will be harvested manually using suitable forestry techniques, minimizing impacts on the surrounding vegetation, and reducing habitat fragmentation.

The tree felling process will involve collaboration with the local Division Forest Office, Community Forest User Groups, and Leasehold Forest Groups, ensuring their involvement and expertise in the process.

Specific details of the tree felling activity, including the identified trees and methods employed, will be documented, and reported in periodic monitoring reports, demonstrating transparency and accountability in the project's implementation.

The project will pay special attention to the preservation of important tree species as designated by the DFO. These identified tree species will be marked separately and safeguarded during the construction phase to ensure the retention and conservation of significant tree species, contributing to the maintenance of biodiversity and ecological balance in the project area.

The recovered felled trees and non-timber forest products (NTFP) will be handed over to the Community Forest User Groups (CFUGs) in compliance with national regulations.

The project will maintain clear demarcation of the working area and strictly avoid encroachment beyond the agreed area of impact. This measure will confine project activities within designated boundaries, minimizing potential adverse effects on surrounding areas.

8.3.1.1.3 Establishment of nursery

The establishment of the tree nursery will commence upon the effectiveness of the loan, providing sufficient time for seedling growth, planting, and management over a period of 5 years. This timeline will allow for the necessary preparations and ensures the availability of healthy and well-developed seedlings for the restoration efforts.

However, if it is determined that purchasing seedlings from existing nurseries is a viable option for the entire project, this alternative approach may be adopted. If the decision is made to establish a nursery, the selection of nursery sites will be done in consultation with the respective DFO and affected User Groups to facilitate the establishment of micro-nurseries. Additionally, the project will procure improved seeds and offer the necessary technical support for the setup and operation of the nurseries. This collaborative approach will ensure that the nursery sites are chosen strategically, considering local expertise and the involvement of relevant stakeholders, while also providing the essential resources and guidance for successful nursery management.

Coordination with Stakeholders
The implementation of compensatory plantation activities will be conducted in close coordination with the Division Forest Office (DFO). Moreover, the involvement of affected Community Forest User Groups and Leasehold Forest User Groups will be ensured to facilitate the process.

Management of the plantation sites
The project proponent will assume responsibility for the management and protection of the plantation sites for a minimum period of 5 years. During this time, various measures will be implemented to enhance the survival rate of the saplings. These measures include erecting fences to protect the planted areas, regularly providing water to the plants, offering necessary care, and monitoring their progress.

After the 5 years period, the project will hand over the management of the plantation areas to the relevant DFO and User Groups. Prior to the handover *i.e.*, for the 5 years, the project will be accountable for ensuring the well-being and development of the reforestation areas. Alternatively, the project may opt to delegate the management of the plantation areas to the local DFO or User Groups, with continued support from the project for designated period of 5 years.

The project will maintain regular monitoring of the reforestation sites, and this monitoring will be included in the semi-annual safeguards monitoring reports. This will ensure that the progress and condition of the reforested areas are regularly assessed and reported on. In the event of any loss of trees and saplings, immediate action will be taken to replace them with new saplings. This proactive approach will ensure that the reforestation efforts remain consistent and that any gaps in tree coverage are promptly addressed to maintain the intended objectives of the project.

8.3.1.1.4 Estimates of the compensatory plantation

In accordance with the regulatory procedures, the project will adhere to the Standards and Work Procedures Regarding the Use of National Forest Areas for Project of National Priority 2076, Forest Act 2076, and Forest Regulations 2079 to appropriately compensate for the acquired forest land and the trees felled from community forests.

Table 8. 2: Compensatory Plantation and cost

Particulars	**Trees/Sampling estimated**	**Total Cost**	**Remarks**
Total trees to be lost from forested area	19,115 trees will be felled		Total forest area is 54.32 ha and the average tree density is about 351.89 trees per ha.
Total forest area lost	54.32 ha	68,870,970.00	NRP 12,67,875.00/ha * 54.32
No. of trees for compensatory plantation, at 1:10 ratio	1,91,150 saplings to be planted		plantation @ 1:10
No of trees for rehabilitation of 54.32 ha of forest area	86,912 saplings to be planted		Plantation @1600 sapling per ha
Cost for plantation (including seedling cost and transportation, land preparation, *etc*.)	@ of NPR 200 per sapling	NPR 55,612,400.00	NPR 200 X 278,062 seedling
Caring of saplings for 5 years (including caring, weeding, watering, watching, *etc*.)	@ NPR 100 per sapling	NPR 327,806,200.00	NPR 100 X 278,062 seedling
Felling of trees including transportation.	@ NPR 5000	NPR 95,575,000.00	NPR 5000 X 19,115 trees
Total cost (NPR)		**NPR 54,78,64,570**	
Total cost (USD)	**(USD 1= NPR 130.97)**	**USD 41,83,130.26**	

8.3.1.2 Conservation initiatives and minimization of forest fragmentation

The removal of trees and vegetation will have adverse effects on the ecological functions, habitat integrity, and biodiversity of the forest, leading to a quantitative degradation of the ecosystem. Thus, the following measures will be carried out to prevent and/or minimize such forest degradation.

8.3.1.2.1 Maintain tree and vegetation within the project area

During the construction of the project structures, the removal of vegetation at designated sites is an inevitable part of the process. However, the project team recognizes that such vegetation clearance can have significant negative impacts on the forest ecosystem and disrupt the habitats of various plant and animal species. To mitigate these effects and demonstrate a commitment to environmental stewardship, the project adopts a proactive approach to minimize vegetation removal.

One of the key strategies employed is designing the project structures and construction activities in a way that works around existing vegetation. By carefully planning the layout and placement of the buildings, roads, and infrastructure, the project aims to minimize the need for cutting down or uprooting trees and other vegetation. This approach ensures that a significant portion of the forest remains intact, allowing for the preservation of critical ecological functions and habitats.

In particular, the project places special emphasis on preserving the powerhouse complex area and the camps. In the design of these sites, efforts will be made to create open areas where existing vegetation and trees can be preserved, thus avoiding unnecessary removal. By adopting this approach, the project can aim to uphold the integrity of the surrounding forest ecosystem and safeguard habitats that support diverse plant and animal species.

Furthermore, the project demonstrates its commitment to environmental responsibility by taking the initiative to green their construction sites. This involves intentional efforts to reintroduce and promote the growth of vegetation in areas where clearing was necessary. To enhance the ecological value of the project area, the project team focuses on planting and nurturing local species that are well-suited to the surrounding environment. By doing so, the project contributes to the restoration of the ecosystem and fosters the revival of native flora and fauna.

Strictly prohibit cutting of trees outside the project area

During the process of clearing the project area, an essential aspect of the conservation effort will be the strict adherence to preserving trees outside of the designated project footprints. This emphasis on tree protection will be particularly applied in the reservoir area, where the project's construction activities are likely to have a more significant impact on the surrounding environment.

To ensure the conservation of trees and vegetation, the project will follow a clear and well-defined approach. The removal of trees will be planned in a manner that aligns with the inundation boundary; the area likely to be submerged by the reservoir. The aim is to retain as much vegetation as possible above this demarcation to maintain the ecological balance and minimize the ecological disruption caused by tree removal.

The project management will issue explicit instructions to the contractor to exercise vigilance and caution during the tree removal process. The contractor will be obligated to follow these guidelines diligently to avoid any unnecessary cutting or trimming of trees outside of the designated project area. This meticulous approach is intended to protect mature trees, preserve habitats, and safeguard the ecological functions of the forest beyond the project's immediate boundaries.

Moreover, the conservation efforts will not be limited to trees alone. The contractor will also be directed to pay attention to the ground vegetation. By doing so, they can help maintain the biodiversity of smaller life-forms such as insects, reptiles, and small mammals that depend on the forest floor for survival. Protecting ground vegetation plays a crucial role in sustaining various interconnected ecological processes, and the project's commitment to this aspect further enhances the overall conservation endeavor.

By adopting this comprehensive approach to tree and vegetation preservation, the project aims to minimize the impact of its activities on the surrounding ecosystem. By safeguarding the trees outside of the project footprint and ensuring the preservation of ground vegetation, the project demonstrates its commitment to ecological sustainability and responsible environmental management.

8.3.1.2.2 Conservation of surrounding forests

The project team fully acknowledges the significance of conserving the surrounding forest areas, especially those thinly populated sites that may hold unique ecological value and as well as conservation of the soil. Understanding the importance of these areas for the overall health of the ecosystem, the project adopts a proactive approach towards their conservation.

The project places a high priority on promoting the expansion of forest growth, especially in the immediate catchment areas of the reservoir. This initiative involves a multi-faceted approach aimed at enhancing forest cover, restoring degraded land, and creating new habitats to support diverse flora and fauna.

One of the primary benefits of improving forest cover in these areas is the reduction of soil erosion and enhancement of slope stability. This, in turn, will lead to better sediment control in the runoff, ultimately extending the lifespan of the reservoir. By bolstering the quality of forest cover, the project seeks to protect the reservoir's water resources and maintain its functionality for a more extended period.

In addition to these local benefits, the project actively encourages the growth of forests to contribute to global environmental goals. Carbon sequestration, a key aspect of forest growth, aids in mitigating the impacts of climate change. By capturing and storing carbon dioxide from the atmosphere, the growing forests help offset greenhouse gas emissions, thereby contributing to efforts to combat climate change.

Moreover, the project recognizes the crucial role of forests in providing essential ecosystem services. Forests play a significant role in regulating water flow, ensuring a steady supply of water to streams and rivers, and acting as a natural buffer against floods and droughts.

Additionally, the forest floor and vegetation act as a protective layer, preventing soil erosion and maintaining soil health, which is vital for sustainable agriculture and land use.

By actively promoting forest growth and recognizing its multiple benefits, the project demonstrates its commitment to responsible environmental stewardship. The project's efforts not only enhance the local environment but also contribute to broader global objectives, including climate change mitigation and the protection of vital ecosystem services that benefit both humans and wildlife.

8.3.1.3 Provision of alternatives to firewood and timber

The collection of firewood, timber, and illegal gathering of NTFP by the construction workers in the surrounding areas can significantly contribute to forest degradation. To prevent such activities, the following actions are proposed:

Alternative sources of energy available
The contractor will be responsible for providing suitable workers accommodation that meets the standards, including cooling and heating facilities and proper meal arrangements. This initiative aims to discourage workers from engaging in activities that are prohibited, such as unauthorized collection of firewood.

To further support this effort, the contractor will ensure the availability of alternative fuel sources, such as kerosene or LPG, which will be stored safely. These alternative fuel sources will be provided for common kitchens and heating purposes in the worker accommodation. By offering alternative fuel options, the reliance on fuelwood will be minimized, reducing the demand for firewood, and promoting sustainable practices.

By implementing these measures, the project aims to create an environment where workers have access to suitable accommodation and alternative fuel sources, discouraging them from engaging in activities that contribute to forest degradation. This approach supports the preservation of the forest ecosystem and encourage sustainable practices.

Promotion of NTFP species in the project area
The project area has rich distribution of NTFPs including Khayar (*Acacia catechu*), Peepal (*Ficus religiosa*), Amriso (*Thysanolaena maxima*), Badahar (*Atrocarpus lakoocha*), Simal (*Bombax ceiba*), Allo (*Girardinia diversifolia*), Amala (*Phyllanthus emblica*), Gittha (*Dioscorea bulbifera*), Batulpaate (*Cissampelos sp*.), Kurilo (*Asparagus racemosus*), Babiyo (*Eulaliopsis binata*), Ghodtapre (*Centella asiatica*), Vyakur (*Dioscorea deltoidea*) Chilaune (*Schima wallichii*), Khanayo (*Ficus cunia*), *etc*.

To safeguard these valuable resources and ensure social and cultural benefits, the project will undertake the following activities:

- ***Engaging Local Communities***: The project will involve local communities, tapping into their traditional knowledge of NTFPs. This collaboration will promote sustainable harvesting practices, ensuring the preservation of NTFPs.

- ***Capacity Building***: Through workshops and training programs, locals will be equipped with knowledge on sustainable harvesting techniques, value addition, and market connections for NTFPs.
- ***Awareness Campaigns***: The project will launch awareness campaigns to highlight the ecological significance of NTFPs and the benefits of their conservation. Emphasizing their cultural importance will instill a sense of pride and responsibility among the locals.
- ***Reforestation Initiatives***: The project will focus on reforestation efforts, giving special attention to NTFP-rich species, to replenish and conserve the natural habitat of these valuable resources.
- ***Agroforestry Promotion***: Encouraging agroforestry practices, combining NTFP cultivation with other crops, will support local livelihoods while preserving NTFPs.
- ***Value Addition and Market Access***: By supporting value addition processes, such as processing, packaging, and marketing of NTFPs and their products, the project will enhance their economic value and improve market access.

By implementing these activities, the project will contribute to the sustainable use and conservation of NTFPs, benefiting both the environment and the well-being of the local communities.

Awareness programs – Forest, NTFP, and Wildlife Conservation
Comprehensive awareness programs will be conducted for the working personnel to educate them about the importance of the forest environment and the significance of maintaining a healthy ecosystem. These programs will emphasize the need to minimize the use of firewood, timber, and other forest products through sustainable practices.

Table 8. 3: Proposed awareness program – Forest and Wildlife Conservation

Nature of awareness program	Target group	Duration of training	Cost	No. of trainings	Remarks
Forest and Wildlife Conservation	Construction workforce, project staff, CFUG	One week	NPR 600,000/ District Total 24,00,000 for 5 years USD 20,000	Twice a year	The cost includes patrolling the project site for checking illegal hunting and poaching

Training on NTFP	CFUG, LFUG members	One week	NPR 600,000/ District Total 24,00,000 for 5 years USD 20,000	Twice a year	

Enforcement of rules and regulations
Strong rules and regulations will be enforced, particularly for the construction workforce. Strict measures will be implemented to deter and penalize individuals who violate these rules. The contractual agreements with the workforce and staff members will include clauses specifying the consequences of rule violations, including potential job dismissal.

Workers will be strictly prohibited from entering forest areas outside of their designated working hours unless they are locals. This measure aims at minimizing human disturbance and protect the integrity of these areas.

Construction workers will be strictly prohibited from cutting fuelwood or timber. This regulation aims to prevent unauthorized logging and depletion of forests.

The purchase, sale, and use of firewood, timber, and NTFP by construction workers will be strictly prohibited. Additionally, activities such as hunting and poaching will also be strictly prohibited. These measures aim to prevent the illegal exploitation of forest resources.

8.3.1.4 Protection species of conservation significance

According to the Forest Rules, compensatory plantations are mandatory for every felled tree in specific rations. For common trees, the ratio is 1:10, while for the protected species, ratio is 1:25 in case of protected areas such as National Parks and its buffer zones and Conservation Areas. In addition to these compensatory plantations, the project can also contribute to the conservation of protected species like Sal and Satisal, in forests of the project districts in collaboration with the community forest, collaborative forests, and Division Forest Office. The cost for the compensatory plantation of protected species is included in the previous section.

Germinating Sal tree seeds in nursery can be challenging due to their recalcitrant nature (Sinha & Pandey, 2020). This means that they have a very short period of viability and must be germinated quickly after harvesting. As a result, Sal tree seedlings are typically not developed in nursery. However, nursery development is feasible for seedlings of Vijay Sal and Sati Sal. There are several other tree species of indigenous origin that can be planted as substitutes for Sal such as Saaj, Seto Siris Baanjhi, Barro, etc. These species have relatively similar growth rates and timber qualities to Sal, and they can be more easily germinated in the nursery. Similarly other tree species that can be recommended for plantation are Harro, Amala, Sisau, Khayar, Pyaar, Tindu, Kusum, Chilaune, Rajbriksha, etc. that are equally useful for ecosystem protection and environmental regeneration.

Furthermore, the project places significant emphasis on preserving ground flora, which includes shrub and herb species of conservation importance. Notably, orchids such as *Vanda sp*. and *Cymbidium aloifolium* are classified as protected according to the Forest Act and Rules (Subedi, et al., 2013). *Cymbidium aloifolium*, commonly known as Aloe-leaved *Cymbidium* or Jaalpakshi in Nepal, holds great reverence in Nepali culture. It holds a vital role in religious ceremonies, festivals, and traditional rituals. Similarly, *Vanda* sp., a genus of orchids encompassing various species, is protected under Appendix II of the CITES.

To ensure the survival and proliferation of these species in their natural habitats, a translocation program is recommended. These orchids will be relocated to suitable habitats in nearby areas as part of *ex-situ* conservation efforts (Rajbhandari, 2014). Suitable locations for translocation include nearby botanical gardens such as Dhakeri Botanical Garden in Banke and protected areas like Banke and Bardia National Parks. These sites offer appropriate facilities and resources to facilitate effective *ex-situ* conservation practices.

Approximately USD 20,000 will be allocated to support the translocation and *ex-situ* conservation efforts of orchids and other ground vegetation. This allocation underscores the project's commitment to safeguarding these ecologically and culturally significant species for future generations.

By following these guidelines and initiatives, the project aims to mitigation the impact of tree felling, promote biodiversity conservation, and contribute to the sustainable management of forest resources.

8.3.1.5 Safety from forest fires

Forest fires pose a significant threat to the forests in the project area, with both natural and deliberate causes contributing to their occurrence (Kunwar, 2006) (Parajuli, Manzoor, & Lukac, 2023). The implementation of hydropower project may increase the incidences of forest fires in the area. To mitigate this risk and protect the forests, the following measures will be implemented.

Firebreaks and clearing

Creating firebreaks by clearing vegetation in strategic locations will help prevent the spread of fires. These areas will be carefully selected and maintained to effectively contain and control potential fire incidents. In collaboration with the DFO and user groups, these fire break lines will be constructed, for which a budget of USD 20,000 will be allocated.

Early detection and rapid response

Establishing a robust early detection system will be crucial in identifying and prompt response. The project will collaborate with the initiatives of ICIMOD and Department of Forest Research and Survey on forest fire detection and monitoring system to be implemented in the project districts. The project will support respective DFO and User groups in strengthening their capabilities in fighting forest fire. A budget of USD 30,000 will be allocated for this purpose.

Public awareness and education

A comprehensive awareness programs will be implemented to educate not only the workforce but also local about the severe consequences and unpredictable losses associated with forest and vegetation degradation. The contractor will be responsible for installing informative signages throughout the project area, emphasizing preventing forest fires. Additionally, in collaboration with the DFO, the project will organize training workshops to enhance awareness among the workforce and local communities.

The annual training program of 3 -5 days in each district, in close coordination with DFO, will be carried out. A budget of USD 12,000 will be allocated for this purpose.

By implementing these initiatives, the project aims to foster a culture of environmental responsibility and enhance the understanding of the local population regarding the crucial role forests play in sustaining ecological balance and livelihoods.

8.3.2 Forest Mitigation Measures - Operation Phase

8.3.2.1 Prevent pressure on the forests

The implementation of the project will inevitably increase accessibility to the surrounding forest areas, leading to potential pressure on these ecosystems. To mitigate such impacts, the following measures will be implemented by supporting the DFOs and user groups from the project area:

- The project will support to undertake afforestation in the project area, particularly in the immediate vicinity of the construction sites. This proactive measure will help minimize the impact on existing forests and contribute to the restoration and expansion of forest cover.
- The project will support to undertake a robust vigilance to prevent and deter illegal hunting and poaching activities.
- The project will support to build awareness amongst stakeholders and local communities about the value of forests and the importance of conserving wildlife. These programs will highlight the ecological importance of the forest ecosystem and foster a sense of responsibility and stewardship towards their conservation.

8.3.2.2 Conservation of plant of conservation significance

During the operation of the project, special attention will be given to nurturing afforested tree species, particularly those under protection category. These trees will be prioritized for nurturing and care over a period of 5 years, after which they will be handed over to DFOs for long term management. The cost for management of these sites have already been included above section.

The protected species that will be cleared during the construction include Sal and Sati Sal. Among these species, Sal is also recorded in surveyed plots. As a compensatory measures, seedlings will be planted following a ratio of 1:10 for each felled tree.

"Germinating Sal tree seeds in nursery can be challenging due to their recalcitrant nature (Sinha & Pandey, 2020). This means that they have a very short period of viability and must be germinated quickly after harvesting. As a result, Sal tree seedlings are typically not developed in nursery. However, nursery development is feasible for seedlings of Sati Sal. There are several other tree species of indigenous origin that can be planted as substitutes for Sal such as Saaj, Seto Siris, Baanjhi, Barro, *etc*. These species have relatively similar growth rates and timber qualities to Sal, and they can be more easily germinated in the nursery. Similarly other tree species that can be recommended for plantation are Harro, Amala, Sisau, Khayar, Pyaar, Tindu, Kusum, Chilaune, Rajbriksha *etc*., that are equally useful for ecosystem protection and environmental regeneration".

8.3.2.3 Conservation of biodiversity in the Project Area

During the operation phase of the project, there is a concern that plant species, particularly those that fall under the protection category and possess conservation significance, may face threats to their survival and well-being. To address this issue and ensure the preservation of these valuable plant species, a coordination mechanism will be put in place.

The project will establish a close collaboration with the Division Forest Office (DFO) to create a coordinated effort in safeguarding these protected and ecologically significant plant species. This coordination will be crucial in minimizing the potential threats posed to these species during the critical initial years of the project.

As part of this collaboration, the project will take on the responsibility of caring for the planted tree species during a specified period, typically set at five years. This proactive approach aims to mitigate any adverse impacts caused by the project's activities on the surrounding flora, especially the protected species.

The coordination mechanism will entail regular communication and information exchange between the project management and the DFO. This will allow for the identification of any emerging threats or issues that may affect the targeted plant species. Appropriate measures will be promptly taken to address these concerns, including implementing protective measures, monitoring the species' health and growth, and taking necessary conservation actions.

By engaging in this coordinated effort with the DFO, the project will demonstrate its commitment to environmental stewardship and responsible management of the surrounding biodiversity. The focus on protecting plant species with conservation significance ensures that these natural treasures are safeguarded for future generations and contributes to the overall sustainability and ecological balance of the project area.

8.3.3 Wildlife Mitigation Measures – Construction Phase

The implementation of the project, both during the construction and operational phases, will adversely affect both herpetofauna and mammal populations. The impacts will primarily stem from disturbances, poaching, and habitat loss. Consequently, safeguarding the local wildlife and their habitats becomes crucial to maintain the environmental balance of the area. This can be accomplished through the following measures.

8.3.3.1 Establishing the Rescue and Rehabilitation Centers

During the construction of the project, the sites can pose significant risk to wildlife, leading to occasional accidents involving both large and small animals. While it may be challenging to completely avoid such accidents, it is essential to address the well-being of the local wildlife that may get injured, trapped, or separated from their mothers.

To address these concerns, it is crucial to establish a "Rescue and Rehabilitation Centre" at the local level, working closely with the DFO. This center will serve as a dedicated facility to provide timely and appropriate care for injured and orphaned wildlife.

The Rescue and Rehabilitation Center should be well-equipped with the necessary resources and staffed with qualified personnel. The recruited staff should be trained in wildlife handling and care to ensure the safe and proper rescue, handling, and treatment of injured animals and those separated from their mothers.

Once rescued, the injured wildlife will receive necessary medical attention and care at the center. The staff will take every possible measure to rehabilitate the animals in captivity until they are completely recovered. During this rehabilitation process, the center will provide an environment conducive to their recovery and overall well-being.

Once the wildlife has fully recovered, they will be safely relocated back to their respective natural habitats, this process ensures that the rehabilitated animals have the best chance of reintegrating into the wild successfully.

The project has committed to allocate funds for the establishment of the "Rescue and Rehabilitation Center" for a period of 5 years during the project's construction phase. In the first year, a total of USD 150,000 will be allocated for infrastructure development, equipment procurement, and running costs.

Starting from the second year, a yearly budget of USD 30,000 will be allocated, summing up to a total of USD 270,000 for the center's operation over the span of 5 years. This financial support will ensure the center's effective functioning and the provision of necessary care for injured and orphaned wildlife during the critical period of the project's construction and operation.

8.3.3.2 Strict Enforcement of the Wildlife Conservation Related Rules and Regulations

During the construction phase of the project, the demand for mammalian meat and trophies may increase, leading to a rise in illegal hunting activities by both locals and the project workforce. The construction of roads may provide better accessibility to prime wildlife habitats, contributing to this issue. To prevent illegal hunting and protect sensitive areas, effective measures must be implemented.

Regulating access to local sensitive areas is essential to avoid illegal hunting. The project should collaborate with relevant line agencies to enforce existing legislations strictly. This includes monitoring and patrolling critical areas to deter and apprehend illegal hunters.

To strengthen the commitment against illegal hunting, the project should incorporate an "anti-illegal hunting" clause into contractual agreements with contractors, sub-contractors, and project employees. This clause should outline the prohibition of any illegal hunting activities and the legal consequences that may follow if violated.

Moreover, the project area is home to globally and nationally endangered species, holding significant importance to local communities, as stated in the IFC GN6 and ADB Safeguard Policy Statement (SPS) (2009). Given this, the project qualifies as a Critical Habitat under the International Finance Corporation's Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Resources. This designation identifies areas of high biodiversity value that require special attention and sensitive development.

Considering its Critical Habitat status, the project must exercise extra caution and responsibility in protecting local wildlife and their habitats. This entails implementing mitigation measures to minimize the project's impact on the critical areas and ensuring the preservation of endangered species and their habitats.

By adopting these measures, the project can play a pivotal role in safeguarding the local wildlife, maintaining ecological balance, and promoting responsible development practices that align with international standards on biodiversity conservation.

The expenses associated with implementing these initiatives will be included in the project's operating cost.

8.3.3.3 Awareness and Training Programs on Biodiversity Conservation

To promote biodiversity conservation and raise awareness in the project area, it is essential to implement various communication and educational initiatives. One effective approach is to publish and distribute general biodiversity conservation awareness posters and pamphlets in the local Nepali language. These materials should be strategically placed in key locations throughout the project area to reach a wider audience.

Additionally, signboards with information about rules and regulations related to wildlife poaching should be prominently displayed in various strategic points. This helps inform both locals and visitors about the legal provisions in place to protect wildlife and deter illegal activities.

It is crucial to address the issue of outsider wildlife poachers and illegal traders who may target animals like Barking deer and Ghoral. Many local people may unknowingly assist these activities due to a lack of awareness about existing legal provisions. To combat this, regular biodiversity conservation awareness-related training sessions should be conducted for the local community. These training sessions should cover topics such as the importance of local biodiversity, the factors leading to biodiversity loss, the significance of public participation in conservation efforts, and an understanding of existing wildlife conservation rules and regulations.

To facilitate these training sessions, a comprehensive Training Manual should be prepared and distributed among key stakeholders. This manual can be provided to local schoolteachers, senior class students, and community forest users' groups, who can then pass on the knowledge to a broader audience. By empowering the local community with knowledge about biodiversity conservation, the project aims to foster a sense of ownership and responsibility among the people for protecting the region's rich natural heritage.

The combination of educational materials, awareness campaigns, and training sessions will contribute to building a more informed and environmentally conscious community, thus bolstering efforts towards effective biodiversity conservation in the project area. The budget allocated for these works is USD 10,000 a year for 5 years, totaling an amount of USD 50,000.

8.3.3.4 Training to Local Contractors, Supervisors, and other Staff

The main contractors, sub-contractors, supervisors, and technical staff of the project wield significant influence over the labor force involved. They are in a prime position to effectively manage and control their workforce, preventing them from engaging in biodiversity-related illegal activities. Educating these key personnel about existing rules and regulations related to biodiversity conservation and the consequences of violating them can play a vital role in curbing such activities in the area.

To achieve this, it is crucial to provide biodiversity conservation-related awareness training to all project staff and contractors right from the beginning of the project. This training should also be conducted periodically to reinforce the importance of biodiversity conservation throughout the project's duration. The training program should cover a range of topics, including:

- ***Importance of Biodiversity Conservation:*** Explaining the significance of preserving local wildlife and ecosystems for the overall health of the environment and human well-being.
- ***Project-Generated Threats to Local Wildlife:*** Raising awareness about potential impacts the project may have on the surrounding wildlife and their habitats.
- ***Responsibility of Project Implementing Agencies:*** Emphasizing the project's responsibility in protecting biodiversity and adhering to conservation guidelines.
- ***Biodiversity Conservation Rules and Regulations:*** Familiarizing participants with existing laws and regulations related to wildlife protection and conservation.
- ***Prevention of Project-Related Injury to Wildlife:*** Providing guidance on how to avoid harming or disturbing wildlife during project activities.
- ***Identification of Likely Species in the Project Area:*** Training participants to recognize local wildlife species to ensure their protection.
- ***Identification of Potential Wildlife Hazards:*** Educating about potential dangers, such as encounters with venomous snakes, and how to handle such situations safely.

- ***Handling Encounters with Dangerous Animals:*** Guiding participants on proper protocols when encountering dangerous animals to ensure human safety and wildlife well-being.

To support the training efforts, a comprehensive Training Manual should be developed and distributed to all personnel involved in the project, including the labor force. This manual will serve as a valuable reference guide, reinforcing the knowledge gained during training sessions.

By equipping the project staff and contractors with the necessary knowledge and awareness, the project can establish a culture of responsible environmental practices, leading to more effective biodiversity conservation efforts and a reduction in biodiversity-related illegal activities in the area. The training costs are included in section 8.1.1.3.

8.3.4 Wildlife Mitigation – Operation Phase

8.3.4.1 Minimize nuisance caused by operation of the project

The operation of the project, especially in the headworks and powerhouse areas, along with the camps, is anticipated to disturb the local wildlife due to factors such as high-intensity lights, equipment noise, and human presence at the site. To mitigate these nuisances, the following measures can be implemented.:

Lighting management

- use downward facing, shield, and low-intensity lighting to minimize light pollution and its impact on wildlife.
- Implement motion-activated lighting systems to reduce continuous light presence when not required.
- Turn-off non-essential lighting during the night to minimize disturbances to nocturnal wildlife.

Noise management

- Soundproof barriers and acoustic materials around noisy equipment and machinery to reduce noise propagation within the powerhouse.
- Regularly maintain and service equipment to ensure smooth operation and reduce noise levels caused by wear and tear.
- Choose quieter equipment and machinery during the design and construction phase to minimize noise generation.

Awareness and training

- Conducting training sessions for the powerhouse staff to raise awareness about the sensitivity of local wildlife to disturbances. They will be educated on light and noise management techniques, fostering a culture of wildlife consciousness among the staff.
- Placing signages in wildlife-sensitive areas, including wildlife crossing signs and prohibitions against honking vehicles, to reduce potential disturbances to wildlife and promote their safe movement.

8.3.4.2 Minimize Habitat Loss and Degradation

To address the significant alterations to local wildlife habitats during the operation phase of the project, the following mitigation measures can be implemented:

- **Habitat Restoration and Creation**: Develop habitat restoration plans to compensate for areas lost due to reservoir formation. Create new habitats in suitable locations to support wildlife populations.
- **Wildlife Corridors:** Establish wildlife corridors that connect fragmented habitats, allowing animals to move freely between different areas and access necessary resources.
- **Monitoring and Research:** Conduct regular monitoring and study to understand the impacts on wildlife populations and behaviors. This information will help in adapting mitigation measures as needed.
- **Low Water Zone Management:** Implement measures to manage the low water zone downstream of the barrage to ensure sufficient water availability for wildlife, especially during critical periods, by maintaining adequate Environmental Flow (Eflow) levels.
- **Public Awareness and Education**: Engage with local communities and stakeholders to raise awareness about the importance of wildlife conservation and the need for effective mitigation measures.
- **Stakeholder Collaboration**: Collaborate with local communities, conservation organizations, and government agencies to ensure a holistic approach to wildlife protection and habitat management.

By incorporating these mitigation measures, the project can minimize the impacts on local wildlife and promote the conservation of biodiversity in the affected areas. Continuous monitoring and adaptive management will be essential to ensure the effectiveness of these measures and maintain a balance between hydropower generation and wildlife conservation.

8.3.4.3 Minimize Habitat degradation due to inadequate waste disposals

Mitigation measures to address solid waste and wastewater impacts during the project's operational phase are essential to protect the region's ecological integrity and wildlife habitats. The following measures can be implemented:

- **Solid Waste Management:** Establish a comprehensive waste management plan that includes proper segregation, recycling, and responsible disposal of solid waste generated from camps and project sites. Regular waste collection and proper waste disposal facilities should be provided to prevent soil and habitat degradation.
- **Wastewater Treatment:** Install wastewater treatment systems to treat the discharge before releasing it into streams. Proper treatment will help maintain water quality and preserve aquatic life, benefiting species like turtles, crocodiles, and otters that rely on clean water for survival.
- **Environmental Monitoring:** Conduct regular environmental monitoring to assess the impacts of solid waste and wastewater discharge on the ecosystem and wildlife. Monitoring data will aid in adjusting mitigation measures as needed.

- **Public Awareness**: Engage with project staff, local communities, and stakeholders to raise awareness about the importance of responsible waste management and the significance of protecting the environment and wildlife.
- **Stakeholder Collaboration:** Collaborate with relevant authorities, conservation organizations, and local communities to ensure collective efforts in mitigating the impacts on wildlife and their habitats.

By implementing these mitigation measures, the project can minimize the negative impacts of solid waste and wastewater discharge, preserve the ecological balance, and protect the wildlife and their habitats in the project area. Responsible waste management practices and proper treatment of wastewater will contribute to the sustainable operation of the project and the overall well-being of the surrounding ecosystem.

8.3.4.4 Illegal Hunting of the wildlife

To mitigate the potential impacts of increased mobility and illegal hunting on local wildlife populations, the following measures can be implemented:

- **Community Engagement and Awareness:** Conduct awareness campaigns and community engagement programs to educate the local community about the importance of wildlife conservation and the negative impacts of illegal hunting. Emphasize the value of conserving wildlife for ecological balance and tourism potential.
- **Enforcement and Surveillance:** Strengthen law enforcement efforts in collaboration with the DFO and CFUGs to prevent illegal hunting activities. Support them to increase patrols and surveillance in sensitive wildlife areas to deter potential poachers.
- **Community-Based Conservation Initiatives:** Involve the local community in conservation initiatives and sustainable livelihood programs that promote alternative income sources, reducing the incentive for illegal hunting.
- **Compensation for Wildlife Damage**: Establish compensation programs for crop and livestock damage caused by wildlife to minimize conflicts and discourage retaliatory killing.
- **Ecological Monitoring:** Conduct regular ecological monitoring to assess the impacts of increased human activity and illegal hunting on wildlife populations. This data will aid in identifying areas that require further conservation measures.
- **Reporting and Whistle-blower Programs**: Encourage the community to report illegal hunting activities through confidential reporting mechanisms. Whistle-blower programs can incentivize individuals to report illegal activities without fear of reprisal.
- **Legal Framework and Penalties:** Support DFO to strengthen implementation of the legal framework and penalties for wildlife poaching to deter potential offenders.
- **Wildlife Rescue and Rehabilitation:** Support DFO to continue with the wildlife rescue and rehabilitation centers to support injured or displaced wildlife and ensure their safe return to the wild.

By implementing these mitigation measures, the project can address concerns related to illegal hunting and conflicts with wildlife, promoting coexistence between humans and local wildlife while maintaining the ecological balance and conserving local biodiversity in the project area.

8.3.5 Bird Mitigation Measures – Construction Phase

8.3.5.1 Protection of Bird Habitat

During the construction phase of the project, there will be a need to clear the vegetation to make ways for the project components. Unfortunately, this action will result in habitat loss for various wildlife, including birds. The removal of trees and vegetation will lead to habitat fragmentation, meaning the natural environment will be broken up into smaller and isolated patches, which can disrupt the normal movement and behavior of avifauna.

To mitigation the impacts of habitat loss and tree felling on bird populations during the construction phase of the project, the following measures can be implemented:

- Habitat Restoration: Develop a habitat restoration plan that includes replanting native vegetation and creating new nesting sites for birds that may have been affected by habitat loss. Planting native trees and shrubs can help recreate a suitable environment for avifauna.
- Artificial Nesting Platforms: Install artificial nesting platforms or bird boxes in the project area to provide alternative nesting sites for birds that rely on trees for breeding.
- Roosting Poles and Perches: Erect roosting poles and perches in the vicinity to compensate for the loss of elevated roosting sites. These structures can provide vantage points for birds to rest and socialize.
- Protected Nesting Areas: Identify and protect certain areas with a high concentration of nesting birds to ensure their safety during the construction phase.
- Monitoring and Surveys: Conduct regular bird monitoring and surveys before, during, and after construction to assess the impacts on bird populations and identify areas that require special conservation efforts.
- Construction Scheduling: Plan construction activities around bird breeding seasons and avoid activities that may cause significant disturbances during critical periods.
- Public Awareness: Raise awareness among project workers and local communities about the importance of protecting bird habitats and nesting sites during the construction phase.
- Expert Consultation: The Environmental and Social Management Unit will include and/or consult with the bird conservation experts and organizations such as Bird Conservation Nepal (BCN) to incorporate best practices for avian protection and habitat conservation during the construction phase.
- Adaptive Management: Implement adaptive management strategies, allowing for adjustments in construction plans based on bird monitoring data and expert recommendations.

By implementing these mitigation measures, the project can help protect bird populations, preserve critical nesting and roosting sites, and promote the overall conservation of avifauna in the project area. It is essential to balance infrastructure development with wildlife preservation to ensure a sustainable and ecologically responsible construction process.

8.3.5.2 Minimize Disturbances to Avifauna

During the construction phase, various project activities like transporting construction materials, operating equipment. Vehicular mobility, and muck disposal can have negative effects on avifauna in the project area. To mitigation the negative effects of the construction activities, the following measures can be implemented:

- Noise Management: Implement noise reduction strategies, such as using noise barriers and scheduling noisy activities during less sensitive bird periods, to minimize disturbances to avifauna. Placing signages in bird-sensitive areas, such as prohibitions against honking vehicles.
- Lighting Management: Use lighting that is bird-friendly, such as motion-activated or shielded lighting, to reduce disturbances to nocturnal bird species.
- Construction Scheduling: Plan construction activities to avoid peak bird breeding seasons and times when birds are most vulnerable to disturbances.
- Awareness: Raise awareness among construction workers and local communities about the importance of protecting bird habitats during construction and the significance of avifauna conservation.

By incorporating these mitigation measures, the project can minimize the negative impacts of construction activities on avifauna, protect bird populations, and contribute to the overall conservation of bird species in the project area. Striking a balance between development and wildlife preservation is essential for sustainable infrastructure projects that respect and protect the local biodiversity.

8.3.5.3 Protect the habitat and foraging ground for Avifauna

During the construction, the project will be undertaking excavation, tunnelling, quarrying, and disposal of spoils and muck, all of which can result in increased sedimentation of the rivers. The increased turbidity can have significant implications for the local ecosystem, particularly for riparian birds that depend on these waters for their survival. To mitigate the negative impacts of increased sedimentation and turbidity during construction on riparian birds, the following measures can be implemented:

- Sedimentation Control: Implement effective sedimentation control measures during excavation, tunnelling, quarrying, and muck disposal to prevent excessive sediment runoff into the rivers.
- Sediment Basins and Filters: Install sediment basins and filtration systems to trap and remove sediment from construction runoff before it enters the rivers.
- Construction Scheduling: Plan construction activities to avoid sensitive periods for riparian birds, such as breeding and nesting seasons, when they are most vulnerable to disturbances.
- Environmental Monitoring: Conduct regular monitoring of water quality, turbidity levels, and bird populations to assess the effectiveness of mitigation measures and identify any potential impacts.
- Adaptive Management: Implement adaptive management strategies to make necessary adjustments to construction practices based on monitoring data and expert recommendations.

- Public Awareness: Raise awareness among construction personnel and local communities about the importance of protecting riparian bird habitats and the potential consequences of increased turbidity.
- Expert Consultation: Consult with ornithologists and avian experts to understand the specific needs of riparian birds and incorporate best practices for their protection.

By incorporating these mitigation measures, the project can minimize the negative impacts of increased sedimentation and turbidity on riparian birds, protect their habitats, and contribute to the conservation of these avian species. Balancing development with environmental preservation is crucial to ensure the sustainable coexistence of infrastructure projects and local wildlife.

8.3.6 Bird Mitigation Measure - Operation Phase

8.3.6.1 Promote habitat creating within the Project Area

Reservoirs, despite offering appealing habitats for water birds, can have significant negative impacts on various bird species. When reservoirs are created, they often flood specific habitats and seasonal areas, which results in the loss of vital sites for reproduction, feeding, and resting for many bird species. The natural cycles of flooding and droughts, which serve as important cues for birds regarding food availability and migration paths in riverine regions, are disrupted by the presence of reservoir. To mitigate the negative impacts of reservoirs on bird species, the following measures can be implemented:

- Habitat Creation: The creation of the reservoir will provide favorable habitats for bird species, promoting the presence of both local and migratory birds for breeding, feeding, and resting. To safeguard these bird populations, the project must collaborate with the Division Forest Office, Tanahu and local security forces to prevent any poaching and hunting activities within the reservoir area.
- Environmental Flows: Regulate water releases from the reservoir to mimic natural flooding and drought cycles, providing cues for bird species about food availability and migration paths in riverine regions.
- Protected Areas and Wildlife Corridors: Designate protected areas around reservoirs and establish wildlife corridors to allow for the movement of bird populations and maintain connectivity between fragmented habitats.
- Nesting Platforms: Install nesting platforms and artificial structures in the reservoir area to compensate for the loss of natural nesting sites.
- Monitoring and Study: Conduct regular monitoring and study on bird populations to assess the impacts of the reservoir and tailor mitigation strategies accordingly.
- Public Awareness: Raise awareness among stakeholders, local communities, and reservoir operators about the importance of bird conservation and the potential impacts of reservoir creation.
- Adaptive Management: Employ adaptive management practices, allowing for adjustments to reservoir operations and conservation strategies based on monitoring data and expert recommendations.
- Hydroelectric Plant Operations: Coordinate water release from the tailrace to minimize sudden surges and allow bird species with reduced flight capabilities to escape safely.

- Conservation Partnerships: Collaborate with bird conservation organizations and experts to develop and implement effective mitigation strategies.

By incorporating these mitigation measures, reservoir projects can help reduce the negative impacts on bird species, maintain bird diversity, and support the natural movement patterns and life cycles of avian populations. Balancing the benefits of reservoir creation with the conservation of bird habitats is essential for sustainable development and wildlife preservation.

8.3.6.2 Impact on reservoir filling on bird population

The creation of the reservoir can significantly affect resource availability and species interactions, influencing the reproductive success and survival of bird populations. While some birds may return to the area, many may be compelled to leave during the reservoir filling phase. Additionally, opportunistic species, including predators that feed on fish and insects, are attracted to the newly available prey. This influx of opportunistic species near the reservoir can intensify density-dependent processes, such as competition, predation, and parasitism, leading to a restructuring of the bird communities.

To mitigate the impacts of reservoir formation on bird populations and promote ecological stability, the following measures can be implemented:

- Conservation Zones: Designate specific conservation zones within and around the reservoir area to protect critical bird habitats and nesting sites.
- Predator Control: Implement predator control measures, especially for invasive or opportunistic species, to mitigate potential negative impacts on bird communities.
- Biodiversity Monitoring: Conduct regular biodiversity monitoring of avian diversity across the project area to assess changes in species composition and identify shifts in community structure over time.
- Adaptive Management: Adopt adaptive management practices that allow for adjustments in reservoir management and conservation strategies based on monitoring data and scientific findings.
- Public Awareness and Education: Raise awareness among local communities and stakeholders about the importance of bird conservation and the ecological significance of maintaining diverse bird populations.
- Expert Consultation: Seek guidance from ornithologists and bird conservation experts to design effective mitigation measures and promote the long-term well-being of bird communities.
- Reservoir Operations: Optimize reservoir operations to minimize disturbances to bird habitats and ensure water levels support avian populations throughout different life stages.
- Collaboration with Authorities: Collaborate with relevant authorities, such as the DFO, to enforce regulations and prevent illegal hunting or poaching activities within the reservoir area.

By implementing these mitigation measures, the project can support bird populations, maintain ecological stability, and contribute to the long-term conservation of avian diversity in and around the reservoir area. Preserving a variety of bird species and their habitats is vital for the overall health and resilience of the ecosystem.

8.3.6.3 Ensure Food Availability for Bird

The construction of the barrage on the Seti River, diverting water to the powerhouse, will result in formation of 13 km long reduced water zone downstream of the barrage up to the confluence of Seti with the Trishuli River. This reduced water zone will have a substantial impact on the natural flow of water downstream, reducing it to a level that can only sustain basic ecological flow for supporting aquatic biodiversity.

To mitigate the impact of the reduced water zone on riparian birds and aquatic biodiversity, the following measures can be implemented:

- Maintain Environmental Flow: Ensure a minimum ecological flow (e-flow) in the reduced water zone downstream of the barrage to support aquatic biodiversity and provide essential habitats for riparian birds.
- Restore Habitats: Undertake habitat restoration efforts along the reduced water zone, creating additional habitats for riparian birds, such as wetlands and riverbank vegetation.
- Monitor Bird Populations: Conduct regular monitoring of riparian bird populations in the affected areas to assess their status and guide conservation efforts.
- Manage Fisheries: Implement strategies to support fish populations, ensuring a stable food source for fish-eating birds.
- Create Wildlife Corridors: Establish wildlife corridors to facilitate the movement of riparian bird populations between different habitats, allowing for adaptation to changes in water flow.
- Protect Riparian Zones: Designate protected riparian zones along the river to preserve natural habitats and nesting sites for riparian birds.
- Raise Awareness: Educate local communities and stakeholders about the importance of maintaining ecological flow and protecting riparian bird habitats.
- Engage Stakeholders: Involve local communities, conservation organizations, and relevant authorities in decision-making processes to collectively mitigate impacts on riparian bird populations.
- Practice Adaptive Management: Adopt adaptive management practices, adjusting in water flow and conservation strategies based on monitoring data and expert recommendations.
- Implement an Ecosystem-based Approach: Manage water resources with an ecosystem-based approach that considers the interconnection of aquatic biodiversity and riparian bird populations.

By implementing these mitigation measures, the project can support riparian bird populations and preserve aquatic biodiversity in the reduced water zone downstream of the barrage. Striking a balance between hydropower needs and ecological preservation is crucial for the long-term sustainability of the ecosystem and its avian inhabitants.

8.3.7 Aquatic Life Mitigation Measures – Construction Phase

8.3.7.1 Facilitate fish migration

During the initial construction phase of the project, a coffer dam will be constructed at the headworks to create a dry riverbed for building the barrage. To maintain the river's connectivity between upstream and downstream of the coffer dam, a diversion tunnel will redirect the river's flow. However, this diversion tunnel may pose challenges for migrating fish attempting to navigate through it. The presence of 22 migratory fish species identified in the area makes them particularly vulnerable to this obstacle. To minimize the impact on the fish and the environment, the following mitigation measures will be implemented:

- ***Designing Fish-Friendly Diversion Tunnel***: The hydraulic characteristics of the diversion tunnel will be carefully designed to mimic a natural flow regime as closely as possible. The goal is to ensure that the water flow through the tunnel remains gentle and conducive for fish passage.
- ***Incorporating Fish-Friendly Features***: Special attention will be given to making the diversion tunnel as fish-friendly as possible. Fish-friendly design features, such as baffles or resting areas, may be incorporated to facilitate the movement of migratory fish and prevent them from getting trapped or injured during their journey.
- ***Minimizing Diversion Duration***: Recognizing the importance of reducing the impact on the fish and the river ecosystem, the project team will work diligently to carry out the diversion for the shortest period possible. By minimizing the time of diversion, disturbances to the river's ecosystem and aquatic life can be limited.
- ***Implementing Sediment Control Measures***: During the diversion period, measures will be implemented to prevent the deposition of spoil and mud in the river. Proper sediment control methods, such as silt curtains or sediment basins, will be utilized to contain and manage any sediments that may arise during construction activities. This proactive approach will prevent water contamination and maintain water quality during the diversion process.

By implementing these mitigation measures, the project aims to reduce the impact of the river diversion on migratory fish and the overall aquatic ecosystem, ensuring the construction proceeds in an environmentally responsible manner.

8.3.7.2 Minimize Fish Stranding

During the initial phase of river diversion, there exists a potential risk of fish stranding at the headwork area. Fish stranding occurs when fish become trapped in isolated pools or sections of the river that have lost their normal water flow, posing hazards to the fish population for various reasons.

To mitigate this risk, the project will implement the following measures:

- Careful and gradual dewatering process during the river diversion phase. This approach involves reducing the water flow in the river channel slowly, giving the fish sufficient time to adjust and move to safer areas.
- Gradual dewatering process, a fish capture and relocation plan will be executed to protect the fish population during the diversion.

- Specially designed fish capture methods, such as traps or nets, will be used to safely capture the fish within the area affected by the diversion. Once captured, the fish will be carefully transported and relocated to suitable habitats either upstream or downstream of the coffer dams. This relocation process ensures that the fish can continue their natural migration and movement patterns in the river without getting trapped or isolated by the construction activities. The fish relocation efforts will be conducted with the utmost care and consideration for the well-being of the fish. Experienced personnel, such as biologists or environmental experts, will be actively involved in the process to ensure that it is carried out in a manner that minimizes stress and harm to the fish population.

By implementing these measures, the project aims to safeguard the fish population and maintain the ecological balance in the river during the diversion phase. This commitment to environmentally responsible practices demonstrate the project's dedication to ensuring that the construction activities do not cause unnecessary harm to the aquatic life in the area.

8.3.7.3 Protection of Riparian Habitat, and Prevent Soil Erosion, and Sediment Deposition into the River

Most of the construction works carried out in this project will locate in proximity with the river, thus, can significantly affect the morphology, water quality, as well as ecology of the Seti as well as Trishuli Rivers. The construction activities include river diversion, excavation works, mining, tunnel excavation, construction of roads, barrages, and others. Therefore, one of the major concerns is destruction of riparian habitats.

To ensure the protection and prevention of the surrounding environment, particularly the riparian habitats and water quality, a comprehensive set of measures will be implemented during the construction phase.

- ***Riparian Habitat Protection***: Recognizing the importance of healthy riparian vegetation, efforts will be made to maintain and protect these habitats to the greatest extent possible. Construction activities crossing through riparian areas will be carefully planned and executed to minimize any damage to the vegetation. Where necessary, immediate re-vegetation with fast-growing native plant species will be carried out to restore the riparian habitat and promote its recovery.
- ***Runoff and Wastewater Management***: To prevent the contamination of the river, runoff from construction sites and tunnel works will be collected in sedimentation ponds or traps before being discharged back into the water body. All hazardous substances will be securely stored and managed in designated sealed areas with proper drainage systems to capture all wastewater for treatment. Measures will also be put in place to prevent and manage spills effectively.
- ***Spoil Area Management***: Spoil areas, where excess materials are stored, will be carefully constructed with bunding, drainage, and retaining walls to prevent the leaching of contaminated water into the environment. This will further protect the water quality and reduce the risk of pollution.
- ***Sediment and Erosion Control:*** A comprehensive sediment and erosion control plan will be developed and strictly implemented to minimize sedimentation in the water body. Various erosion control measures, such as silt fences, erosion control blankets,

and vegetative buffers, will be employed to prevent soil erosion and maintain the water's clarity.

- ***Riverbank Protection and Stabilization:*** The riverbank will be protected and stabilized to prevent erosion and the loss of valuable soil into the water. Techniques like bioengineering and riprap may be employed to reinforce and stabilize vulnerable sections of the riverbank.
- ***Waste Disposal:*** Proper waste management practices will be adhered to during construction. Solid waste generated from the construction activities will be disposed of at designated sites, following environmental regulations and guidelines.
- ***Wastewater Treatment:*** Any wastewater arising from construction or camp facilities will undergo appropriate treatment before being discharged into the water body.

This will ensure that the water released back into the river meets environmental standards and poses no harm to aquatic life or water quality.

By implementing these comprehensive measures, the project aims to protect and preserve the riparian habitats, maintain water quality, and mitigate the environmental impacts of the construction activities on the surrounding ecosystem and water resources. It reflects a commitment to sustainable construction practices that prioritize environmental conservation and responsible development.

8.3.7.4 Prevent Fishing by the workforce and locals

During the initial diversion phase of the Seti River, there is a potential risk of fish stranding in certain areas. This occurs when the water level is suddenly and temporarily reduced, leaving the fish stranded on dry land or in isolated pools. There is a possibility that locals and construction workers might take advantage of this situation and engage in fishing activities.

To ensure responsible fishing practices and minimize the impact on fish stocks during the construction phase, a series of specific measures will be implemented to raise awareness among workers and prevent fish capture during the river diversion and in the diversion area afterwards.

- ***Awareness Training:*** Workers involved in the construction activities will undergo comprehensive training on fishing regulations and the significance of protecting fish during the diversion phase. The training will emphasize adherence to the regulations and avoidance of any activities that could harm fish populations. Workers will be made fully aware of the potential consequences of non-compliance, including immediate termination for those found trapping or fishing in the diversion reach in violation of the regulations.
- ***Fish Exclusion Measures during Blasting***: Proactive measures will be taken to prevent damage to fish stocks caused by blast shocks. Fish exclusion measures will be implemented to prevent fish from accessing the blast areas. Temporary fencing or screens will be erected in the river around the blast zone, creating a physical barrier that keeps fish away from the potentially hazardous area. Furthermore, the use of explosives will be timed to periods when fish are less likely to be in the area, such as daylight hours or the dry season when fish movement is reduced.
- ***Environmental Monitoring***: Regular environmental monitoring will be conducted to assess the impact of construction activities on fish populations and their habitats. This monitoring will help identify any potential issues or unintended consequences related

to fish populations, allowing for timely adjustments or additional mitigation measures if needed.

- ***Collaboration with Fisheries Experts***: The project will establish collaboration with fisheries experts and environmental agencies to gain valuable insights and recommendations for fish protection measures during the construction phase. Expertise from these entities will be integrated into the project's planning and execution to ensure the most effective conservation strategies are employed.

By implementing these measures, the project aims to safeguard fish populations and maintain environmental conservation standards throughout the construction process. The focus on awareness training, fish exclusion during blasting, and close collaboration with experts reflects a commitment to responsible and sustainable practices, prioritizing the protection of fish and aquatic ecosystems

8.3.8 Aquatic Life Mitigation Measures - Operation Phase

8.3.8.1 Prevent Sediment deposition in the reservoir

During the project operation, notable changes are expected in the sediment transport and deposition patterns of the Seti. The sediments coming into the river from the immediate catchment area as well as Madi river might increase the turbidity of the reservoir and deteriorating the water quality, which will affect the fish population.

To mitigate soil erosion and sediment transport during the construction of the project, a comprehensive approach will be adopted, focusing on both the catchment area and downstream of the tailrace.

- ***Catchment Area Management***: Efforts will be made to reduce sediment production in the catchment through effective erosion control methods. Land management approaches, such as afforestation and terracing, will be implemented to stabilize the soil and prevent erosion. Afforestation involves planting trees and vegetation to hold the soil in place and minimize runoff. Terracing creates level steps on steep slopes, reducing the speed of water flow and preventing erosion. By applying these techniques, sediment production in the catchment area will be reduced, thereby decreasing the potential for sediment reaching the reservoir.
- ***Sediment Trapping***: Measures will be taken to trap sediment before it reaches the reservoir. Sedimentation ponds or traps will be strategically constructed to capture sediment-laden runoff from construction activities. These sediment traps will allow the sediment to settle, preventing it from reaching the reservoir and reducing the risk of sedimentation.
- ***Downstream Soil Erosion Mitigation***: Downstream of the tailrace, various techniques will be employed to minimize soil erosion. Vegetation plantation along the riverbank will stabilize the soil and prevent bank erosion. Bioengineer practices, which involve using natural materials like plants and rocks to control erosion, will be utilized to reinforce vulnerable areas. Rock riprap, which involves placing large rocks along the riverbank, and gabions, which are wire cages filled with stones, will be employed as additional erosion control measures.

- ***Sediment and Erosion Control Plan:*** A detailed sediment and erosion control plan will be developed before the project construction begins. This plan will outline specific measures to minimize sedimentation of the water body, ensuring that construction activities are carried out in an environmentally responsible manner.

By implementing these soil erosion and sediment control measures, the project aims to minimize the impact on the river's ecosystem and water quality. This approach reflects a commitment to sustainable construction practices that prioritize the preservation of the environment and the long-term health of the water body.

8.3.8.2 Environmental Flow in Reduced Water Zone

Due to the project operation, the downstream stretch of the river, spanning about 14 km from the Barrage to the S/T confluence will experience lower discharge. This decrease flow leads to vegetation proliferation along the riverbanks, resulting in a more stable river course, which reduces lateral erosion and sediment transport to the area. However, this diminished sediment transport can compromise the availability of food sources for macro-invertebrates in the reduced water zone, particularly in the Seti River, where the discharge will be significantly lower. Many of these organisms rely on specific microhabitats or sediment layers to find food, such as algae, organic matter, and detritus. The obstruction of sediment transport downstream of the barrage can disrupt the availability of these food sources, partially leading to food shortages for macro-invertebrate populations. This can have cascading effects on the entire river ecosystem, as these organisms serve as vital food sources for fish and birds.

The TSHPP project will implement specific mitigation measures to address the potential impacts of reduced water flow during the dry season on the river stretches downstream of the barrage up to the Trishuli river confluence. These measures are designed to minimize the loss or degradation of aquatic habitat, particularly critical spawning, and nursing grounds for key species like *Tor putitora*.

Minimum Environmental Flow:
To protect the river's ecological balance, the TSHPP project has proposed a minimum environmental flow of at least 5.08 m^3/s during the dry season. The established depth is essential for the survival and well-being of key species like Tor putitora, as it provides suitable conditions for their reproductive activities and sustenance.

To ensure the effectiveness of implementing a minimum environmental flow during the dry season, continuous monitoring of fish and macroinvertebrate populations, as well as river use activities, will be carried out during the initial phase of operation. This monitoring process will provide valuable data on the response of the river ecosystem to the minimum flow release.

The abundance of fish and macroinvertebrate taxa will be assessed to determine if the recommended flow is adequate to sustain their populations and essential habitats. Additionally, the monitoring will evaluate the impact of the minimum flow on the overall river use activities and the socio-economic aspects related to it.

If the monitoring findings indicate that the recommended minimum flow is insufficient to meet the ecological requirements of the river and support the biodiversity, the project will take an adaptive approach. Based on the data collected, necessary adjustments will be made to the minimum environmental flow, ensuring that it remains sufficient for the river's health and ecosystem balance.

Compliance with Hydropower Development Policy:
The TSHPP project ensures that the implemented minimum environmental flow aligns with the requirements stipulated in the Hydropower Development Policy of 2001. This policy framework aims to maintain ecological integrity while harnessing hydropower potential, guiding responsible water resource management practices.

By implementing these mitigation measures, the TSHPP project demonstrates its commitment to protecting aquatic habitats, preserving critical spawning, and nursing areas, and maintaining the overall health and sustainability of the river ecosystem. The proactive and adaptive approach underscores the project's dedication to responsible water resource management and environmental conservation.

8.3.8.3 Maintain water quality of the reservoir

The formation of the reservoir along the Seti River will permanently transform a portion of its natural riverine habitat into a lacustrine habitat. This transformation will significantly impact the river ecosystem, affecting sediment accumulation, substrate composition, water temperature, water level fluctuations, light penetration, nutrient accumulation, and dissolved oxygen levels. These changes will have implications for the availability and quality of habitats for aquatic species, potentially altering biodiversity and ecological dynamics. Proper management and mitigation strategies will be crucial to ensure the sustainable conservation of aquatic life in the area.

To address the issue of nutrient accumulation and delay eutrophication in the reservoir, specific measures will be implemented during the construction phase. Before filling the reservoir, the existing vegetation in the area will be removed to reduce the initial nutrient load. This action aims to prevent excessive nutrient input into the reservoir, which could lead to eutrophication and subsequent algal overgrowth.

Furthermore, bioengineering techniques will be employed to stabilize loose slopes in the reservoir rim. These techniques involve the use of natural materials and native plant species to reinforce and stabilize the reservoir's edges. Local species will be selected for planting, as they are better adapted to the local climate and soil conditions. The bank stabilization measures will prevent erosion and sedimentation, minimizing the input of nutrients from eroded soil and protecting water quality.

By applying these measures, the project aims to create a more stable and balanced ecosystem within the reservoir. Reducing nutrient accumulation and employing bioengineering methods will contribute to the long-term health and sustainability of the aquatic environment, mitigating the potential negative impacts of eutrophication and ensuring a healthier habitat for aquatic species.

8.3.8.4 Enhance Spawning and Nursing Grounds

The creation of the reservoir may result in the loss of crucial spawning and nursing areas for fish, affecting the survival of fish larvae due to the still waters causing eggs to sink to the bottom. Different fish species will experience varying effects, with some facing declines while others remaining unaffected. Fish may also encounter challenges such as shoreline erosion and rapid drawdown, impacting their reproduction. On the positive side, the reservoir can benefit aquatic birds by providing a new habitat. The project could also offer employment opportunities for local fishermen and communities through fish trapping, hauling, and tourism development. Overall, the project will significantly impact the regional aquatic ecosystem with long-term consequences, emphasizing the need to manage and preserve the ecosystem's health and balance.

To minimize the loss of riverine habitat and mitigate the reduction in spawning and nursing grounds, the project will implement enhanced protection measures for the riverine ecosystem, with particular attention to preserving the crucial spawning and nursery gravel beds of *Tor putitora*.

To enhance the spawning and nursing grounds in the stretch with reduced water flow, several additional measures will be implemented:

- ***Manipulating Boulders***: Angular and large boulders will be strategically arranged to create pools that serve as suitable locations for spawning. These pools will also function as escape cover for fish during periods of low water levels, providing a safe refuge for them.
- ***Flushing Discharge***: Flushing discharges will be released downstream of the dam to maintain the quality of the spawning gravel. This measure ensures that the sediment composition remains suitable for successful spawning and incubation of fish eggs.
- ***Tree Planting***: To enhance the habitat, tree planting initiatives will be conducted along the riverbank. The addition of trees will increase shelter cover, provide shade, and introduce allochthonous nutrient input (organic matter from outside the river) into the ecosystem, benefiting fish and other aquatic life.
- ***Spawning and Incubating Channels***: Specific spawning and incubating channels will be constructed to offer additional protected areas for the reproductive processes of fish, ensuring a conducive environment for successful spawning and hatching.

By implementing these measures, the project aims to safeguard the riverine ecosystem and create a more favorable environment for fish spawning and nursery requirements. These conservation efforts demonstrate a commitment to protecting critical habitat, preserving biodiversity, and maintaining the health and balance of the river ecosystem.

8.3.8.5 Facilitate Fish Migration

The TSHPP project involves constructing a barrage over the Seti River, which will hinder fish migration, affecting their access to suitable feeding and spawning grounds. The main dam's presence will influence migratory fish behavior, with most likely choosing to migrate along the Trishuli River due to the reduced water stretch in the Seti River caused by the barrage. The impact of the barrage on fish migration and spawning will have significant and long-term consequences for fish populations in the project area. Careful consideration and management are essential to ensure the conservation of the aquatic ecosystem and sustain fish populations.

8.3.8.5.1 Fish ladder

The Aquatic Animal Protection Act of 1960 mandates the inclusion of fish ladders or aquatic animal hatcheries in hydropower projects to ensure the unimpeded movement of aquatic animals. Fish ladders, also known as fish passes, are vital for assisting fish migration, but their use is relatively new in Nepal. Existing fish ladders in the country have faced challenges such as improper design, low attraction flow, and lack of maintenance, leading to inefficiency. These issues include excessive water turbulence, inadequate water depth, insufficient water flow, and debris accumulation, all of which hinder fish passage through the fish ladder.

Moreover, globally, fish passes built in large dams with significant head differences may not always be effective. To address this uncertainty and mitigate fish loss caused by migration barriers created by dams, many recent hydropower projects in Nepal have favored the establishment of fish hatcheries as an alternative and effective measure.

Therefore, incorporating fish ladders or hatcheries in hydropower projects is essential to protect aquatic animal migration and ensure the conservation of fish populations in Nepal's waterways. Proper design, construction, and maintenance of fish passes can overcome barriers to fish migration, while fish hatcheries provide artificial breeding opportunities to sustain aquatic populations affected by dam constructions. Therefore, a fish ladder has been proposed in the Lower Seti Barrage to ensure fish migration.

8.3.8.5.2 Fish Hatchery

To mitigate the loss of habitat and increase the population of targeted fish species, such as *Tor putitora*, the TSHPP project proposes the construction of a fish hatchery instead of a fish ladder. The hatchery will utilize artificial breeding techniques to produce fingerlings of the targeted species, which will then be stocked into the reservoir and the reduced water stretch as part of the 'Fish Hatchery and Fingerlings Stocking Plan.' The objective of this offset measure is to ensure that there is no net loss or even a potential gain in the population of the targeted fish species.

Two potential fish hatchery sites along the banks of the Dhad Khola have been identified at this stage. These sites were selected based on various factors, including topography, soil type, availability of water sources, natural breeding areas, and accessibility. However, further studies will be conducted to confirm the final location of the fish hatchery site.

The construction of the fish hatchery is planned to take two years, commencing at least a year before the dam construction starts. This strategic timing will ensure that fish fingerlings are available for stocking during the first year of the project's operation. By implementing this fish hatchery and stocking plan, the TSHPP project aims to mitigate the impact of habitat loss and support the sustainable conservation of the targeted fish species in the affected water bodies.

Table 8. 4: Potential Fish Hatchery Sites

Characteristics of Fish Hatchery	**Fish hatchery Option I**	**Fish hatchery Option II**
Latitude, Longitude	27.878937°N, 84.347561°E	27.878960°N, 84.346111°E
Altitude	About 305 *masl*	About 300 *masl*
Source and water Type	Dhad Khola (perennial source)	Dhad Khola (perennial source)

Source: Field Survey

Figure 104: Proposed hatchery site

The successful experience of the Kali Gandaki fish hatchery demonstrates the feasibility of successfully spawning and rearing certain species in a hatchery. Notably, Golden Mahseer and Snow Trout breeding and study have been accomplished at the Fisheries Research Centre in Trishuli, along with Golden Mahseer breeding at the Fisheries Research Centre in Pokhara. The knowledge gained from these endeavors, along with valuable lessons learned, will be utilized in the development of the fish hatchery and fish stocking plan.

To ensure the effective implementation of the hatchery, design and fish hatchery experts will collaborate during the design, planning, and implementation stages. Detailed planning for the fish hatchery and restocking will be carried out in the first year of project construction. Subsequently, close monitoring of the results will be conducted, allowing for plan revisions and adjustments as necessary. By leveraging the insights from past successes and fostering interdisciplinary expertise, the project aims to establish a well-functioning fish hatchery that contributes to the conservation and proliferation of the targeted fish species.

Table 8. 5: Status of Fish Species Under Captive Breeding

IUCN Target Species	Location of Hatchery
Tor putitora	Kaligandaki Fish Hatchery (KGFH) Syanja; Fisheries Research Center (FRC), Pokhara; Fisheries Research Center (FRC), Trishuli; and Institute of Agricultural and Animal Science (IAAS), Rampur.

Source: Shrestha (2012)

At the tailrace, cooler water from the tunnel outlet mixes with warmer water from the reduced water reach of Seti River, as well as a large amount of warmer water from Trishuli river. As a result, it is assumed that there is no significant net decrease in temperature downstream of the tailrace in summer.

8.3.8.5.3 Catch and Haul

In addition to the fish hatchery, the project will also implement the "Catch and Haul" program as a complementary measure to facilitate fish migration. The primary objective of this program is to catch adult migrating fish downstream of the dam and then release them upstream of the dam, allowing them to access their natural spawning and feeding grounds.

The "Catch and Haul" program will specifically focus on the migratory fish species Tor putitora, which moves both upstream and downstream of the dam during its life cycle. This program will work in conjunction with the fish hatchery program, as both require the capture of mature target fish species for their respective purposes.

By integrating the "Catch and Haul" program with the fish hatchery and fish stocking initiatives, the project aims to ensure a comprehensive and effective approach to support fish migration and maintain healthy fish populations. Local fishermen will be given priority employment opportunities within this program, further engaging and involving the community in conservation efforts and promoting sustainable fishing practices. The collaborative efforts of the fish hatchery and the "Catch and Haul" program will contribute to the preservation and enhancement of aquatic biodiversity and ecological balance in the region.

8.3.8.5.4 Employ local fishermen in the Hatchery and Catch-and-Haul

In response to the loss of fishing income, the project will provide job opportunities to affected fishermen based on their skills and the level of impact experienced. Opportunities in fish trapping, hauling, and hatchery work will be offered to fishermen and their families, considering their expertise and the extent of the impact on their livelihoods. Additionally, the affected fishermen will benefit from cheaper electricity rates and various advantages stemming from the presence of the dam and reservoir. These benefits include opportunities in local tourism, catering services, and utilizing the reservoir for fisheries or cage culture. Moreover, fishermen will receive fish seeds from the hatchery at a reduced cost, supporting them in fish cultivation. By providing alternative means of subsistence and income, such as fish trapping, hauling, and hatchery work, the project aims to alleviate pressure on native fish species. This sustainable approach helps maintain the food supply for riparian species that rely on fish as a critical component of their food chain.

8.3.8.6 Peaking mode of operations

The peaking operations downstream of the tailrace, including thermopeaking, can have significant impacts on the aquatic ecosystem. Sudden flow surges during peaking hours can disrupt fish growth, habitat use, and benthic fauna composition. Spawning activities may be disturbed, and young fish and invertebrates might be displaced. Conversely, abrupt flow reduction during peaking can lead to fish and aquatic life getting stranded, affecting water quality and nutrient cycling. Higher ramping rates can increase stranding occurrences and disrupt fish migration. Additionally, the release of colder water downstream can hinder fish spawning and hatchings and may contain dissolved gases and toxic substances. Thermopeaking can disrupt the environmental cues essential for fish migration and affect their growth, reproduction, and physiological processes. The overall effect will be moderate-high magnitude, regional in extent, long-term in duration, and of high significance, warranting proper management and monitoring to preserve the river ecosystem and its inhabitants.

Rapid changes in flow rates downstream of a tailrace can have negative impacts on the aquatic ecosystem. To address this, extended ramp-up and ramp-down periods are recommended instead of abrupt changes in flow. By gradually increasing or decreasing the flow, the ecosystem can better adjust to the changes, reducing potential disruptions to fish and other aquatic life.

Another effective mitigation strategy involves implementing a very short-term flow reduction before the main reduction, known as conditioning flow. This process helps juvenile fish and other aquatic organisms learn to emigrate to deeper water when flow reductions occur. By conditioning them to seek deeper water during flow reductions, the risk of stranding in side-channels or pools can be significantly reduced[4].

By employing these measures, the project aims to minimize the adverse impacts of flow fluctuations on the downstream ecosystem, ensuring the overall health and sustainability of the aquatic life in the area. The use of extended ramp-up and ramp-down periods, along with conditioning flow, demonstrates a commitment to responsible and environmentally friendly hydropower operations.

8.3.8.7 Fish entrained or impinged.

Fish face risks of entrainment and impingement in the power plant's intake flow, which can lead to stress, injuries, and mortality. These impacts disrupt fish movements, migration, and access to suitable habitats for essential life stages. While the overall magnitude is low, the significance of these impacts on fish populations and the aquatic ecosystem is considered medium, lasting as long as the power plant operates. Mitigation measures are crucial to address these challenges and ensure the long-term sustainability of fish populations in the affected area.

To prevent fish entrainment and impingement through turbines or over spillways, the project will implement various measures. One common approach is the use of a physical mesh or a behavioral screen, both designed to keep fish away from the intake areas where entrainment and impingement could occur.

Physical mesh is a type of barrier made of strong, fine-mesh material installed at the intake points of the turbines or spillways. This mesh acts as a physical barrier that prevents fish from being drawn into the power plant or trapped against the structures. The mesh is designed to allow water to pass through while keeping fish and other aquatic organisms out of harm's way. It is an effective method for reducing the risk of entrainment and impingement and protecting fish populations.

In addition to the physical mesh, behavioral screens are another innovative solution used to deter fish from entering dangerous areas. These screens leverage fish behavior by creating specific stimuli that discourage fish from approaching the intake points. Examples of behavioral screens include electrical barriers, strobe lights, bubble curtains, and acoustics.

Electrical barriers use low-voltage electrical fields to create discomfort for fish, deterring them from entering restricted areas near the intake. Strobe lights create flashing patterns that disrupt fish movement and make the area less attractive to them. Bubble curtains generate a barrier of bubbles, which confuses fish and prevents them from approaching the intake. Acoustic devices emit specific sound frequencies that can repel fish and guide them away from potential danger.

By combining the physical mesh or behavioral screens with trash racks, which are coarse racks that filter out larger debris from the water before it enters the turbines or spillways, the project aims to enhance fish protection and reduce the risks of entrainment and impingement. These mitigation measures reflect the project's commitment to sustainable practices and the preservation of aquatic ecosystems, ensuring that fish populations can thrive and contribute to the overall health of the river ecosystem. Continuous monitoring and evaluation of the effectiveness of these measures will also be essential to make any necessary adjustments and improvements in the long run.

8.3.8.8 Minimize Cumulative Impact

The TSHPP's impact on fish and aquatic organism production can have far-reaching consequences for the ecosystem. Riparian animals reliant on fish as their primary food source may face population decline. Additionally, reduced riverine fisheries could adversely affect the livelihoods of fishing communities, leading to economic hardships and disruption of traditional ways of life.

The cumulative effects of TSHPP and other planned water diversion projects may further degrade river ecosystems. These projects can impede fish migration, alter flow regimes, and impact physicochemical parameters and nutrient cycling.

Given the broad-ranging consequences, the overall impact of TSHPP and other projects is of high magnitude, affecting the larger riverine system, and likely to be long-term. To mitigate these effects, comprehensive environmental management and conservation strategies are essential, including protecting fish habitats, managing water flow, and supporting local fishing communities. Careful planning and monitoring are crucial for the sustainable development and operation of hydropower projects in the region.

The cumulative impacts resulting from multiple projects within the Seti and Trishuli watershed present a complex challenge that cannot be addressed by a single project alone. To effectively mitigate these impacts, projects situated in the area of cumulative impact should adopt a collaborative approach. This involves implementing various measures, such as fish passes, fish hatcheries, e-flow management, habitat protection, the Ward and Watch system, and fish population monitoring.

Each project operating within the region of cumulative impact should take responsibility for mitigating the specific impacts it causes. Monitoring data collected from each project should be shared transparently with the provincial government and other relevant projects. This information exchange is crucial for effective collaboration and coordination among the concerned projects and governmental bodies.

To facilitate smooth collaboration, a working body should be established, comprising one representative from each project. This working body will act as a forum for discussion, decision-making, and joint planning, ensuring that all projects contribute to mitigating the cumulative impacts and promote sustainable environmental practices in the region. By working together, the projects can enhance the effectiveness of their mitigation efforts and ensure the long-term health and integrity of the Seti and Trishuli river ecosystems.

The primary target of the project, however, will be to maintain no net loss or gain in the fish population, particularly of the target species - *Tor putitora*. The following comprehensive set of measures will be adopted:

- ***Banning Illegal Fishing Methods***: Existing illegal fishing methods, such as using electric current or explosives, will be completely prohibited throughout the project impact area. This will help protect the fish population from destructive fishing practices.
- ***Prohibiting Non-Selective Fishing Practices***: Non-selective fishing practices, like the use of gill nets and smaller mesh size nets, will be strictly prohibited within the project impact area. This measure aims to avoid the unintentional catch of non-target species and preserve the ecosystem's balance.
- ***Protecting Spawning and Nursing Grounds***: Fishing will be prohibited in the tributaries that serve as important spawning and nursing grounds for Tor putitora during their breeding season. This safeguard ensures that the fish have a suitable environment for successful reproduction.
- ***Regulating Sediment Mining***: Sediment mining will only be permitted in designated areas, and it will be strictly prohibited in ecologically sensitive locations, such as tributaries and fish breeding areas. This helps prevent disruption to essential fish habitats caused by sediment removal.

- ***Enforcing Rules and Regulations***: A robust watch and ward system will be established, collaborating with local government authorities to enforce the rules and regulations effectively. This ensures compliance with fishing restrictions and conservation measures.
- ***Establishing Fish Hatcheries***: To compensate for the loss of spawning habitat and support the reduction in reproduction, fish hatcheries will be established specifically for Tor putitora near Dhad Khola. These hatcheries will aid in breeding and stocking fish in the impacted area.
- ***Implementing Catch and Haul Program***: A catch-and-haul program will be initiated for Tor putitora to facilitate its migration. This program will help the fish navigate around potential barriers and enhance their access to suitable habitats.
- ***Launching Awareness Program***: An awareness program will be launched to promote the conservation of the target species, Tor putitora. This initiative aims to educate local communities, fishermen, and stakeholders about the importance of preserving the species and its habitat.

By adopting these measures, the TSHPP project aims to ensure the sustainable conservation and management of the *Tor putitora* population within the project impact area. The comprehensive approach focuses on habitat protection, fishing regulation, and species enhancement to maintain the ecological balance and safeguard the biodiversity of the region.

8.3.8.9 Awareness among local communities

An awareness-raising program will be launched to educate local communities residing in the Seti and Trishuli Rivers basins about the detrimental impacts of illegal and destructive fishing methods, introduction of alien species, unmanaged sediment mining, and pollution on the river ecology. Many local people are unaware of the socio-economic and conservation importance of aquatic resources in the region. The program will target schoolteachers, students, fishermen, locals, community forest user groups, mothers' groups, local government representatives, and concerned stakeholders. Social mobilizers will be hired to lead the awareness campaign, utilizing community meetings, workshops, and training sessions to inform people about the significance of conservation and the actions they can take to protect the area's aquatic resources.

8.3.8.10 Watch & Ward arrangement

A team of individuals will be hired to monitor and prevent illegal fishing practices, destructive fishing methods, and fishing in tributaries during *Tor putitora* breeding season. They will also take measures to prevent sand and rock extraction from ecologically sensitive areas and work towards conserving the targeted biota of the project area. Collaborating closely with the local government, this team aims to achieve significant and impactful results in safeguarding the aquatic ecosystem

8.4 Socio-Economic Environment – Construction Phase

8.4.1 Land acquisition adhering to the Regulatory Framework

The process of acquiring land for the purpose of project implementation is underpinned by a commitment to adhere to the regulatory framework outlines by the GoN. Central to the endeavor is the Land Acquisition Act 2019, which serves as a primary guiding document in governing land acquisition procedures. Additionally, the project's approach is underscored by the principles enshrined within the ADB's SPS, which serves as an international benchmark for responsible and ethical project execution.

By strictly adhering to the provisions stipulated in the Land Acquisition Act 2019, the project ensures that the acquisition process aligns with the country's legal framework. This approach guarantees transparency, fairness, and respect for the rights of landowners and affected communities throughout the acquisition process. The Act serves as a vital tool in securing land with due process, mitigating potential disputes or controversies.

In parallel, the guidance provided by both the Land Acquisition Act and ADB's SPS extends beyond mere procedural adherence. The amalgamation of the legislations and ADB's SPS instills a robust foundation for ensuring not only legal compliance but also ethical and responsible land acquisition. By incorporating internationally recognized standards and local regulations, the project underscores its commitment to transparent, accountable, and community-centric practices.

8.4.2 Minimize acquisition of privately owned cultivated land

To effectively address the need for minimizing physical or economic displacement, comprehensive measures are recommended to be undertaken during the planning and design phases of the project. By prudently considering the layout and arrangement of project's facilities, the necessity for land acquisition can be substantially reduced. In line with this, an innovative approach is suggested, encompassing the establishment of alternative disposal sites at both the headworks and powerhouse sites.

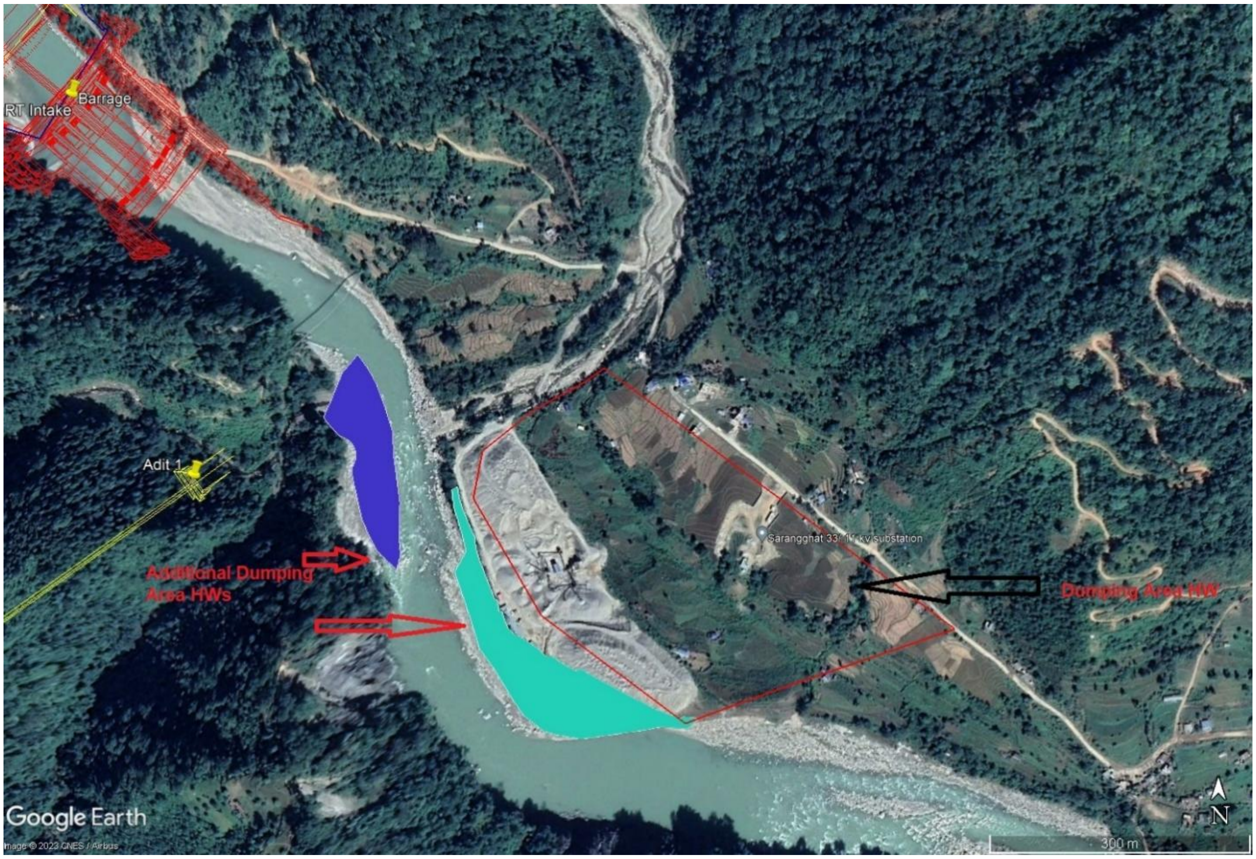


Figure 105: Proposed Dumping Area at HWs and Additional (Alternate) Dumping Area at HWs

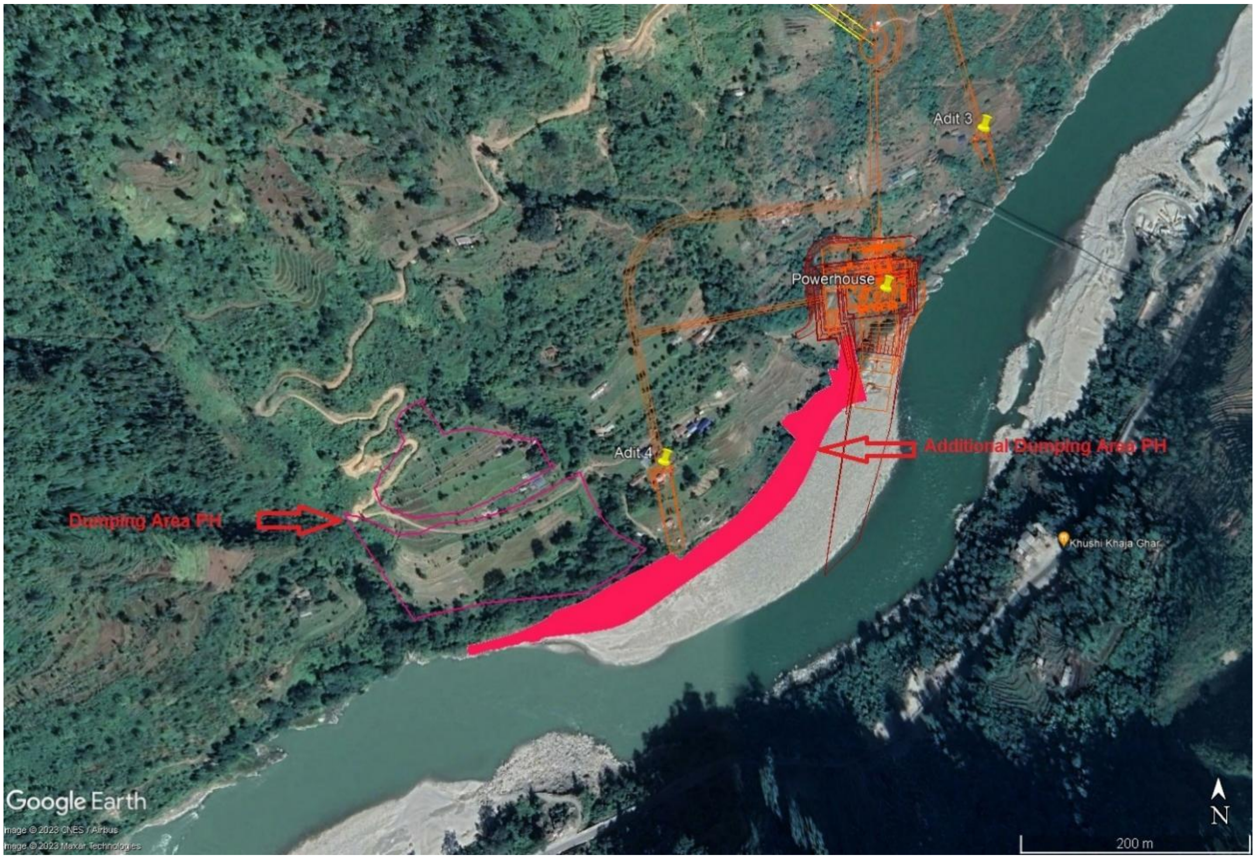


Figure 106: Proposed Dumping Area at PH and Additional (Alternate) Dumping Area at PH

Following this strategy, the locations designated for disposal as outlined in the project's design would necessitate the temporary acquisition of 12.31 ha of total land under which 0.22 ha are privately owned cultivated land. Nevertheless, this study introduces an alternative approach. This involves the placement of disposal sites near the Seti River. However, to execute this alternative, the construction of embankment walls along the proposed disposal site is imperative. These embankments serve the purpose of preventing the risk of spoil being washed away by the river's currents. Such an occurrence would introduce sediment-laden water into the Seti River compromising its water quality.

Furthermore, to ensure the long-term stabilization of these newly proposed sites, a multi-faceted strategy will be employed. Following the completion of the disposal works, the implementation of compensatory plantation efforts combined with bioengineering techniques will be applied to the sites. This approach not only aid in stabilizing the acquired land, but also contributes to enhancing the environmental quality of the area.

8.4.3 Formation of the Compensation Fixation Committee

In accordance with the stipulations set forth in the Land Acquisition Act 2019, the process of determining compensation rates for the acquired land is structured around the establishment of a committee. This committee will be led by the Chief District Officer (CDO) of the pertinent District (Tanahu and Chitwan), who assumes the role of chairperson. The committee itself encompasses a diverse composition, bringing together key stakeholders to ensure a comprehensive and impartial assessment of compensation.

This committee will be assembled to include various pivotal voices. Firstly, the chairman of the affected municipalities will in included, representing the local government that holds a vested interest in the outcome. Additionally, representatives from the affected HHs are also included, ensuring that the concerns and perspectives of those directly impacted are well-represented.

The presence of a representative from the Land Revenue Office adds an essential legal and administrative perspective to the proceedings. Moreover, the inclusion of a representative from the project ensures that project-specific insights are incorporated into the deliberations.

8.4.4 Permanent Acquisition and Compensation for Land

The compensation process adheres to the legal provisions outlines in the Land Acquisition Act and NEA's established practices, ensuring fair compensation for the affected landowners based on market rates.

Table 8. 6: Indicative compensation cost of private land

SN	Project Component	Area Private (ha)	Area (Kattha)	Indicative Rate (NPR/Kattha)	Amount (NPR)
1	Intake Area	-		28,168.72	
2	Reservoir FSL 275m	14.23	1125.45	28,168.72	31,702,485.92
3	Reservoir Buffer 278m			28,168.72	
4	Permanent Camp Area-A	0.44	30.83	28,168.72	868,441.64
5	Employer Camp Alternative-2	2.28	159.80	9,389.57	1,500,453.29
6	Powerhouse Area	6.3	441.56	9,389.57	4,146,058.53
7	Surge Shaft	0.084	5.88	9,389.57	55,210.67
Total (NPR)		**23.334**	**1763.52**		**38,272,650.05**
Total (USD)					**292,224.56**

Note: 1 ha = 70.09
USD 1 = NPR 130.97 (Nov, 2022)

8.4.5 Purchase of Stranded or Residual Land Plots

The acquisition of land plots that are considered stranded or residual holds potential to offer a viable solution. These plots, while not economically feasible at their complete replacement value, can serve as strategic acquisitions. By procuring such parcels, the project can not only minimize costs but also contribute to efficient land utilization, alleviating potential displacement issues.

8.4.6 Temporary Acquisition and Compensation for Land

The project necessitates securing temporary land access agreements for approximately 61.15 hectares. These agreements are imperative to facilitate the construction activities. The designated lands will serve construction-related functions, including the establishment of construction camps, stockpiling, quarrying, disposal, and other relevant tasks. Post-construction, these lands will be diligently restored to their initial condition and function.

The success of the restoration process holds significant importance in determining the extent of impact on the temporarily acquired land. Through meticulous planning and execution of restoration efforts, adverse effects on the land can be minimized. This approach enables the land to be reinstated to its former state, thereby allowing it to resume its original purpose or usage. The careful management of the restoration process stands as a pivotal factor in mitigating the project's impact on the temporarily acquired land.

Table 8. 7: Indicative cost for temporary acquisition of the land

SN	Project Component	Area Private (ha)	Area (Kattha)	Indicative Rate (NPR/Kattha)	Amount (NPR)
1	Explosive Store House/Barrack	0.41	32.42	28,168.72	913,229.90
2	Access Road to Adit 2				
3	Batching Plant and Laboratory A				
4	Batching Plant and Laboratory for Tunnel B	0.54	42.70	28,168.72	1,202,804.34
5	Clay Area Private Land				
6	Dumping Area-HW				
7	Additional Dumping Area at Intake				
8	Dumping Area-PH	0.22	17.39	9,389.57	163,284.62
9	Temporary Labor Camp A	0.82	64.85	28,168.72	1,826,741.49
10	Temporary Labor Camp B				
11	Temporary Labor Camp C	1.15	90.95	9,389.57	853,981.39
12	Old Alluvial Deposits and Coarse Aggregate				
13	Adit-2				
14	Adit-3	0.03	2.37	9,389.57	22,253.28
15	Adit-4				
16	Access Road to Surge Shaft Adit 4 & Adit 3	0.9	71.18	9,389.57	668,349.59
17	RBM-1				
18	RBM-2				
19	RBM-3				
20	RBM-4				

SN	Project Component	Area Private (ha)	Area (Kattha)	Indicative Rate (NPR/Kattha)	Amount (NPR)
21	RBM-5				
22	Rock Quarry - B				
Total (NPR)		4.07	321.86		56,50,644.62
Total (USD)					43,466.49

8.4.7 Restoration of Temporary Acquired Sites

Upon the conclusion of construction activities, the project is committed to the thorough restoration of sites that were utilized on a temporary basis. These sites encompass laborur camps, contractor camps, batching plants, disposal areas, quarry sites, and various other facilities essential for the construction phase. The restoration endeavors aim to reinstate the conditions of these sites to either their previous state or, in certain cases, to a condition surpassing their initial condition.

The site restoration process is meticulously structured and executed, following a series of well-defined steps:

- Dismantling of Structures: All structures erected for temporary purposes during the construction phase are systematically disassembled. This includes labor camp accommodations, contractor facilities, and any other structures that were established to support construction operations.
- Removal of Equipment: Equipment and machinery used temporarily, such as those at batching plants or other construction-specific facilities, are efficiently removed from the site. This ensures that the area is cleared of any construction-related equipment.
- Landscaping: Landscaping efforts are initiated to restore the site to a visually appealing and functional state. This may involve reshaping the terrain, contouring the land, and addressing any grading requirements.
- Restoration of Topsoil: The topsoil, which is crucial for the re-establishment of vegetation and the overall health of the land, is carefully restored. Any soil that was disturbed or displaced during construction is reinstated to its original position.
- Re-vegetation: A significant component of site restoration is the introduction of vegetation. This step involves planting native vegetation, trees, and other appropriate flora to encourage natural ecosystem regeneration and stability.

By implementing these steps, the project ensures that the temporary sites are revitalized and brought back to their previous condition, or even improved, post-construction. This comprehensive approach to site restoration not only aligns with environmental sustainability principles but also emphasizes the project's commitment to responsible and ethical construction practices.

8.4.8 Compensation for the Private Structures

The privately owned structures impacted by the project encompass a diverse array of buildings, spanning residential and commercial properties, along with amenities such as bathrooms, toilets, safety tanks, taps, water tanks, storage houses, kitchens, animal sheds, dining halls, chicken coops, and fishponds. A total of 268 privately constructed structures are expected to be affected by the project.

Table 8. 8: Details of Acquisition of Structure

Structure type	**Municipality-Ward**				
	Bandipur-6	**Byas-14**	**Devghat-3**	**Devghat-4**	**Bharatpur-29**
Bathroom	5				
Campfire Place	2				
Church	-	1			
Dining Hall	2				
Dipping Pool	1				
Fish Farm	3	4			
Generator Hall	1				
Residential House	13	6	6	27	1
Residential and Commercial House	20				
Commercial House	2				
Kitchen	7	2	2	8	
Temporary House	5		3		4
Poultry Farm	1				
Public Structure	3			4	
Safety Tank	5				
Animal Shed	10		14	29	1
Store House	1			4	
Tap	3	5		14	

Structure type	Municipality-Ward				
	Bandipur-6	Byas-14	Devghat-3	Devghat-4	Bharatpur-29
Toilet	11	3	2	17	1
Waiting Room	1				
Washing Room	1				
Water Tank	4				
Total	101	30	27	103	7

The project is committed to providing compensation at the replacement cost for the structures to be acquired. This compensation will cover several aspects, including:

(a) Compensation for the land occupied by the structures,
(b) Compensation for the cost of structure itself, and
(c) Compensation for other accessories associated with the structure, such as hand pumps, *etc*.

Furthermore, the owners of the affected structures will retain the right to use salvaged materials from the buildings. It is important to note that the value of these salvaged materials will not be deducted from the overall compensation amount. This provision ensures that the affected individuals can utilize salvaged materials as they see fit without any impact on the compensation they are entitled to receive. The project aims to provide a fair and comprehensive compensation package that considers all aspects of the acquired structures, allowing affected HHs to rebuild and recover in a meaningful way.

8.4.9 Relocation and Resettlement Assistance Allowance for Displaced HHs

The displaced HHs will receive the following additional allowances:

a) house rent allowance will be provided for a period of 6 months, totaling NPR 30,000, with a monthly allowance of NPR 5000. This allowance is provided under the assumption that a new house will be constructed within that timeframe.
b) one-time dislocation allowance of NPR 15,000 will be provided to cover the costs associated with the displacement.
c) transportation allowance of NPR 30,000 per HH will be provided to assist with the transportation of the goods and materials to the new location.
d) Recognizing the vulnerability of the certain groups, such as Dalits, Indigenous groups, Female-Headed HHs, or economically poor HHs, additional allowances will be provided as a social security for the duration of 6 months, totaling NPR 30,000, with monthly allowances of NPR 5000.

8.4.10 Compensation for Non-Titleholders

There are about 22 HHs utilizing land without official ownership titles. These HHs also have temporary structures established on these lands. It has been noted that they have been occupying and using the land for an extended duration. Consultation with these HHs, along with interactions during the Public Hearing, revealed that the local municipality intends to grant land ownership to these HHs. However, legal proceedings for this intention are still pending completion.

Consequently, these HHs are poised to face distinctive difficulties arising from the lack of formal land ownership documentation. Despite their established and longstanding use of the land, the absence of legal ownership titles presents complexities in relation to their rights, entitlements, and, consequently, the process of determining compensations for the acquisition of these lands by the project.

Compensating non-title holders of land and structures necessitated a multifaceted approach that considers their unique circumstances. The following methods of compensation has been proposed:

Providing monetary compensation to non-title holders is a common practice. This compensation can be determined by considering the land's market value, along with its effects on livelihoods and displacements. The Compensation Fixation Committee, established for this purpose, will undertake valuation and assessment to determine compensation. The valuation process incorporates factors like (a) valuation of land to lost, (b) valuation of the structures in the land to be lost, (c) loss of income and occupation, and (d) impact of displacement to HH. The non-title holder HHs to be displaced will also receive the "additional allowances" same as other displaced HHs will receive.

8.4.11 Compensation for Loss of Local Business

Construction of the Powerhouse Complex at the Gai Ghat will necessitate the displacement of several local shops owned by the residents. Notably, Gai Ghat holds significant important as the starting point for Jeep Transportation, drawing a considerable influx of customers, particularly to the shop located near the suspension bridge. These establishments serve as both grocery stores and tea stalls, fulfilling essential local needs.

Understanding the impact of this displacement on the local shop owner's, the Compensation Fixation Committee will undertake the evaluation. This Committee will thoroughly assess the business value of the affected shops and subsequently formulate recommendations regarding appropriate compensation for the businesses being displaced. This comprehensive approach aims to fairly address the economic implications faced by the shop owners due to the project's development.

8.4.12 Legal Assistance to Affected HHs including the non-Title Holders

To safeguard the rights of affected HHs and the non-title holder HHs throughout the compensation process, a vital measure that will be implemented is that the project will make legal assistance available to them. The assistance serves as a support mechanism to ensure that these individuals have the necessary legal guidance and representation to navigate the complexities of the compensation proceedings.

Legal assistance entails a range of activities aimed at upholding their rights and interests. This assistance may involve:

- Legal representation – the affected HHs will have access to legal experts who can advocate for their rights and interests during negotiations and interactions with authorities or compensation committee.
- Information dissemination – Legal professional will ensure that the affected HHs are informed about their rights, entitlements, and options throughout the compensation process. This empowers them to make informed decisions.
- Documentation and procedures – Legal assistance includes helping non-title holders complete required paperwork, adhere to formal procedures, and submit necessary documentation accurately and on time.
- Dispute resolution – In the event of disagreements or disputes related to compensation, legal representatives can mediate or engage in dispute resolution processes to secure fair outcomes.
- Ensuring fair compensation – Legal experts will work to ensure that the compensation offered to the affected HHs is commensurate with the losses incurred and aligns with legal standards and norms.

By providing legal assistance, the project acknowledges the importance of equitable treatment for non-title holders. This support aims to level the playing field, ensuring that their rights are respected, and their interests are protected. Moreover, legal assistance contributes to transparency, fairness, and accountability in the compensation process, fostering a sense of trust and cooperation between the project and the affected non-title holders.

8.4.13 Compensation for the Loss of Standing Crop and Agricultural Productivity

The project entails acquiring privately-owned agricultural lands, resulting in the loss of productive land, and standing crops. This loss affects not only economic potential of farmers' primary income source due to the destruction of crops, leading to severe financial setbacks. Simultaneously, reduced agricultural production could undermine food security, causing shortages and higher prices, especially for subsistence farmers. This disruption to livelihoods poses short- or long-term challenges, potentially escalating poverty, and socio-economic issues, while decreasing local agricultural productivity could increase dependence on imports, jeopardizing regional self-sufficiency in food production.

As outlines in the baseline section, the project will secure about 40 ha of agricultural land – 21.63 ha permanently and 18.43 ha temporarily. This will lead to a loss of crops which equates to around 50.6 MT of cereal crops permanently and 43.12 MT temporarily. Consequently, the annual income loss of the farmers is estimated to be NPR 18,94,562 from permanently acquired land, and NPR 16,14,739 from temporarily acquired land, thus total NPR 35,09,302.

The following mitigation measures will be carried out to compensate the loss of the cultivated land:

8.4.13.1 Reimbursement for the Loss of Crops

Compensating farmers for the value of crops lost due to land acquisition is a crucial step in addressing the immediate financial challenges they face. When agricultural lands are acquired for projects, the disruption to cultivation leads to direct crop losses, impacting the income of farmers who rely heavily on their harvests. By providing reimbursement for these lost crops, farmers are offered a tangible solution to mitigate the sudden financial setback they experience.

This compensation strategy is particularly significant because it not only acknowledges the economic contributions of the farming community but also demonstrates a commitment to their well-being during a period of transition. The compensation seeks to restore a sense of financial stability to affected farmers by acknowledging the value of the crops that would have been harvested under normal circumstances. This is especially relevant when considering that many farmers invest significant resources, including time, labor, and capital, in the cultivation process.

In the case of this specific project, the compensation amounts to NPR 35,09,302, encompassing both the permanent and temporary land loss. This sum reflects the cumulative value of the crops that would have been produced in the span of a year on the acquired lands. By providing this compensation, the project demonstrates its commitment to the livelihoods of the farmers and its recognition of the importance of sustaining their economic well-being.

8.4.13.2 Agricultural Assistance

The project recognizes the importance of supporting local farmers and enhancing agricultural productivity within the project area. Despite the acquisition of land for the project's implementation, there will still be considerable portions of cultivated land available. However, the utilization of these lands for optimal cultivation has not been fully realized. To address this, the project is committed to providing valuable agricultural assistance to the farmers in the area.

The proposed agricultural assistance encompasses a multifaceted approach aimed at improving farming practices and overall productivity.

8.4.13.2.1 Intensification of Food Production

The intensification of food production is a pivotal activity that will be implemented both as compensation and an enhancement measure in the project area. The plan encompasses a comprehensive set of interventions designed to enhance food production. It includes the adoption of improved farming practices, the utilization of upgraded seeds, fertilizers, irrigation, and the provision of other essential inputs. Additionally, the program envisions enhancement of skills amongst the farmers through training and technical assistance by agricultural technicians.

Taking into consideration the potential for increased yields resulting from these measures, the plan foresees the implementation of enhanced paddy cultivation practices on both Khet and Bari lands, with the latter currently predominantly utilized for maize cultivation. In this endeavor, the project will play a vital role in facilitating and supporting local farmers, a critical component in the endeavor to maximize crop productivity.

In collaboration with the District Agriculture Development Office and local cooperatives, training programs on skill enhancement of farmers will be designed and implemented. These training programs will target to enhance the capabilities and skills of farmers, enabling them to make optimal use of land resources by adopting advanced agricultural methods and innovating cropping strategies. The training curriculum encompass a diverse spectrum, encompassing cash crop, vegetable cultivation, horticulture, and livestock management.

8.4.13.2.2 Fruit Tree Cultivation

The implementation of the fruit tree production is set to take place on *Bari* and *Pakho Bari* farmlands in the immediate catchment area of the reservoir. Additionally, effort will be made to extend this initiative to the remaining project municipality areas. This strategic undertaking aims to harness the potential of fruit tree cultivation as a sustainable and economically viable alternative. The fruit tree saplings, once established on slopes, are projected to yield fruits within a span of 4-5 years. Over the long term, farmers are expected to derive more substantial economic benefits from fruit tree cultivation compared to traditional crops like maize and other annual varieties.

It must, however, acknowledge that during the initial phases, until the fruit bearing stage is reached, farmers might experience a temporary reduction in cereal grain production that caters to their families' sustenance. However, this temporary setback is balanced by the eventual advantages presented by fruit trees. Furthermore, this endeavor is expected to yield a surplus of ground cover, which in turn would bolster fodder availability for livestock.

The framework of this program encompasses several vital components:

- A compensation package will be implemented to support the transition from annual crops to perennial crops or fruit trees until they beginning to bear fruits. This acknowledges the initial shift in crop focus and its financial implications for farmers.
- Farmers will undergo training on multiple facets, including ecological land management, post-harvest techniques, packaging, storage, and marketing. The provision of drip irrigation systems, as well as the supply of suitable fruit tree sapling, forms a crucial part of this training phase.

8.4.13.2.3 Commercial Vegetable Cultivation

The project area is in vicinity to larger markets centers such as Bharatpur, Damauli, Mugling, Pokhara, as well as the highway that connect to Kathmandu. Therefore, the project area has high economic viability to become production area for the commercial vegetable.

The plan entails a series of pivotal actions designed to equip participating farmers with the knowledge and tools necessary for successful commercial cultivation. These actions include training sessions, enhancement of irrigation systems, with a focus on introducing drip irrigation techniques on slopes, utilization of improved seeds, and adopting of integrated pest management practices.

To catalyze the commercial vegetable production aspect, a focus on relatively flat land areas will be prioritized, accompanied by improvements in the irrigation infrastructure to facilitate sustainable vegetable cultivation. Moreover, the project will actively encourage local farmers to engage in supplying agricultural produce to the project's workforce. This dual-purpose approach not only ensures that project benefits extend to the local populace but also serves as a motivational incentive for farmers to transition into commercial agricultural practices.

The innovative ventures initiated by Project Affected Families (PAFs) will be fortified through the provision of support, including guarantees that facilitate access to loans from Local Commercial Banks. This financial backing will serve as a catalyst for the establishment and expansion of agricultural enterprises. Collaboratively, cooperatives will play a pivotal role in facilitating business ventures, spanning both animal husbandry and agricultural activities focused on fruits and vegetables.

By implementing these multifaceted interventions, the Commercial Vegetable and Fruit Production Plan aims to stimulate economic growth, enhance livelihoods, and foster a self-sustaining cycle of agricultural commerce. This approach exemplifies the project's commitment to not only mitigating impacts but also nurturing local economies and empowering farmers within the project-affected areas.

8.4.13.2.4 Improved irrigation

One pivotal aspect of the project's agricultural assistance initiative involves the enhancement of irrigation systems. Recognizing the critical role that water management plays in agriculture, the project will collaborate closely with local communities to identify areas where irrigation systems can be built or improved. This collaborative approach ensures that the solutions are aligned with the specific needs and preferences of the community members who possess intimate knowledge of the local landscape and its challenges.

By offering comprehensive support in terms of technical knowledge, essential inputs, and improved irrigation infrastructure, the project seeks to empower local farmers to unlock the full potential of their cultivated lands. This proactive approach not only addresses the potential agricultural productivity loss resulting from the project's activities but also contributes to the long-term sustainability of farming practices in the region. Through these efforts, the project aims to foster a resilient and thriving agricultural sector that benefits both the local communities and the broader region.

8.4.14 Relocation of the Janata Primary School

The construction of tailrace will impact Shree Janata Primary School at Gai Ghat, Dev Ghat – 3. It was established in 2046 BS, the school provides education from Class 1 to 5, with 18 students and 3 teachers. The school’s facilities cover 510 sq m. This school is serving the population of the Gai Ghat.

To maintain uninterrupted education during the construction phase, Janata Primary School will temporarily relocate to Rastriya Basic School, located on the opposite side of the Trishuli River from Gai Ghat. This move will cater to the current 18 students. The project will allocate resources to enhance and construct essential infrastructure and facilities at Rastriya Basic School, ensuring smooth continuation of classes.

Simultaneously, the project will embark on constructing fully equipped school in Gai Ghat. This school will be designed to meet the educational needs of the community once the construction phase concludes. This forward-looking approach aims to provide a modern and well-equipped educational institution capable of accommodating local students, including the children of the staff working in the powerhouse.

The temporary relocation strategy not only ensures uninterrupted education for the affected students but also acknowledges the significance of maintaining the educational fabric of the community during this transition. The development of enhanced facilities at both the temporary and permanent school locations demonstrates the project's commitment to the long-term educational well-being of the local population. By facilitating these measures, the project seeks to minimize the disruptions caused by the relocation and enhance access to quality education throughout the construction phase and beyond.

8.4.15 Relocation of the Community Halls of Gai Ghat

The construction of the Powerhouse Complex will involve the removal of the Community Hall situated in the Gai Ghat. Discussion with the Ward No 3, Dev Ghat Municipality representatives will take place to arrange a temporary relocation for the Community Hall to a suitable alternative site. Following the construction phase, the project will rebuild the Community Hall at Gai Ghat, complete with necessary equipment, amenities, and facilities.

8.4.16 Addressing Housing and Land Market Impacts

Anticipated growth in the population of surrounding settlements, resulting from the influx of both direct workers and induced migrants, is an integral aspect of the project's operation. This is particularly relevant around the central project works. It is foreseeable that the main concentrations of direct workers and migrants seeking entrepreneurial prospects will emerge in the subsequent locations:

- Sarang Ghat
- Gai Ghat

To mitigate the potential impacts of this population upsurge on housing and land markets, a range of mitigation strategies should be instituted during the construction phase. The project's design must incorporate a substantial housing capacity that caters to the accommodation needs of all direct workforce participants throughout the construction period. This pertains to both the project's own personnel and the staff associated with the various contracting entities involved.

Furthermore, to inform and assist individuals with housing options and land access in the principal settlement zones, an informative campaign should be undertaken. This initiative would encompass disseminating comprehensive details about available housing alternatives and land availability. This repository of information will be effectively managed and kept up to date by a dedicated "Housing and Accommodation Assistance and Information Desk," which will operate under the aegis of the Environmental Social Management Unit (ESMU).

8.4.17 Improving Accessibility and Functionality of Food and Essential Commodity Markets

Increased population in the project area during the construction phase will generate increased demand for essential commodities and food. This might have put pressure on the small-scale markets and settlements of the project area. Therefore, special measures are needed to be in place to mitigate and compensate the potential impact of increased population on prices and markets of food and other basic commodities.

To address this, a multi-facet approach is necessary. The first step involves enhancing agricultural productivity. This can be achieved through facilitating improved access to technology, essential inputs, and skill development among the HHs engaged in agriculture. Special measures should be considered to promote local food production to supply the increased demand for food crops by increased population. These measures are discussed in Agriculture Assistance Program.

Additionally, establishing efficient channels for food distribution becomes crucial. Collaborative efforts can be undertaken to link with Damauli or Bharatpur, which are the larger market centers with larger supply of food and commodities. This cooperation with other market centers can ensure a steady influx of food supplies to the project area. Moreover, expanding storage capacity within the project area is essential to prevent food scarcity during period increased demand.

8.4.18 Facilitating Access and Sustainable Utilization of Natural Resources

The availability and accessibility of natural resources are expected to undergo transformations, both during the construction and operation phases. The increased population in the project area due to the influx of workers will trigger an escalated demand for firewood and energy sources. To effectively manage this increase in energy demand, a comprehensive approach of managing supply and demand becomes imperative. Addressing the supply side involves providing support to Community Forest User Groups for sustainable harvesting of the firewood. In tandem with the supply-side intervention, promoting the adoption of more efficient and safer cooking appliance in the project area becomes important too. Be encouraging the utilization of energy-efficient cooking technologies, the demand for firewood can be rationalized, reducing pressure on local forests.

Moreover, considering the necessities of the project camps, alternative energy sources such as LPG cooking gas or kerosene should be readily available. By adopting such alternatives, the project can effectively reduce its dependency on forest resources for energy needs, thereby contributing to the conservation of local ecosystems.

8.4.19 Employment Opportunity

During the construction phase, ample employment opportunities will be available in the project. The project has estimated requirement of about 1200 workers. The project will prioritize the SPAF and PAF in the recruitment process. To enhance the skills and capacities of locals for undertaking project related job and improve their competitiveness for the job openings, the project will run an on-site training program for them even before the commencement of construction activities.

The project will engage in discussions with contractors and local communities to establish mutually acceptable employment conditions. The bidding documents and contract specification will include stipulations for hiring in the following order of priority SPAF, PAF, and residents of the project affected municipalities. These priorities will be based on agreements reached during consultations.

8.4.20 Ensuring Law and Order

Because of the significant increase in the workforce during the construction phase, potential conflicts of interest could arise between the workers and the locals. This situation potentially to lead to disagreements and tensions, thereby posing a risk of disrupting law and order. To prevent and/or effectively handle such situations, the following measures will be implemented:

- Develop a labor management plan that gives precedence to employing local workforce in the project, which is one of the issues emphasized during consultation with locals during the study. As a part of this initiative, an on-site training institute to enhance the skill set of the locals. This aims to make the locals more competitive for the job openings in the project.
- Ensure adequate housing and lodging arrangements for the arriving workforce in the labor camps. The arriving workforce will be mandated to reside with these camps.
- Integrate provisions of promoting responsible behavior and adherence to local cultural norms, both during work hours and leisure periods.
- Maintain ongoing involvement with local communities, government authorities, police force, and pertinent stakeholders throughout the process of labor management and law enforcement.

8.4.21 Occupational Health, Community Health Management & Emergency Response

Undertaking of hydropower project, particularly during the construction phase, has its risks towards workers and staff working in the project. It can also put the locals under the risk and create emergency situations. The project must evaluate the possible risks as a part of its occupational health hazards, community health hazards, and prepare emergency response approaches.

8.4.21.1 Occupational Health Safety

- Training and awareness - rovide training to workers on proper equipment operation, safety protocols, and hazard recognition to reduce the risk of accidents. Such training shall be conducted in the beginning of worker’s job at the project, as well as refreshed on a regular basis.
- Personal Protective Equipment - Mandate the use of appropriate PPE, such as helmets, gloves, and safety goggles, to minimize exposure to physical and chemical hazards.
- Ergonomic Design - Design workstations and equipment with ergonomic considerations to minimize strain and the risk of musculoskeletal disorders.

- Health Surveillance - Conduct regular health check-ups for workers to detect early signs of health issues and provide timely intervention. Establish a continuous health monitoring system for workers to identify and address any occupational health concerns promptly. To address non-emergency health cases, consider setting up first aid/emergency health centers within respective camps. These facilities can effectively manage non-critical situations within the camp itself. Emergency cases that surpass camp capabilities can be referred to communal health centers or health posts. This approach can alleviate the burden on local community health facilities.
- Primary health facilities at the site – The primary health facilities for the workers and first aid kits at the sites must be always maintained.

8.4.21.2 Community Health Safety Measures

- Environmental Monitoring - Implement regular monitoring of air, water, noise & vibration to identify pollution sources and take corrective measures.
- Vector Control - Implement measures to control stagnant water and prevent the breeding of disease-carrying vectors.
- Healthcare support - Establish healthcare centers or clinics to provide medical assistance to both project workers and residents.

8.4.21.3 Emergency Response

- Emergency response plans - Develop well-defined emergency response plans that outline procedures for various potential scenarios, including natural disasters and accidents.
- Drills and training - Regularly conduct emergency drills involving both workers and local communities to ensure preparedness and familiarity with response procedures.
- Early Warning System - Set up systems to provide timely alerts for potential natural disasters, enabling evacuation and response actions.
- Collaboration with authorities - Establish communication channels with local authorities and emergency services to ensure a coordinated response during emergencies.

These mitigation measures should be integrated into the project's overall planning and implementation strategy. Regular monitoring, evaluation, and adaptation of these measures will help ensure the safety and well-being of both workers and the local community, while effectively addressing potential risks and challenges.

8.4.22 Improve Gender Sensitive and Prevent Gender Based Violence

Despite of the recent advancements in Nepal on Gender equality, challenges persist in achieving complete gender equality, with instances of gender-based discrimination still prevalent in certain sectors. Cultural norms still deeply ingrained in society can reinforce gender disparities, particularly impacting women in rural areas, marginalized communities, and indigenous populations, such as those in the project area. Moreover, there have been multiple instances where women have faced discrimination in project employments have even subjected to violence and abuse. These issues need to be effectively addressed as integral components of the mitigation measure.

8.4.22.1 Equal opportunities for men and women in the project:

Equal opportunity policy – develop and enforce equal opportunity policies that ensure fair recruitment practices regardless of gender. The project should actively seek to diversify its workforce and challenge traditional gender stereotypes.

Skills Enhancement Programs – The on-site training institute should prioritize women recruitment. The training programs that emphasize skills over physical strengths suitable for women shall be conducted. This can empower women to take on a broader range of roles within the project.

Wage Parity – Enforce wage parity for men and women performing the same tasks, eliminate the wage gap based on gender. Also enforce legislative measures if such instances are reported.

Promote women - In addition to endorsing and commemorating the contributions of all workers, particular attention will be directed toward endorsing and acknowledging the contributions of women within the project. This effort aims to challenge the notion that only men are effective in specific roles.

8.4.22.2 Project to Become Gender Sensitivity, Inclusive and Control Gender-based Violence/ Trafficking:

Gender-Sensitive Infrastructure – Establish separate and hygienic facilities such as toilets and showers for women. This fosters a safe and respectful environment, enabling female workers to participate fully.

Awareness and Training Programs – Conduct gender sensitization programs, gender-based violence, trafficking for project staff, contractors, workers, and locals. These programs can promote understanding of gender issues and the importance of inclusivity. Collaborate with local communities to raise awareness about gender-based violence and establish support systems.

Safe Reporting Mechanisms - Implement confidential and easily accessible reporting mechanisms for incidents of gender-based violence. Ensure that those who report are protected from retaliation.

Partnership - Collaborate with local NGOs, law enforcement agencies, and community organizations to prevent trafficking, identify potential victims, and provide support.

8.4.22.3 Gender Sensitivity Towards Affected Female-Headed HHs

Customized Resettlement Plans – The compensation measures that was discussed above have incorporated additional emphasis to the vulnerable groups such as additional allowances recognizing higher vulnerabilities of the Female-Headed HHs.

Livelihood Assistance – The gender sensitivity was incorporated in the as a part of social assistance program that investigates supporting the Female-Headed HHs in skills development, alternative business established, *etc*.

Empowerment Initiatives - Implement programs that empower women through financial literacy, leadership development, and access to resources.

8.4.23 Traffic Management

The construction activities, especially the transportation of construction materials and personnel, pose a significant risk of traffic congestion and accidents during the construction phase. To mitigate these potential issues, several measures need to be considered:

Proper coordination and careful programming of transportation activities are essential to minimize the impact of traffic congestion. This involves planning construction material deliveries and personnel transportation to avoid peak traffic periods.

- Launching public information and awareness campaigns is crucial to inform locals about major traffic areas and periods affected by construction activities. This helps local populations plan their movements accordingly.
- Establishing a centralized transportation and traffic management unit can optimize traffic flows, reducing congestion and accident risks. This unit can monitor construction-related transportation activities and adjust schedules as needed.
- Given the heavy traffic caused by construction, prioritizing the maintenance of main routes is essential. Implementing a periodic maintenance program for these routes ensures they remain in good condition, reducing accident risks and project construction delays.
- If multiple contractors are working on different project sites, fostering coordination among them is vital. This can involve sharing information about transportation schedules, routes, and potential road closures to avoid unnecessary congestion.
- Utilize traffic management techniques such as implementing one-way traffic systems, temporary traffic diversions, and utilizing flagmen to optimize traffic flow in construction areas.
- Clearly marking speed limits and using appropriate signage in construction zones can help prevent accidents and guide drivers through changing traffic conditions.
- Provide safety training for construction personnel regarding traffic management and safe practices while working near roadways. This enhances overall safety for both construction workers and road users.
- Develop comprehensive emergency response plans in case of accidents or traffic-related incidents. Having predefined protocols can minimize response times and reduce the severity of potential accidents.
- Maintain open communication channels with local authorities, transportation agencies, and the community to address concerns, provide updates, and gather feedback regarding traffic management efforts.
- Utilize technology solutions such as real-time traffic monitoring and data analytics to anticipate and respond to traffic congestion issues promptly.
- Establish a feedback mechanism through which community members can report concerns related to traffic management. This helps address issues in real time.

By implementing a holistic approach that combines planning, communication, safety measures, and coordination, the impact of traffic congestion and accident risks can be minimized during the TSHPP construction phase.

8.5 Socio-Economic Mitigation Measures - Operation Phase

8.5.1 Restoration of the Cultural and Religious Structures

The reservoir will be formed once the project comes into operation, which will start inundation process. The inundation is a permanent impact of the project, thus the loss of land in the reservoir will be permanent. The acquisition and compensations will be completed in the construction phase and address in the previous section of this report.

8.5.2 Restoration of cremation sites

In addition to the anticipated land inundation resulting from the reservoir, the project will also inundate some sites of cultural and religious importance. This encompasses cremations sites that hold profound meaning for the local communities, serving as site where they conduct the final rites for their departed ones. Throughout the study, a total of 14 such cremation sites were identified and documented, with details outlines in both the baseline and impact assessment sections of this report. Though the team has reported that the cremation sites do not currently have any built-up structures and are only the riverbanks.

Given the deep-rooted cultural and spiritual significance of these cremation sites, it becomes imperative to approach their potential displacement with utmost sensitivity. The proposed mitigation strategy involves the meticulous identification and establishment of alternative cremation sites. This approach is underpinned by the profound respect for the cultural and religious beliefs held by the local communities.

To fulfill this commitment, the project will take a proactive stance in constructing fully equipped cremation structures in strategically chosen tributaries. These structures will be thoughtfully designed to seamlessly facilitate the entire process of conducting last rites, enabling the locals to uphold their traditions without any unwarranted disruptions.

Central to the effectiveness of this strategy is the active engagement of the local populace. By directly involving the community members in consultations. By directly involving the community members in consultations and discussions, their valuable insights and preferences will be integrated into the design and layout of these new cremation sites. This inclusive approach underscores the project's commitment to preserving the essence of the communities' practices while adapting to the changing landscape.

In essence, this approach not only recognizes the cultural and religious heritage intertwined with these cremation sites but also demonstrates a practical solution that respects and accommodates the communities' needs. By thoughtfully considering every aspect of this relocation process, the project aims to ensure that the local population can continue to carry out their rituals in a manner that resonates with their beliefs and sustains their connections to their ancestral practices.

8.5.3 Protection of the temples

The forthcoming reservoir's water levels are projected to approach the vicinity of three temples gracefully positioned along the riverbank cliffs. These temples are imbued with cultural and spiritual significance, weaving into the intricate tapestry of the region's identity. Despite the proximity of the reservoir's waters, it's noteworthy that the inundation of these revered temples is not anticipated.

To safeguard these temples from the encroachment of water and the potential effects of the reservoir, meticulous measures are planned. The implementation of embankments and protective walls is on the agenda, aimed at ensuring the preservation of the temple precincts. These engineering interventions are designed to serve as effective barriers, safeguarding the temples' surroundings from any potential alterations due to changing water levels.

This approach underscores a proactive strategy to uphold the sanctity of these cultural landmarks while mitigating the potential impacts of the reservoir's formation. The careful balance between preservation and modernization showcases a commitment to honoring the region's heritage while embracing necessary infrastructure development.

8.5.4 Ecosystem Services

The project implementation will result in the compromise of ecosystem services, and a significant aspect is the potential loss of forest resources that have long been managed and utilized by the Community Forest User Groups (CFUGs). These CFUGs have played a crucial role in managing these forested areas, ensuring sustainable resource utilization, and benefiting the local communities. The loss of these resources could have far-reaching consequences.

While the mitigation measures outline in the forestry section of this report rightly focused on compensating for the direct loss of forest vegetation and forest area, it’s important to recognize and address the broader implications that stem from the compromised access to these forest resources. These resources serve as vital ecosystem services that the CFUGs have been enjoying and benefiting from over the years. They contribute to the economic, social, and cultural well-being of the local communities in multifaceted ways.

Addressing the compromised access to these forest resources involves a comprehensive approach that goes beyond simple compensation for physical losses. It requires:

8.5.4.1 Involving Affected CFUGs in Compensatory Plantation

Involving the members of the Community Forest User Groups (CFUGs) in the various stages of compensatory plantation procedures is a strategic approach that holds multiple benefits. This inclusive engagement encompasses tasks such as forest clearance, nursery management, plantation activities, as well as the protection and subsequent management of the reforested site. This collaborative effort serves to achieve several intertwined goals.

First and foremost, engaging CFUG members in compensatory plantation procedures allows them to actively participate in generating economic benefits. By involving the community in these activities, the CFUGs can create employment opportunities and supplement their income. The skills and experience possessed by CFUG members become valuable assets in the success of the plantation efforts, ensuring that the compensation process aligns with their capabilities.

Moreover, this approach also capitalizes on the CFUGs' connection to the land and their understanding of local conditions. Their intimate knowledge of the environment enhances the efficiency and effectiveness of planting procedures, leading to higher chances of successful reforestation. This also empowers CFUGs to have direct ownership and involvement in the entire lifecycle of the reforested areas.

8.5.4.2 Prioritize Compensatory Plantation in the Affected Community Forests

The strategic prioritization of reforestation sites within the affected community forests holds significant merit. By focusing on the restoration of degraded forest sites within these community forests, CFUGs contribute to the enhancement of overall forest quality. This means that even though they may experience a loss of physical land area, the improved condition of the forest can effectively compensate for any reduction in available forest resources. This way, the CFUGs' requirements for forest resources can potentially be fulfilled through the revitalized and expanded forest ecosystems they help to create.

An additional advantage emerges from the reforested areas themselves. As these areas mature, CFUG members gain the opportunity to utilize the forest resources they produce. This reinforces their access to essential resources, thereby reducing their dependency on the forest areas that may have been impacted by the project. By managing the reforested areas sustainably, the CFUGs secure their own future resource base.

In conclusion, involving CFUG members in the full spectrum of compensatory plantation procedures is a well-rounded approach that combines economic compensation, skill utilization, sustainable resource management, and community empowerment. It not only addresses the immediate impacts of the project but also creates a foundation for long-term resilience and benefits for the CFUGs and the environment.

8.5.4.3 Optimizing Downstream Water Use

The implementation of TSHPP can have significant impacts on the downstream water users and uses, including changes in water flow, quality, and availability. It’s noteworthy that the present study has not indicted any substantial utilization of the Seti River downstream; instead, local communities are relying on the tributaries connected to the Seti River. Nonetheless, it’s crucial to acknowledge that the project’s implementation may compromise the prospective utilization of the Seti River in the future.

Implementing effective mitigation measures is crucial to ensure that the needs of D/S communities, and ecosystems are adequately addressed. Some of the mitigation measures to consider are:

Environmental Flow Assessment – Undertake a comprehensive assessment of the Eflow necessary to sustain the health and vitality of downstream ecosystems and habitats. Though locals are not using the water from the Seti River they are using the River for fishing, recreation, and cremation. The Eflow assessment shall incorporate these aspects of the river use in the assessment.

Ensure Cultural and Religious Activities – Ensure that locals can perform to cremation and religious activities on the Seti Riverbanks, which might require certain discharge on the Seti River. Alternatively, as discussed above, consult with locals to identify secure alternative locations for these activities, such as on the banks of the tributaries.

Permanent Cremation Sites – as discussed earlier, the project will build in consultation with the locals to build permanent cremation sites on the banks of the tributaries to the Seti River in this stretch that can respect cultural and religious practices. These structure not only provide safe spaces but also integrate community values into the project planning.

Emergency Protocols – Establish protocols to manage unexpected situations like abrupt water flow changes during water diversion and flushing. Ensure that downstream communities re adequately informed and prepared to respond to potential hazards.

Cumulative Impact Assessment - Conduct assessments to evaluate the cumulative impacts of the TSHPP in conjunction with other existing or planned projects, ensuring a holistic understanding of downstream effects.

8.5.5 Public Services and local infrastructure

8.5.5.1 Rerouting of the Buddha Singh Marga

Buddha Singh Marga serves as a crucial motorable link between the project area and Damauli Bazar, spanning 24 km from Damauli Bazar to Ghumaune along the left bank of the Trishuli River. The impending construction of a connecting bridge holds the promise of significantly reducing travel time and enhancing accessibility to both Damauli and the project site. The road currently facilitates pedestrian and motorcycle crossings through a suspension bridge and has been instrumental in enabling the movement of goods and passengers, serving as a pivotal route to the Tribhuwan Highway, which connects major locales including Bharatpur, Chitwan, and Kathmandu. The road also interconnects neighboring settlements like Bandipur, Rishing, Vyas, Devghat, and Aanbu Khaireni. However, despite its importance, the road remains incomplete for year-round usage, lacking essential elements such as bridges and bitumen surfacing. A projected 7.28 km of the road is at risk of inundation due to the impending reservoir formation. Vulnerable sections prone to flooding necessitate rerouting and flood protection measures. To ensure uninterrupted access, proactive steps are essential, including the establishment of resilient infrastructure and meticulous planning to safeguard transportation for the local community and the project's success.

To avert the threat of inundation, the 7.28 km stretch susceptible to submersion will be rerouted to higher ground during the construction phase.

8.5.5.2 Submergence of suspension bridges

The anticipated inundation of suspension bridges is poised to have a profound and far-reaching impact on the daily lives of the neighboring communities flanking the Seti River.

These suspension bridges hold a pivotal role in facilitating essential transportation and communication networks, essentially functioning as lifelines for the local inhabitants. Consequently, the submergence of these bridges because of the reservoir's filling stands to present considerable challenges to the communities' mobility and interconnectedness.

8.5.5.3 Improving Connectivity

Among the affected bridges, one of notable significance is the suspension bridge situated adjacent to the Shree Seti Ganga Primary School. This bridge holds a vital position as a connecting link between Bandipur-6 and Devghat-3. Its importance lies in its role as a conduit for residents, affording them access to indispensable educational resources, healthcare services, marketplaces, and various amenities accessible within both these settlements. The bridge's impending submergence represents a substantial disruption to the communities' access to these vital facilities and services, highlighting the significant implications of the project's impact on their day-to-day lives.

As part of the project's construction phase, there are plans to establish access roads and bridges. Many of these roads are intended to remain functional even after the construction is finalized, thereby enhancing connectivity within the project regions.

8.5.5.4 Relocating Shree Seti Ganga Basic School

The creation of the reservoir will result in the submersion of Shree Seti Ganga Basic School, situated in Kharaetar, Bandipur-6. Founded in 2044 BS, the school serves students ranging from Playgroup to Class 8. Presently, the school accommodates a student body of 72, under the guidance of a teaching staff comprising 13 teachers, including 4 hired through private channels.

Encompassing an area of 763.11 square meters, the school's premises encompass diverse facilities essential for the holistic development of students. These amenities encompass classrooms, a dedicated computer laboratory, restroom facilities, a playground area, potable water sources, consistent electricity supply, and internet connectivity, all of which contribute to an enriching learning environment for the students. The impending submersion of the school due to the reservoir's formation not only signifies the physical loss of a place of education but also underscores the wider implications for the local community and its educational resources.

The project entails the relocation of the school to a new site, a decision that will be reached through collaborative consultation with the school management. This careful deliberation will ensure that the accessibility of the students remains unhampered by the transition. The new school, constructed with an enhanced focus on infrastructure, amenities, and aesthetics, is poised to represent a marked improvement over the previous facility. Importantly, the construction endeavors will be concluded before the commencement of the project's operations, thereby guaranteeing that no disruption to school activities will arise. This proactive approach to relocating and upgrading the school reflects the project's commitment to minimizing adverse impacts while concurrently enhancing the educational environment for the students.

8.5.5.5 Establish GRM

A Grievance Redress Mechanism is a structured process or system put in place by projects to address complaints, concerns, or grievances raised by individuals or groups who are affected by their activities. The purpose of GRM is to provide an accessible and transparent way for people to voice their issues and seek resolution. As a means of mitigation, the project will establish a Grievance Redress Mechanism (GRM) to provide affected individuals with a platform to voice their concerns and address any issues related to land damage resulting from operational phase activities. In the context of large-scale projects such as TSHPP, these mechanisms can help prevent conflicts, promote transparency, and contribute to the overall sustainability and responsible management of the project. A well-implemented GRM can lead to positive outcomes by allowing affected parties to have their voices heard, grievances addressed, and issues resolved in a way that benefits both the community and the project's developers.

8.5.5.6 Downstream water users and uses

Several safety measures will be implemented to ensure the well-being and awareness of individuals in the designated project area:

Siren installation - A comprehensive safety siren system will be established along the section between the dam site and the tailrace. At a minimum, this siren system will be installed at two strategic locations. The sirens will serve as audible alerts, providing immediate and clear indications of potential hazards to individuals in the vicinity.

Information Boards - Information boards will be thoughtfully placed to raise awareness regarding hazardous areas. These boards will offer essential guidance and information about danger zones, enhancing the understanding of visitors and local residents about areas that require caution.

Public Awareness Campaigns - A targeted effort will be made to disseminate information and promote public awareness. These campaigns will focus on educating the public about the potential risks associated with specific locations and activities. This proactive approach aims to empower individuals to make informed decisions while navigating the area.

Patrolling Activities - Regular patrolling activities will be conducted to ensure that safety protocols are adhered to and to respond promptly to any potential emergencies. The presence of patrolling personnel will further contribute to creating a secure environment and addressing concerns in real time.

Risk Assessment for River Activities - A comprehensive assessment will be undertaken to determine the danger zones and safe periods for activities such as rafting along the river stretch. This analysis will factor in variables such as water flow, dam operations, and other relevant parameters, with the aim of safeguarding individuals engaging in recreational pursuits.

These multifaceted safety measures underscore the project's commitment to minimizing risks and promoting safety awareness within the project area. By integrating these initiatives, the project aims to create an environment that prioritizes the safety and well-being of all individuals who interact with the designated regions.

8.6 Community Support Program (CSP)

As per the Concept Paper and Work Plan for National Energy Crisis Allevation and Electricity Development Decade, 2015, 0.50% of the total project cost needs to be allocated for Community Support Program (CSP). The project is anticipated to have an impact on a total of 285 households (HHs), both on a permanent and temporary basis due to the process of land acquisition. This occurrence will give rise to two distinct categories of affected families: Severely Project Affected Families (SPAF) and Project Affected Families (PAF). The project will implement CSP to cater to the needs of these households in light of the changes they will undergo.

For this project, a total of NRS 120,600,000.00 (USD 9,00,000.00) is proposed for CSP. Following are the sectors covering CSP:

The CSP will consist of the following components:

a) Education Support Program

Schools which are in vulnerable condition and located in the affected wards of the municipalities, will be supported through an educational support program. Under this, programs such as renovation of existing school facilities, supporting by providing learning materials such as books, computers, laboratory equipment and extra-curricular activities will be carried out. The total amount for the provision shall be NRS. 10,000,000.00.

b) Community Forest/Leasehold Forest Support Program

As a part of community forest support program, the project will organize tree plantation campaigns, provide necessary tools and equipments for forest management such as fencing to protect young trees, and tools for planting and maintaining trees. Aditionally, the CFUGs will also be given training on managing community forests. Assistance will be provided to affected CFUGs in preparing/updating their CFUG operational plans. A total of 15 CFUG and 5 LFUGs will be affected by the project and this support program will be targeted to these user groups.

Each User Groups will be allocated a sum of NRs 5,00,000.00. The total cost allocated for this program is NRs. 10,000,000.00.

c) Infrastructure Support Program

The project aims to support people/stakeholders of each project affected wards in the infrastructure and services facility sector. Support will be provided for following infrastructures:

- Support for building permanent cremation sites: There are significant number of temporary cremation sites that will be impacted due to the formation of reservoir. The project will assist in building permanent cremation sites in coordination with the locals and stakeholders. Around 15 cremation sites will be affected. Therefore, the project will support NRs. 150,000.00 for each cremation sites totalling to NRs. 22,50,000.00 under this program.
- Water supply and security support program: The project will support for the enhancement of existing water supply systems in the project area. The cost allocated for this is NRs 10,000,000.00
- Small scale irrigation support program: Under this, the project will support the communities for the improvement/construction of irrigation infrastructure. The total cost under this program is NRS. 10,000,000.00

d) Support for skill based and livelihood enhancement training

This program will focus on skill-based and livelihood enhancement training for fostering sustainable community development. This program will aim to equip local residents with the slills necessary to improve their economic prospects and enhance overall community resilience. Trainings such as Vocational Trainings and workshops that are in demand within and outside the community, such as welding, electrical fittings, installation will be provided. Additionally, entrepreneurship development programs on business skills, financial literacy, marketing and digital skills for business management will be provided. 15 days training package for 285 HH with NRs 10,000.00 per day is allocated for this program with a total cost of NRS 42,750,000.00

e) Health Sector Support Program

This program will focus on supporting health institutions in the project area. Additionally, health camps will also be organized each year during the construction period of the project for 5 years. One health institution from each affected wards will be supported with a sum of NRs. 300,000.00 totaling to about NRs. 30,00,000.00. Additionally, health campaigns will be conducted each year for 5 years. The cost allocated for one health camp is NRs. 20,00,000.00. The total cost allocated under this is NRs. 10,000,000.00

f) Cultural Support Program

The project will assist and promote cultural groups to strengthen their traditional culture. The cost allocated under this program is NRs. 10,000,000.00

g) Promotion of local products (agriculture, horticulture, livestock, NTFP) in project area:

The project will identify one major product in each affected wards and assist for their promotion. The total cost allocated for this is NRs. 15,600,000.00

The summary of CSP cost is given in table below:

Table 8. 9: Summary of CSP Cost

SN	Description	Amount (NRs)
1.	Education Support Program	10,000,000.00
2.	Community Forest/Leasehold Forest Support Program	10,000,000.00
3.	Infrastructure Support Program	
	Cremation Sites	22,50,000.00
	Water Supply and Security Support Program	10,000,000.00
	Small Scale Irrigation Support Program	10,000,000.00
4.	Support for skill based and livelihood enhancement training	42,750,000.00
5.	Health Sector Support Program	10,000,000.00
6.	Cultural Support Program	10,000,000.00
7.	Promotion of local products	15,600,000.00
	Total Amount	120,600,000.00

9 Grievance Redress Mechanism

The Grievance redress mechanism will be established at the project site to receive and manage any grievances (complains) such as any disagreeable decisions, practices and activities, technical and general project-related issues and disputes that may arise from the project and facilitate prompt resolution of affected person' issues, concerns, problems, or claims. Affected persons may include members of the local community or construction workers. The community will be made fully aware of their rights and the procedures for doing so verbally and in writing during community meetings and consultations. The project wide GRM will address both environmental and social safeguard and other related eligible grievances/complaints raised by affected persons in a timely and culturally appropriate manner. The GRM is aimed to provide a trusted way to voice and resolve concerns linked to the project, and to be an effective way to address displaced people's concern without allowing it to escalate resulting in delays in project implementation. Hence, the Grievance Redress Committee (GRC) will be formed in advance to address the grievances of local community members.

THL's (Tanahun Hydropower Limited) Project Management Office (PMO) will establish and publicize the GRM to receive and manage any grievances that may arise from the project and facilitate prompt resolution of affected person's issues, concerns, problems, or claims using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to the affected persons at no costs and without retribution.

Affected people can approach the court of law at any time and independently of the project's grievance redress process. Affected peoples may (subject to eligibility criteria) also access The GRM will be set up upon loan effectiveness and be operationalized prior to the commencement of any civil works, including enabling works. Besides, at the construction sites and the PMO offices, boards will be set up which give the contact details of people to be contacted in case of any grievances. The information will be specifically related to the construction works and provided in local language describing the project, the grievance mechanism and where and whom stakeholders can deliver their complaints, and in what form, verbal or written. Communities within the project's area of influence will be made aware of this GRM through (i) community awareness raising during community meetings, (ii) pamphlets distributed to the public in the direct vicinity of the project site, in Nepali and translated in local language as applicable; and (iii) notices on the radio and/or local newspaper, at local THL offices, and on THL's website.

PMO and the contractor will appoint community engagement officers/GRM focal (PMO project level focal and Contractor site level Focal). All staff of THL, PMO and the contractors, as well as local and central government and other entities directly involved in the GRM process will receive training prior to the start. Any concerned person or group of people can file a complaint through the project's GRM, at any time and at no cost.

GRM focal will actively engage with the affected local communities and construction workers throughout pre-construction, construction and at the onset of operation, providing an opportunity for community members or workers to approach them with any grievance/complaint. Affected peoples may also lodge grievances/complaints online through

THL's website, by phone at numbers provided, by submitting a note in a suggestion box kept on site, by sending a letter, or in person at a project-site office or at the closest THL office. The GRM will follow a three-tier structure namely:

9.1 1st Level Grievance (Site Level):

During the first level grievance, the contractor's site level focal will be in charge. All grievances/complaints will be sorted by the focal for their eligibility, level of urgency and by nature of the project. Within 3 days of receiving the application, the focal will contact the applicant to acknowledge the receipt of the grievance, provide a complaint registration number, and set up a meeting in presence of the contractor's project manager. A formal reply will be addressed to the complainant and will be informed about the process and of his/her possibility to subsequently escalate the complaint in case no resolution was found at this stage. The contact to the second GRM will also be included. Other participants such as contractor's environment, health and safety, subcontractor's representative, PMO's junior EHS (Environment Health & Safety) office when on site etc can be called to this meeting. The affected person(s) may come in presence of two representatives of their choice (selected so as to be gender inclusive), including a representative of their IP group if applicable. To keep this first level simple, the number of meeting attendees will be kept as much as possible to between 4 and 8, but ideally 4, for flexibility and ease of dialogue.

The first meeting shall take place no later than one week after receipt of the grievance/complaint. The complainant and the contractor's site level focus will discuss and try to agree on the course of action to be taken to resolve the complaint. The duration for this course of action will also be discussed and agreed upon. Minutes of the meeting will be kept with signatures of all the participants to document the GRM process and will be annexed in the GRM file. If both parties agree on the resolution, steps will be taken as per agreed resolution. If both parties do not agree on a resolution, the complaint may be escalated to the second level of GRM.

The timeline for addressing the resolution will be 7 days. If the complainant has difficulty to travel to meeting location upon short notice, the location of the meeting may be flexible and focal will take remedial action, keeping the complainant informed at each stage or every fortnight, whichever the shortest will take remedial action, keeping the complainant informed at each stage or every fortnight, whichever the shortest. Such actions should be taken in the briefest delay, within a maximum time frame of 30 days. However, all simple complaints will be resolved within 7 days of the meeting being held. Following resolution, if the complainant is not happy with the resolution or if no action has been taken within the agreed timeframe, they can escalate the grievance to the second level of GRM.
A log of all active complaints, even if resolved within the first level of GRM, must be communicated to PMO's focal fortnightly by the contractor's on-site focal

9.2 2nd Level Grievance (PMD Level):

The second level of GRM is headed by the PMO's project manager, supported by PMO's project-wise focal. If a complaint has not been resolved at the first level of GRM, it is escalated to the second level. If workers wish to file a complaint and are not comfortable logging it with the first level GRM, they can file it directly to this second level of GRM. All complaints will be sorted by eligibility and level of urgency and by nature (suggestions or comments, grievances/complaints related to adverse impacts of the project on an individual or group, violations of law, etc.). Just as for the first level, all grievances will be properly recorded, and the concerned person or group will be formally informed of the receipt; timeline; and resolution. PMO's focal will send within 3 days of receipt a letter to the complainant acknowledging receipt; within 15 days a meeting should be held, and resolution action plan and timeline agreed upon with the complainant.

The meeting should aim to have between 4 and 8 members, including PMO's project manager, PMO's focal, the complainant who may be accompanied by or represented by two representatives including one IP representative if applicable, PMO's senior environment, health and safety, biodiversity and/or social officer, as well as other members if applicable, including contractor's representative, local rural office representative, community organization representative etc. As for the first level, the second level may have two outcomes: if the parties found a resolution and the complainant signed their approval of the resolution, such actions should be taken in the briefest delay, within a maximum time frame of 30 days. However, all simple complaints will be resolved within 7 days of the meeting being held. If no resolution has been reached, the grievance is forwarded to the third level of the GRM.

9.3 3rd Level Grievance (CDO Level):

In the third level GRM, the same process of logging the grievance/complaint, communicating with the complainant and reporting will be followed. The third level of GRM is handled by THL project manager who will form a grievance redress committee chaired by the Chief District Officer, District Administration Office and made up of PMO's focal and environment or social officers (depending on the nature of the complaint), two representatives of the complainant including indigenous peoples representative if applicable, as well as, as applicable, a representative of the contractor, government representatives for environment or social issues (such as but not limited to land revenue, survey, forest office, agriculture office, municipality representatives etc.), NGOs or CSOs representatives, etc. For ease of discussion, the meeting will try to gather no more than 10 participants.

The grievance redress committee will agree on the resolution approach and action plan, inform concerned parties about actions to be taken and their timeline, and will monitor progress through regular follow-ups. Resolution will be as prompt as possible; receipt of complaint will be acknowledged to the complainant within 3 days, the resolution approach agreed upon within 15 days and actions taken within 45 days. However, all simple complaints will be resolved within 7 days of the meeting being held. Approval of the resolution by the complainant will be sought in writing. If the complainant is still dissatisfied after this stage, they may avail of the court of law.

All entries to the site's grievance/complaints register, whether resolved at initial informal level on site or at any of the three levels of the GRM, along with updates on ongoing or completed actions taken to address the grievance/complaint, will be included in monthly reports by the Contractor to PMO and in periodic monitoring reports from PMO to Funding agency.

PMO's ESMU unit will monitor the overall grievance resolution process along with PMO and will recommend any improvements to increase the efficiency, timeliness, and fairness of the process.

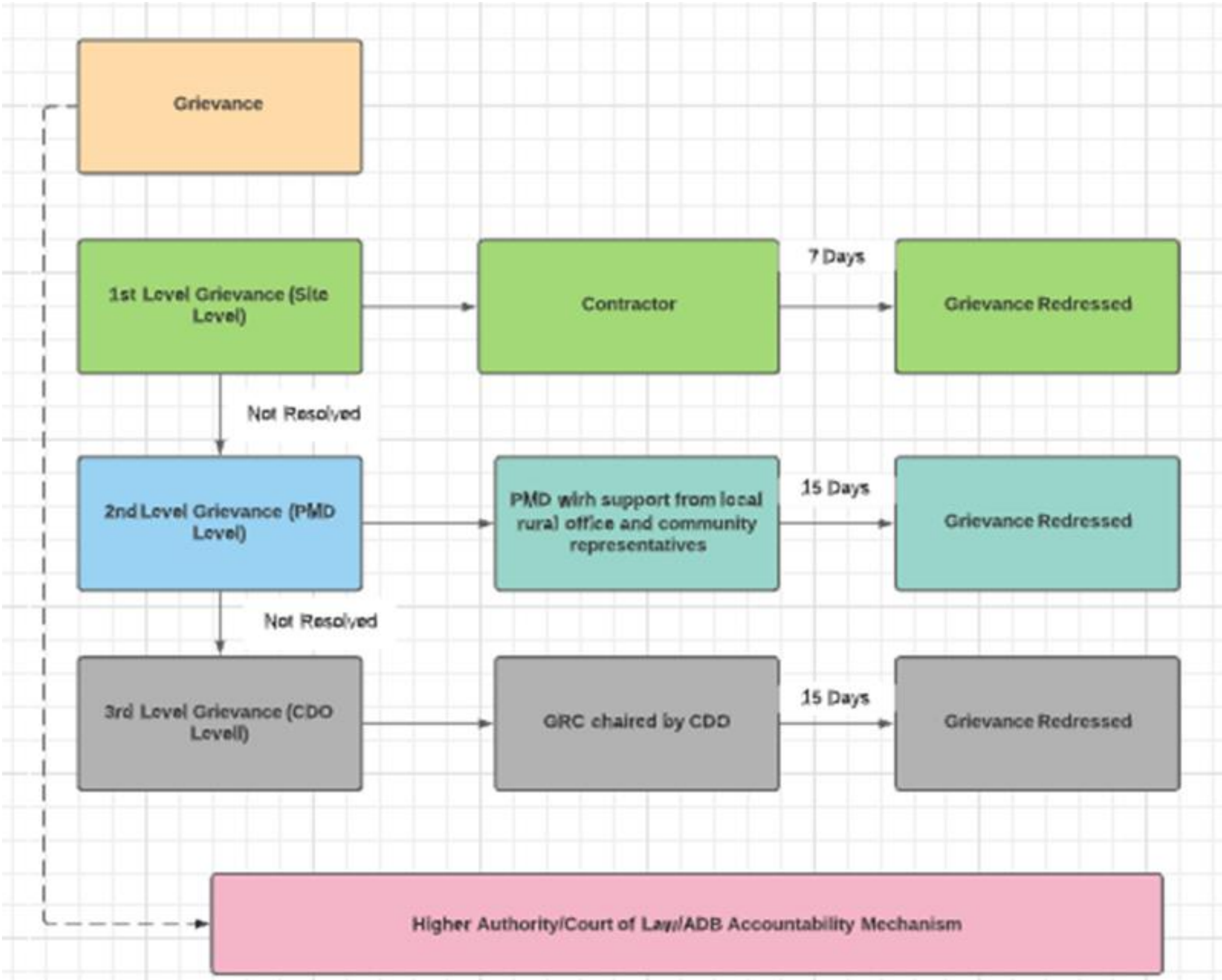


Figure 107: Project's Grievance Redress Mechanism

Table 9. 1: Summary of GRM level responsibilities and timelines

GRM Level	Composition	Maximum timeline
First Level of GRM (site-level)	Responsibility: Contractor's project manager supported by contractor's community engagement officer/GRM focal Other parties involved, as applicable: - 2 representatives of affected person (gender inclusive, including 1 representative of IP group as applicable)	3 days: confirmation of receipt to complaint 7 days: meeting between contractor's project manager and complainant and action plan agreed upon (or escalation to level 2) Maximum 30 days: action taken and grievance resolved, although any environment safeguard grievances that are n emergency or pose a health

GRM Level	Composition	Maximum timeline
	- Contractor’s representative - Subcontractor’s representative - PMO Junior EHS officer when on-site Total Meeting members: 4-8	and safety risk to workers or community members must be resolved immediately by the contractor Information and reporting to PMO community engagement officer/GRM focal on two-weekly basis by contractor.
Second Level GRM (project-level)	Responsibility: PMO’s project manager supported by PMO community engagement officer/GRM focal Other parties involved, as applicable - 2 representatives of affected persons (gender inclusive, including 1 representative of IP group as applicable) - Representative of the contractor - PMO senior environment, health and safety, biodiversity and/or social officer as applicable depending on environment or social issues being resolved - Local rural office and community organization representative Total meeting members: 4-8	3 days: confirmation of receipt to complaint 15 days: meeting between PMO project manager and complaint and action plan agreed upon (or escalation to level 3) Maximum 30 days: action taken, and grievance resolved Information and reporting to THL board and management by PMO community engagement officer/GRM focal.
Third Level of GRM (committee-level)	Responsibility: Chief District Officer, District Administration Office as chair; PMO project manager as facilitator Other parties involved, as applicable: - 2 representatives of affected persons (gender inclusive, including 1 representative of IP group as applicable) - PMO community engagement officer/GRM focal	3 days: confirmation of receipt to complaint 15 days: grievance redress committee meeting and action plan agreed upon Maximum 45 days: action taken, and grievance resolved Information and reporting to THL board and management by PMO community engagement officer/GRM focal.

GRM Level	Composition	Maximum timeline
	- Representative of the contractor - Government representatives as applicable depending on environment or social issues being resolved (e.g. land revenue, survey, forest office, agriculture office, municipality representative etc) - NGOs/CSOs representatives depending on environment or social issues being resolved - Other as applicable Total Meeting Members: <10	

Table 9. 2: Template for grievance/complaints register entries

Registration Number	Date of Complaint	Details of complainant (Name, Address, Email, Contact Number) if confidentiality is requested, highlight here	Entry point of complaint (person/ entity)	Description of complaint	Date and content of communication to complainant (date complaint acknowledged by level 1/2/3, feedback sent etc.)	Date of meetings held and outcome (attach minutes of meetings)	Time line agreed upon for resolution and action plan	Status (outstanding, overdue, solution agreed upon, solution under implementation resolved)	Other remarks

10 Environment Management Plan

The Environment Management Plan (EMP) presents a comprehensive set of mitigation measures aimed at preventing, reducing, mitigating, or compensating for any adverse environmental impacts and risks identified in preceding sections. By implementing the strategies outlined in the EMP, the project aims to ensure the responsible and sustainable management of environmental concerns at every stage of its lifecycle. The plan's measures are designed to minimize the project's ecological footprint, safeguard natural resources, and protect the surrounding ecosystem and communities from undue environmental harm. Regular monitoring, adherence to environmental regulations, and proactive intervention are emphasized to promote successful environmental management throughout the project's execution and operation. The EMP serves as a vital framework for promoting environmentally responsible practices and achieving a harmonious balance between energy development and environmental preservation.

The EMP is designed to offer comprehensive guidance for the detailed design, pre-construction, construction, and operation and maintenance phases of the project. It aims to ensure compliance with Nepali environmental regulations, health and safety standards, and the safeguard policy statement (2009 of the ADB). By incorporating both national requirements and international best practices, the EMP identifies and address potential environmental impacts and risks during the project's implementation.

The EMP assigns responsible agencies to undertake specific actions and outlines the estimated investments required to carry out the proposed plans. It serves four main objectives: (i) providing a proactive, feasible, and practical working tool to measure and monitor on-site environmental performance; (ii) guiding and controlling the implementation of corrective measures based on findings and recommendations; (iii) detailing specific actions necessary to mitigate the environmental impact of the subproject; and (iv) ensuring strict compliance with Occupational Health and Safety (OHS) recommendations.

While some impacts may be permanent and cannot be mitigated, the EMP explores appropriate compensatory measures or opportunities for enhancing positive impacts. By diligently adhering to the EMP's provisions, the project seeks to achieve a balance between its objectives and environmental preservation, striving for responsible and sustainable development throughout its lifecycle.

A copy of the Environment Management Plan (EMP) will be consistently present at work sites. The EMP will be incorporated into the bidding and contract documents, making it binding on all contractors operating at the site. Any non-compliance or deviation from the conditions outlined in this document will be considered a failure in compliance.

To ensure adherence to the EMP, bidding documents, and contract clauses, the contractor will be required to prepare a site-specific EMP (SEMP) and an Occupational Health and Safety (OHS) Plan, along with various other plans of action, code of conduct, procedures, and protocols. The contractor must seek approval from the employers before proceeding with field mobilization.

By incorporating the EMP and relevant documents into the contractual clauses and on-site practices, the project aims to foster a culture of responsible environmental management and safety measures. This comprehensive approach ensures that all contractors actively contribute to the successful implementation of the EMP, promoting sustainable practices and minimizing environmental impact throughout the project's execution.

10.1 Institutional Arrangement for undertaking Environmental and Social Programs

10.1.1 Tanahu Hydropower Limited (THL)

The TSHPP is currently under development by Tanahu Hydropower Limited (THL), a subsidiary of Nepal Electricity Authority (NEA) founded in 2012.

10.1.2 Project Management Office

The Project Management Office for the TSHPP will establish the Environmental and Social Management Unit (ESMU) as the implementing agency for environmental and social programs. The Project Director in the Project Management Office will oversee and coordinate the implementation of the environmental mitigation and monitoring plan and hold the authority to make final decisions on these matters. However, the Project Director may delegate some responsibilities to the ESMU.

Most of the mitigation measures will be executed during the construction phase as specified in the tender document clauses. The project will either carry out these measures independently with technical support or collaborate with relevant line agencies and stakeholders. The Contractors involved in the project will be required to prepare Environment Protection Plans, Health and Safety Plans, and other relevant environmental programs, which will then be approved by the Project Director based on ESMU's recommendations.

In cases of breaches of environmental tender clauses, non-compliance, or non-performance, the Project Director, with authorization from THL Office, has the power to stop work or impose penalties on the Contractors.

The Project Director Office is responsible for ensuring the timely and high-quality implementation of mitigation and enhancement measures, as well as effective monitoring. Additionally, the Project Director will establish agreements with public, private, or other stakeholders to carry out approved environmental and social programs, as suggested by ESMU.

10.1.3 Environmental and Social Management Unit

The Environmental and Social Management Division will be established within the Project Management Office right from the start of the project implementation. The unit will directly report to the Project Director. As depicted in the figure below, the ESMU will consist of 3 distinct sub-units, namely.

(a) Resettlement and Social Management Sub-Unit
(b) Grievance Redressal Mechanism Sub-Unit
(c) Environmental Monitoring Sub-Unit

The Environmental Monitoring Sub-Unit will be responsible for carrying out physical and biological mitigation and enhancement programs. On the other hand, the Resettlement and Social Management Sub-Unit will focus on activities such as land acquisition and compensation, resettlement and rehabilitation, community development, livelihood programs, health-related initiatives, and other social projects. Likewise, Grievance Redressal Mechanism Sub-Unit is responsible to receive and act on complaints or grievances reported by stakeholders of private or public institutions enabling prompt actions on any issues raised by them and to avail services more effectively.

These sub-units will also oversee the implementation of environmental and social programs conducted by both the project itself and its contractors, in line with contractual agreements. ESMU will also report on compliance matters.

During the project's construction phase, ESMU will operate as a fully staffed office. However, as the project transitions to the operation phase, it will be downsized and restructured. The functions and responsibilities of ESMU will be influenced by the findings of an Environmental Audit conducted by an external agency within three months of completing the construction work. The Environmental Audit will assess the project's environmental compliance during the construction phase, identify emerging issues, evaluate the environmental and social work required for the operation phase, and suggest mitigation and enhancement measures to be implemented during that phase.

After the Environmental Audit, the regular workload of ESMU may significantly reduce or cease altogether. The THL can choose to retain certain aspects of monitoring to be managed by EMSU. However, these aspects must be carefully formulated during the pre-construction stage.

The ESMU will be responsible for reviewing various plans, including the Environment Protection Plan, Health and Safety Plan, Waste Management Plan, and other environmental and social plans, which are prepared by the contractors. The division will then assist the Project Management Office in promptly approving these plans.

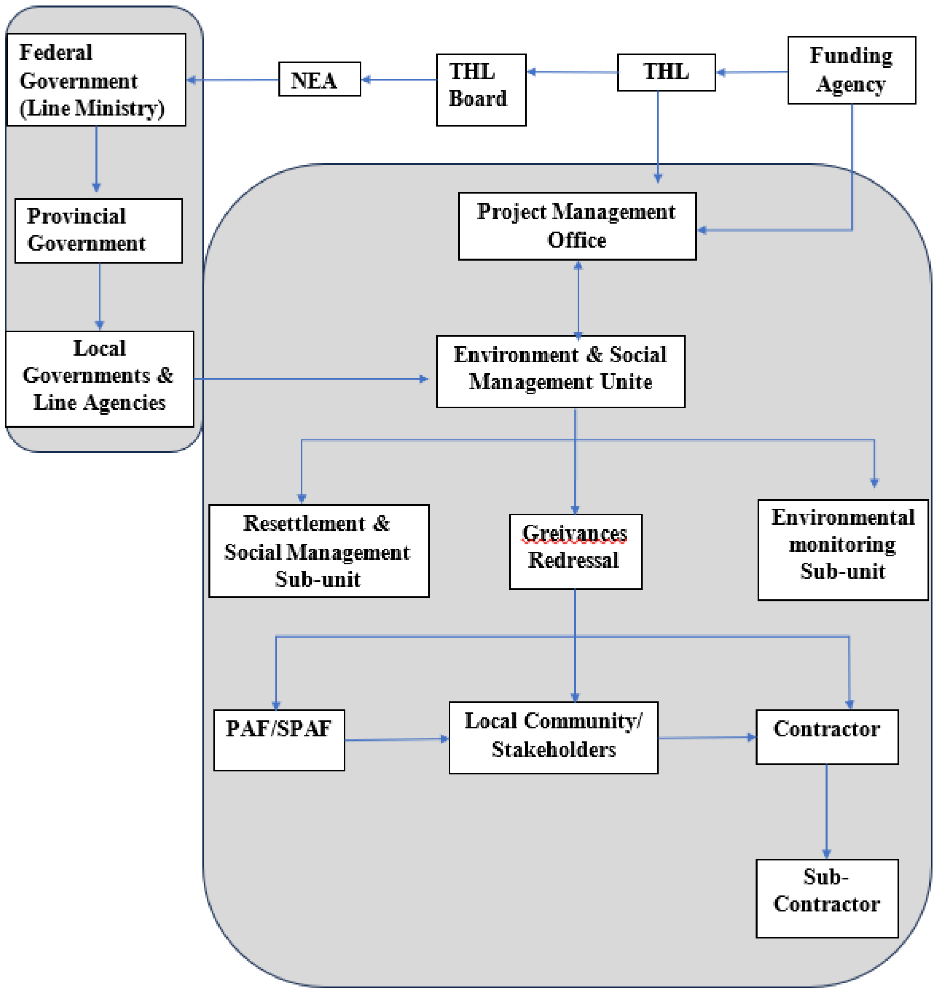


Figure 108: Framework of Environmental and Social Management Unit

According to EPR 2020, the proponent bears the responsibility for environmental management of the project. For TSHPP, this responsibility will lie with the THL, and its project management office (PMO).

The establishment of the ESMU will be planned at least 8 months prior to the civil construction tender award of the project, ensuring timely initiation of the monitoring activities. While the ESMU will directly report to the Project Manager, the EMSU will be responsible for coordinating with the project's supervising consultant. Furthermore, the ESMU will also take lead in coordinating and engaging with the stakeholders.

10.2 Coordinate and cooperation with the other stakeholders

In addition to this institution, the project has to coordinate with central, provincial, and local level governments and line agencies. The roles and activities are summarized in the table below:

Table 10. 1: Roles and responsibilities of the stakeholders.

Organization	Roles and Responsibilities	Timings
Ministry of Forest and Environment (MoFE)	Incorporate environmental measures and associated costs into the project documents and tender clauses. Oversee the overall project monitoring process. Conduct audits to assess the project's performance.	• Prior to Final Project approval • At least once a year during construction • After two years of project completion- operation phase
Ministry of Energy, Water Resources, and Irrigation (MoEWRI)/ DoED	Ensure the inclusion of environmental measures and associated costs in the project documents and tender clauses. Conduct monitoring activities for the overall project.	• Prior to Final Project approval • At least twice a year during construction and once during operation
THL-PMO	Ensure that the EIA and EMP measures are incorporated in the final project design and costs. Acquire necessary permits and approval for project construction and operation. Ensure that the project construction activities are in accordance with legislative requirements. Implementation of repair and maintenance of project components including environmental safeguards as recommended by EMP, MoEWRI, DOED and MoFE Monitoring and record keeping regarding environmental measures and impacts as per EMP Ensure public participation and involvement in all phases of project implementation	• Prior to contract award • Before construction • During construction continuously • During operation continuously • During operation continuously • Project period continuously
External Monitors (Ems)	Review and recommend the final design of the project and ensure that the EMP measures are included in the design and tender. Review monitoring and auditing reports of the supervising consultants and project-environmental monitoring sub-unit (ESMU) and recommend corrective	• Prior to contract tendering in Detail Design Phase • During construction phase every six months

Organization	Roles and Responsibilities	Timings
	measures to meet the objectives of EMP	
Detail Design Consultants	Incorporate environmental mitigation measures as per EM’s recommendation in the design, project cost and tender documents. Include EIA recommendations in the design, project cost and tender documents.	• During Detail Design Phase
Supervising Engineers	Approval to civil construction as per design Monitoring of civil construction as per detail design Ensure that the EMP provisions are implemented and recorded. Ensure that the project corrective actions are duly implemented	• Continuously in Construction Phase
Construction Contractor	Implement civil construction as approved by supervising engineers. Implement mitigation measures as specified in EMP and recommended by Supervising engineers. Front line Monitoring and record keeping of environmental mitigation measures as per EMP through a special monitoring unit Maintain good public relationship with the project area people	• Construction phase continuously
Municipalities, wards office and local stakeholders.	Monitor that the environmental and social mitigation measures are implemented in all stages of the project as per EMP, RAP, SPAF Ensure that the public participation and involvement in the project implementation is maximized by the project owner, consultants, and contractors	• Project Period

EMP structures for different phases of project development and implementation are illustrated in Figures 9.2 (a) and 9.2 (b)

10.2.1 Pre-construction Phase

The EMP for the preconstruction phase will include land acquisition and compensation, resettlement and rehabilitation, public concern issues, co-ordination with line agencies and local

NGOs and INGOs. The allocation of an adequate budget for the implementation of preconstruction measures and follow-up for contract clauses that need to be incorporated in tender documents are the other activities to be managed or conducted during the pre-construction phase. THL will have the prime responsibility for dealing with pre-construction issues.

During this phase, co-ordination and approval of Community Forest User's Group will be sought for felling the trees within the project construction area.

During this phase, a Compensation Fixation Committee will also be formed to deal with all the compensation matters. This committee will comprise of Chief District Officer, Chief District Land Administration and Revenue Officer, Project Chief, and Representative of concerned municipality or rural municipality.

10.2.2 Construction Phase

This phase is the most critical as it requires expertise and resources to manage the construction phase impacts. The implementation of the suggested mitigation measures outlined in Chapter 8 with the EMP is a vital tool and is dependent on liaison with local governments, District Coordination Committee (DCC) and other line agencies. The Proponent will be responsible for carrying out the requirements for mitigation and implementing the EMP through an approach to be formulated by them. At this stage it is merely the control functions that can be described under the management approach.

The ESMU will be responsible for implementing the day-to-day Environment Management Plan. The ESMU will consist of experts from THL, Ministry, local administrators and other qualified personnel and consultants from the local market.

This Unit may serve as a communication channel between the project and the local communities and UM/RM officials, and cooperate with other NGOs, and INGOs development organizations. The ESMU will work in close co-ordination with local bodies, DCC, NGOs, INGOs and contractors. A project compensation unit (RSISU) will also be established under the Environmental Unit that will oversee that compensation aspects are handled with the required care by the project company. A separate unit will be formed which will have direct link with the ESMU to deal with resettlement issues.

10.2.3 Operation Phase

An environment unit will be formed under the Plant Manager for monitoring during the operation phase. This unit will consist of the representatives from THL. Regular monitoring will be done for parameters like compensation releases, water quality and forest cover etc.

10.2.4 Reporting Requirements

The ESMU will prepare and disseminate a report containing information on the implementation status of the environmental protection measures and monitoring results quarterly during the construction period and annually during the operation phase. The unit will also prepare and disseminate the environmental compliance report annually and make it public to provide the people and concerned organizations an opportunity to evaluate the environmental soundness of the project.

10.3 Mitigation Measures

Most cost effective and pragmatic mitigation and enhancement measures for all perceived adverse impacts of the identified environmental issues for construction and operation phases shall be identified to minimize the adverse environmental impacts and maximize the beneficial ones.

A mitigation and enhancement matrix has been prepared, which is presented in table 112. The actions in the mitigation plan are set out according to when they are to be implemented by THL and the contractor, e.g. during (i) detailed design and pre-construction preparatory activities; (ii) on-site enabling, construction, testing and commissioning work activities which are primarily the responsibility of the contractor; and (iii) operations and maintenance activities which are the responsibility of the proponent.

Table 10. 2: Environmental Management Plan

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
B1	Economy	Enhancement of Local Economy	Job openings, employment opportunities	Project Area	Prioritizing locals in employment	Construction phase	Contractor /Project	Project Cost	PMO/ESMU
			Enhanced Skill Development						
			Opportunity for local business						
			Improved Access		Creation of new roads and bridges				
B2	Biodiversity	Habitat formation in reservoir	New habitat for various aviation species	Reservoir	Reservoir formation	Operation Phase	Contractor /Project	Project Cost	PMO/ESMU
B3	Green house Gas	Reduction of GHGs	Project Operation	Regional	Project Implementation		Project	Project Cost	
SN	Subject Area	Negative Impact Mitigation Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
Construction Phase									
Physical Environment									
1.1	Land Use	Compensation for the acquisition of the land for project	In case of private land, compensation	Project Sites	Coordination with Stakeholders	Prior to the commencement of the	Contractor /ESMU	Project cost	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
		components will be provided. The details are discussed in forestry and socio-economic section of this report.	shall be provided to the landowners			construction			
1.2			Compensation for the non-titled land shall be decided by the "Compensation Fixation Committee"		Formation of compensation fixation committee				
1.3			Forested government land shall also be compensated		Negotiations with affected HHs				
1.4		Restoration of the site to the pre-project condition	Implement erosion control measures	Temporary Project Sites	Project design/planning	After the completion of construction works	Contractor	Project cost	
1.5			Revegetate the sites and use soil amendments		Coordination with Stakeholders				
1.6			Implement effective stormwater management systems						
1.7			Removal of temporary structures or facilities used		Consultation with affected owners				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
			during construction						
2.1	Slope stability and erosion	Slope Stabilization and Erosion Control by:	Toe embankments and/or toe buttressing and/or slope angle reduction	Project Sites	Project design/planning	During Construction Works	Contractor	USD 200,000.00	PMO/ESMU
2.2		-Modification of slope geometry	Drainage galleries/tunnels and/or sub horizontal drains		Civil Works				
2.3		-Drainage	Removal of potential slides						
2.4		-Retaining Structures	Erosion protection measures						
2.5		-Internal Slope Reinforcements	Soil nailing/ground anchors		Coordination with Stakeholders				
2.6			Enhancing vegetation quality						
3.1	Rivers and Water Quality	Prevent water pollution by implementing proper erosion and sediment control measures,	Construction of sediment basins or sediment ponds	All project sites	Civil Works	During Construction Works	Contractor	USD 100,000.00	PMO/ESMU
3.2			Install silt fences and erosion control mats						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
3.3		stormwater management practices, and pollution prevention strategies	Establish and maintain vegetation on bare or disturbed areas		Re-evaluation of the project design, if necessary			Project cost	
3.4			Employ techniques like terracing, contour plowing, or hydroseeding						
3.5			Schedule construction activities during dry weather periods						
3.6		Control of Oil, Chemical and other substance spillage	Storage areas to be located at safe distance from water bodies						
3.7			Workshop facilities to be positioned at least 100 m away from water bodies						
4.1	Natural Spring	Preserving springs during the tunnel construction	Conducting a comprehensive hydrological survey	Tunnel area	Civil Works	During Construction Works	Contractor	USD 20,000.00	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
4.2	Sources		Continuous monitoring of water levels		Baseline monitoring				
4.3			Grouting and waterproofing techniques		Planning			Project cost	
4.4			Scheduling tunnel construction with consideration to groundwater levels		Timing of Construction				
4.5			Contingency plans for water supply						
5.1	Air Quality	Mitigating air pollution through Construction Pollution Prevention Plan	Dust suppression through water spraying systems or sprinklers	All project sites	Planning	During Construction Works	Contractor	USD 70,000.00	PMO/ESMU
5.2			Temporary fencing to be installed to reduce the impact of wind on dust dispersion		Civil Works			USD 50,000.00	
5.3			Dusty operations to be done in enclosed environment, and use of dust collectors					Project cost	
5.4			Prohibition of burning of wastes						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
5.5			stockpiles to be located at least 500 m away from residential areas		Baseline monitoring				
5.6			Regular monitoring of air quality and compliance					USD 50,000.00	
5.7			Masks will be provided to workers who have prolonged exposure to the pollution		Enforcement of existing rules and regulations regarding safeguards on air pollution			Project cost	
5.8			Use of low-emission or cleaner technologies						
5.9			Covers in trucks transporting materials to prevent dispersal of dust						
6.1	Solid Waste	Mitigating waste management through Construction	Robust waste collection and segregation system will be put in place	All project sites	Proper Planning	During Construction Works	Contractor	USD 25,000.00	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
6.2		Waste Management Plan	Implement 3R concept among the workforces	including camps					
6.3			On-site incineration units to be constructed, however, open burning will be strictly prohibited		Composting /3R implementation				
6.4			On-site, enclosed composting facilities to be provided		Management of the equipment and materials related to waste management				
6.5			Regular waste audits to be conducted						
6.6			Training and awareness session to the workforce on SWM (Train SWM)		Coordination and cooperation with relevant parties working in solid waste				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
					management				
6.7			Collaboration with local waste management authorities		Training and awareness work				
Biological Environment									
7.1	Forest	Compensation for removal of trees and vegetation and lost forest area	Compensation for lost forest area-an equivalent amount of land to GoN will be provided based on specific rates for different land types	Project Sites	Following existing rules and regulations on forest resources	During Construction	Contractor	USD 41,83,130.26	PMO/ESMU
7.2			Forest clearance will be carried out in accordance with the Forest Act 2076/Regulations 2079 and Standards and Work Procedures for Utilization of National Forest Areas for Projects		Resource allocation for plantation				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
			of National Priority 2076.						
7.3			Compensatory plantation for removal of trees will be carried out at the ratio of 1:10 at the standard of 1600 seedlings/ha		Coordination with DFO and User groups				
7.4			Coordination with respective DFO and User groups in this process						
7.5			THL will be responsible for caring of the site for 5 years, and handover to respective DFO/User groups after this period						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
7.6			Species composition of the reforested area will consist of locally native species						
8.1		Marking and felling of trees	Acquisition of forest clearance permission	Project Sites	Coordination with the relevant parties and cooperation with them	Prior to the commencement of the construction	Contractor		PMO/ESMU
8.2			Enumeration and marking of the trees to be fell in collaboration with DFO, CFUG, and LHFUGs		Survey and enumeration of forest resources				
8.3			Ecological importance survey						
8.4			Documentation and reporting of tree felling		Civil Works				
8.5			Recovered felled trees and NTFP will be handled over to the CFUGs in compliance with national regulation						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
9.1		Establishment of Nursery	Selection of nursery sites in consultation with DFO and User groups	Allocated site	Coordination with DFO and User groups	During construction	Contractor	USD 10,000.00	PMO/ESMU
9.2			Procurement of improved seeds and setup for operation of nursery		Resource allocation				
10.1		Conservation initiatives and minimization of forest fragmentation	Maintain tree and vegetation within the project area	Project Sites	Plantation and conservation works	During Construction	Contractor	Project cost	PMO/ESMU
10.2			Strictly prohibit cutting of trees outside the project area		Resource allocation				
10.3			Efforts to be made to create open areas where existing vegetation and trees can be preserved, avoiding unnecessary removal		Civil Works				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
10.4			Reintroduce and promote the growth of vegetation in areas where clearing is necessary		Regular monitoring of activities				
10.5			Conservation of surrounding forest						
11.1		Provision of alternatives to fuelwood and timber	Make available alternative sources of energy	Project sites including camp areas	Resource allocation	During Construction	Contractor	Project cost	PMO/ESMU
11.2			Promotion of NTFP species in the project area		Engaging local communities, capacity building, awareness campaigns			USD 10,000.00	
11.3			Awareness programs on forest and NTFPs (Aware FOR/NTFP/BIO-DIV)		Market Access				
12.1		Protection of species of conservation significance	Compensatory plantation at the ratio of 1:25 for species of	Project Sites	Plantation and conservation works	During Construction	Contractor	Cost included in 7.1-8.5	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
			conservation significance						
12.2			Ex-situ conservation of orchid by translocating them to Dhakeri Botanical garden, Banke and Bardiya National Parks		Coordination with the DFOs and User groups			USD 5,000.00	
13.1		Safety from forest fires	Creating firebreaks and clearing	Project Sites	Coordination with the DFOs and User groups	During Construction	Contractor	USD 20,000.00	PMO/ESMU
13.2			Establishing a robust early detection system		Strengthening capacity of DFOs and User groups				
13.3			Implementing comprehensive awareness programs		Trainings and workshops				
14.1	Wildlife	Establishment of Rescue and Rehabilitation Centers	Recruit staff well trained in wildlife handling and care	Project Sites	Collaborate with DFO	During Construction	Contractor	USD 100,000.00	PMO/ESMU
14.2			Relocated injured wildlife safety to natural habitats		Resource allocation				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
14.3			Allocate funds for establishment for 5 years						
15.1		Strict enforcement of conservation rules and regulations	Regulating access to local sensitive areas to avoid illegal hunting	Project Sites	Coordination with the DFOs and User groups	During Construction and Operation	Contractor	USD 50,000.00	PMO/ESMU
15.2			Monitoring and patrolling critical areas						
15.3			Inclusion of anti-illegal hunting clause into contractual agreements with contractors						
16.1		Awareness and Training programs on biodiversity conservation	Publish and distribute general biodiversity conservation awareness posters and pamphlets	Project Sites	Coordination with the DFOs and User groups	During Construction and Operation	Contractor	USD 50,000.00	PMO/ESMU
16.2			Placement of signboards with information on wildlife poaching						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
16.3			Biodiversity related awareness trainings for local contractors, supervisors and other staffs, local community (Aware FOR/NTFP/BIO-DIV)						
16.4									
17.1	Avifauna	Protection of bird habitat	Habitat restoration by replanting native vegetation	Project sites	Forestry Management works	Construction Phase	Contractor	USD 50,000.00	PMO/ESMU
17.2			Installing artificial nesting platforms or bird boxes		Civil Works				
17.3			Installing erect roosting poles and perches		Installation of platforms				
17.4			Protecting nesting areas		Conservation works				
17.5			Regular bird monitoring and surveys during various project cycles		Surveys and reports				
18.1		Minimize disturbance to Avifauna	Implement noise reduction strategies	All project area and	Enforcement of rules and regulations	Construction Phase	Contractor	Project cost	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
18.2			Using bird friendly lightening, reduce disturbance to nocturnal bird	adjoining area					
18.3			Plan construction activities to avoid peak bird breeding seasons		Civil Works				
18.4			Raising awareness among contruction workers and communities (Aware WILD-BIRD-FISH)		Trainings and workshops			USD 50,000.00	
19.1		Protecting the habitat and foraging ground	Control sedimentation and maintain water quality of rivers	All project area	Forest management works	Construction Phase	Contractor	Cost included in 2.1-2.6	PMO/ESMU
19.2			Plan construction activities to avoid sensitive periods for riparian birds					Project cost	
19.3			Monitoring of water quality and sedimentation and bird populations		Civil Works			Cost included in 17.5	
19.4			Adaptative management based on monitoring data		Trainings and workshops			Project cost	

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
19.5			Raising awareness among construction workers and communities (Aware WILD-BIRD-FISH)					Cost included in 18.4	
20.1	Aquatic Life	Facilitate fish migration	Designing fish frendly diversion tunnel	Project's Seti river stretch	Civil Works	Construction Phase	Contractor	Project cost	PMO/ESMU
20.2			Incorporating fish friendly features						
20.3			Minimizing diversion duration		Construction scheduling				
20.4			Applying proper sediment control measures						
21.1		Minimize fish stranding	Execute fish capture and relocation during river diversion	Project’s seti river stretch		Construction Phase	Contractor	USD 10,000.00	PMO/ESMU
22.1		Protection of riparian habitat, prevent soil erosion and sediment deposition	Construction activities in areas with riparian vegetation shall be carefully planned and executed	All project area	Civil Works	Construction Phase	Contractor	Project cost	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
22.2			Immediate re-vegetation of fast-growing native plant species for riparian habitat recovery		Forest management works				
22.3			Sediment ponds or sediment traps for collection of runoff from construction sites					Cost included in 3.1	
22.4			Spoil area management					Project cost	
22.5			Bioengineering techniques for riverbank protection and stabilization					USD 100,000.00	
22.6			Implement proper waste management practices					Cost included in 6.1-6.7	
22.7			Treatment of wastewater from camps						
23.1		Prevent fishing by workforce and locals	Awareness trainings to construction workers (AWARE	Seti River	Trainings and workshops	Construction Phase	Contractor	Cost included in 18.4	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
			WILD-BIRD-FISH)						
23.2			Implementing fish exclusion measures during blasting		Civil Works			Project cost	
23.3			Regular environmental monitoring on the impact of construction on fish populations		Surveys and reports			USD 10,000.00	
23.4			Collaboration with fisheries experts						
Socio-economic Environment									
24.1	Land Acquisition	Land compensation during land acquisition	Strictly adhering to Land Acquisition Act 2019, and ADB's SPS	All project Area	Formation of compensation fixation committee	Prior to construction	Contractor	Project cost	PMO/ESMU
24.2			Formation of compensation fixation committee		Negotiations with affected HHs				
24.3			Purchase of Stranded or residual land plots		Compensation mobilization				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
					using banking instruments				
25.1		Temporary acquisition	Temporary land access agreements for 41.81 ha involving 248 land parcels	Temporary Project Sites	Land agreements and commitments	Prior to construction	Contractor	Project cost	PMO/ESMU
26.1		Restoration of temporary land to original condition	Dismantling of structures, removal of equipment	Temporary Project Sites	Civil Works	After the completion of construction works	Contractor	Project cost	PMO/ESMU
26.2			Landscaping		Revegetation				
26.3			Restoration of top soil and revegetation						
27.1		Minimize acquisition of privately owned cultivated land	Establishment of alternative disposal sites at both HWs and PH sites	Project sites	Poject design	Design phase	Design consultant	Project cost	PMO/ESMU
28.1		Compensation to non-title holders	Compensation decidedd by compensation fixation committee	Project sites	Formation of compensation fixation committee	Prior to construction	Contractor	Project cost	PMO/ESMU
29.1		Relocation and resettlement	provision of house rent allowance @ NPR 5000 per	Project Sites	Formation of compensatio	Prior to construction	Contractor	Project cost	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
		allowance for displaced HHs	month for 6 months		n fixation committee				
29.2			One-time dislocation allowance @ NPR 15,000						
29.3			Transportation allowance of NPR 30,000 per HH		Negotiation with affected HHs				
29.4			Additional allowance as social security allowance for vulnerable groups @NRS 5000 for 6 months		Compensation mobilization using banking instruments				
30.1		Compensation for loss of local business	Evaluation of businesses						
31.1	Private built structures	Compensation of the private structures	Compensation of land occupied by structures	Project Sites	Formation of compensation fixation committee	Prior to construction	Contractor	Project cost	PMO/ESMU
31.2			Compensation of cost of structure		Negotiation with affected HHs				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
31.3			Right to use salvaged materials		Compensation mobilization using banking instruments				
32.1		Temporary Relocation of Janata Primary School	Temporary relocate to Rastriya Basic school at Gaighat	Gaighat	Collaboration with school management			USD 200,000.00	
32.2			Construction of fully equipped school in Gaighat		Collaboration with District Education Office				
33.1		Relocation of community hall of Gaighat	Relocation of community hall temporarily during construction		Collaboration with Municipality			Project cost	
33.2			Construction of new hall after construction phase						
34.1	Agriculture	Compensation for the loss of standing crops and agricultural productivity	Reimbursement for the loss of crops	Project affected cultivated lands	Formation of compensation fixation committee	Prior to construction	Contractor	USD 200,000.00	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
34.2			Support for agricultural assistance through intensification of food production, fruit tree cultivation, commercial vegetable cultivation and improved irrigation		Negotiations with affected HHs, Compensation mobilization using banking instruments				
35.1	Livelihood	Social assistance program to the affected HHs	Enhancing and support in the livelihood of HHs affected	Project Area	Formulation of stakeholder engagement plan	Prior and during construction	Contractor	USD 100,000.00	PMO/ESMU
35.2			Promotion and preservation of culture and traditions		Maintain database on affected HHs-SPAF and PAF				
35.3					Training and awareness				
35.3					Financial and technical assistance				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
36.1	Population influx and housing demands	Provision of substantial housing capacity for workforce	Construction of labor camps and employer's camps	Project area	Civil Works	During construction	Contractor	Project cost	PMO/ESMU
36.2			Operation of "Housing and Accommodation Assistance and Information Desk"		Resource mobilization				
37.1	Employment	Generation of employment opportunities	Prioritizing SPAF and PAF in the recruitment process	Project area	Maintain database of affected SPAF & PAF	During and after construction	Contractor /THL	Project cost	PMO/ESMU
37.2			Enhancing skills and capacities of locals (Train-SKILL)		Trainings and workshops			USD 50,000.00	
37.3			Including stipulations for hiring SPAFs in the bidding documents and contract specifications					Project cost	
38.1	Gender Vulnerable	Promote gender equality and inclusion of	Establish separate and hygenic facilities for women	Project Area	Enforcement of rules and regulations	During construction	Contractor	Project cost	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
38.2	Groups	vulnerable groups in the project area	Conduct gender sensitization programs (Aware GENDER-IP-DALIT)		Formulation of stakeholder engagement plan			USD 20,000.00	
38.3			Implement confidential and easily accessible reporting mechanisms for incidents of GBV		Maintain database of affected SPAF & PAF			Project cost	
38.4			GRM effectively implemented		Training and awareness and financial and technical assistance				

Operation Phase

Physical Environment

39.1	Land Use in reservoir	Compensation for acquisition of land	Compensation of private lands	Reservoir area	Formation of compensation fixation committee	Prior to construction	ESMU/Contractor/DFO/User Groups	Project cost	PMO/MoFE

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
39.2					Negotiation with private HHs				
39.3			Compensation of forests		Cooperation with the DFO and CFUGs/LEFUGs				
39.4					Following existing rules and regulations				
40.1	Slope stability and erosion	Erosion control and soil conservation	Terracing, contour plowing	All project sites	Civil Works	Construction Phase	Contractor	USD 100,00,000	PMO/ESMU
40.2			Maintaining natural vegetation cover in the catchment are						
40.3			Constructing small sediment retention structures		Bioengineering works				
40.4			Maintaining buffer around the reservoir and Buddha Singh Marga and vegetating these areas						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
40.5			Employing bioengineering techniques						
40.6			Regular maintenance of sediment control structures		Monitoring and maintenance				
40.7			Implement effective stormwater management practices						
40.8			Establish sediment monitoring program						
41.1	Environmental Flows	Adhere to E-flow criteria and values	Ensure that the reduced flow stretch supports ecological balance of the river system	Dewatered stretch of Seti river	Project design/planning	Design Phase, Prior to the commencement of the construction	Contractor	Project cost	PMO/ESMU/MoFE
41.2			Adhere to recommended discharge recommended by E-flow modelling		E-flow modelling				
42.1	Hydropeaking		Implement Flow Regulation strategies	Downstream of tailrace	Planning	During construction and post-	O&M Operators, ESMU	Project cost	PMO

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
42.2			Install velocity dissipation structures downstream		Civil Works	construction phase			
42.3			Regular monitoring of downstream conditions		Installation				
42.4			Implement warning systems						
Biological Environment									
43.1	Forest	Prevent pressure on forest	Support to undertake afforestation in project area and immediate vicinity	Project Sites	Plantation and conservation works	During Construction	Contractor	Project Operation cost	PMO/ESMU
43.2			Undertake robust vigilance to prevent illegal hunting and poaching		Enforcement of rules and regulations				
43.3		Conservation of plant of conservation significance	Special attention to nurturing afforested tree species of protection category for 5 years	Afforested sites	Survey and monitoring, caretaking	During Construction and Operation	Contractor	Project Operation cost	PMO/ESMU
43.4									

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
43.5			Nursery development		Collaboration with DFOs/CFUGs/LFUGs			USD 10,000.00/ year	
43.6		Conservation of biodiversity in the project area	Coordinated effort in safeguarding the protected and ecologically significant plant species	Project Sites	Regular monitoring of activities	During Construction and Operation	Contractor	Project cost	PMO/ESMU
43.7			Caring of the planted species for 5 years		Coordination with the DFOs and User groups				
44.1	Wildlife	Minimizing nuisance caused by operation of the project	Lighting management	Project sites	Civil Works	During Construction and Operation		Project cost	PMO/ESMU
44.2			Noise Management		Construction scheduling				
44.3			Awareness and training (Aware WILD-BIRD-FISH)		Trainings and workshops			USD 10,000.00/ year	
45.1		Minimize habitat loss and degradation	Develop habitat restoration plans to compensate for area lost due to reservoir formation	Project Sites	Coordination with stakeholders	During construction	Contractor	USD 50,000.00	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
45.2			Establishing wildlife corridors to connect fragmented habitats		Forest Management works			USD 50,000.00	
45.3			Regular monitoring and study		Survey and monitoring				
45.4			Low water zone management					Project Operation cost	
45.5			Maintaining adequate e-flow levels		Discharge regulation				
45.6			Collaborate with local stakeholders on conservation initiatives						
46.1		Control illegal hunting of wildlife	conduct awareness campaigns and community engagement programs (Aware WILD-BIRD-FISH)	Project Sites	Coordination with DFO and User groups	During construction	Contractor	USD 50,000.00	PMO/ESMU
46.2			Strengthen law enforcement efforts		Trainings and workshops				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
46.3			Involve community in conservation initiatives and sustainable livelihood programs		Resource allocation				
46.4			Compensation for wildlife damage					USD 10,000.00/ year	
46.5			Ecological monitoring		Surveys and monitoring			Project Operation cost	
46.6			whistle blower programs					USD 10,000.00/ year	
46.7			Support wildlife rescue and rehabilitation centers						
47.1	Avifauna	Promote habitat creating within the project area	Regulating Environmental flows	All project sites	Operation of plant	During Construction and Operation	O&M operators, ESMU	Project Operation cost	PMO/ESMU
47.2			Designate protected areas around reservoirs						
47.3			Establish wildlife corridors						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
47.4			Maintain existing and Install new nesting platforms as per requirement					USD 5000/year	
47.5			Conduct regular monitoring and study on bird populations		Surveys and reports			USD 10,000.00/ year	
47.6			Raising awareness among stakeholders, communities (Aware WILD-BIRD-FISH)		Trainings and workshops			Included under 46.1	
47.7			Collaborate with bird conservation organizations to implement effective mitigation strategies						
48.1		Ensure food availability for Birds	Undertake habitat restoration efforts	All project sites	Afforestation programs	Construction and Operation Phase	contractor	Project Operation cost	PMO/ESMU
48.2			Implement strategies to support fish populations		Coordination with stakeholders				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
48.3			Designate protected riparian zones						
49.1	Aquatic life	Prevent sediment deposition in the reservoir	Implement catchment area management approaches such as afforestation, terracing	Reservoir area	Afforestation programs	Construction Phase	Contractor	Project Operation cost	PMO/ESMU
49.2			Sediment trapping through construction of sedimentation ponds or traps		Civil Works				
49.3			Develop detailed sediment and erosion control plan						
50.1		Implement minimum E-flows during dry season	Monitoring of fish and macroinvertebrate populations	Dewatered stretch of Seti river		Operation phase	O&M personnel, ESMU	USD 10,000.00/ year	PMO
50.2			Take adaptive approach to make necessary adjustments to maintain E-flows		Regulate flows			Project Operation cost	
50.3			Compliance with hydropower		Following existing				

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
			development policy		rules and regulations				
51.1		Maintain water quality of the reservoir	Removal of existing vegetation in reservoir before filling	Reservoir area	Coordination with DFO , CFUGs	During construction, operation	Contractor	Project cost	PMO/ESMU
51.2			Planting native plant species to reinforce and stabilize reservoir's edges to control erosion and sedimentation		Following existing rules and regulations				
52.1		Enhance spawning and nursing grounds	Arrange angular and large boulders strategically to create pools for location suitable for spawning	Project's Seti river stretch	Civil Works	During construction period	Contractor	USD 10,000.00/ year	PMO/ESMU
52.2			constructing specific spawning and incubating channels						
52.3			Tree planting along the riverbank		Afforestation programs			Project cost	
52.4			Flushing discharge to be released downstream						

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
53.1		Facilitate fish migration	Construction of fish hatchery for Tor putitora	Project's Seti river stretch	Resource allocation	Construction and Operation Phase	Contractor /ESMU	USD 500,000.00	PMO
53.2			Implement catch and haul program		Coordination with DFO, User groups				
53.3			Employ local fisherman in the hatchery and catch and haul program						
53.4		Implement extended ramp-up and ramp-down period	Gradually increasing and decreasing flow	Tailrace	Flow regulation	Operation phase	O&M personnel	Project cost	PMO/ESMU
53.5			implementing conditional flow						
53.6		Prevent fish entrained or impingement	Use of physical mesh or a behavioral screen	Diversion structure	Installation of devices	Construction Phase	Contractor	USD 10,000.00	PMO/ESMU
Socio-economic Environment									
54.1	Cultural Heritages	Restoration of cremation sites	Constructing fully equipped cremation structures	Reservoir area	Consultation with stakeholders and locals	Construction Phase	Contractor		
54.2					involvement of local populace			USD 75,000.00	PMO/ESMU

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
54.3		Protection of temples	Implementation of embankments and protective walls in the reservoir area near temples	Reservoir area	Civil Works, collaboration and consultation with stakeholders			USD 30,000.00	
55.1	Ecosystem services	Participatory approaches for improving drivers that enhance ecosystem services	Compensatory plantation in affected CFs	CFs	Collaboration with affected CFUGs	Construction Phase	Contractor	Compensatory plantation cost	PMO/ESMU
55.2			involving affected CFUGs in compensatory plantation						
55.3		Optimizing downstream water use	E-flows assessment	Seti river	Surveys and monitoring	Operation phase		Project cost	
55.4			Ensure cultural and religious activities						
56.1	Public services and local infrastructures		Rerouting of Buddha Singh Marga	Project area	Civil Works	Construction phase	Contractor	Project cost	PMO/ESMU
56.2			construction of new access roads and bridges		Collaboration with stakeholders and locals				
56.3			Relocation of Shree Seti Ganga Basic School		Collaborative decision making with			USD 200,000.00	

SN	Subject Area	Positive Impact Enhancement Measures	Activities	Location	Method	When to do	Implementation agency	Estimated HR, Budget, time	Monitoring and Evaluation
					school management				
57.1	D/S water users	Implement safety measures	Installation of sirens	Project area	Civil works	Construction and Operation Phase	Contractor	Project cost	PMO/ESMU
57.2			Installation of information boards		Installation of devices				
57.3			Public awareness campaigns (Aware SAFETY)		Coordination with locals				
57.4			patrolling activities		Trainings and workshops				
57.5			Risk assessment for river activities						

10.4 Environmental Management Budget

Preliminary cost estimates for implementation of the EMP over the 5 years implementation period are shown in the tables below. These estimates are subject to revision. The EMP cost will be funded by the project. The total cost for environmental mitigation measures is 83,10,488.00 USD. Any costs referenced in the table below are indicative only and will need to be updated following open bidding process of PSC and contractor, *etc*.

10.4.1 Cost of Environmental and Social Management Unit

The project will have to maintain a fully functional Environmental and Social Management Unit that plays a crucial role in overseeing the project's environmental and social considerations. From the outset, during the pre-construction phase, throughout the construction phase, the ESMU will be actively functioning. Its primary role is to ensure that the project's activities align with environmental and social standards, regulations, and best practices. This means that the ESMU will be responsible for monitoring and managing potential environmental impacts, as well as assessing and addressing social implications that might arise during the project's implementation.

As the project progresses, the ESMU's responsibilities remain active until the project's fist Environmental Audit is conducted, which typically takes place after the project has been operational for 2 years. Upon the completion of the Environmental Audit, the ESMU will transfer its responsibilities to THL and operation team of the project. The transition reflects the long-term sustainability perspective of the project. It ensures that environmental and social management remains a priority not only during the construction phase but also throughout the project's operational lifespan.

10.4.2 Cost of Environmental Mitigation Measure

The indicative cost envisioned are presented below:

Table 10. 3: Indicative budget for the ESMU

SN	Particulars	Preconstruction	Construction	Operation	Total	Remarks
		(1 year)	(5 years)	(2 years)		
1	Team leader	4,800,000	24,000,000	9,600,000	38,400,000	
2	Resettlement and Social Management team expenses	9,600,000	48,000,000	19,200,000	76,800,000	2 experts and 2 assistants
3	Grievance Redressal Mechanism team expenses	9,600,000	48,000,000	19,200,000	76,800,000	2 experts and 2 assistants

SN	Particulars	Preconstruction (1 year)	Construction (5 years)	Operation (2 years)	Total	Remarks
4	Environmental Monitoring team expenses	24,000,000	120,000,000	48,000,000	192,000,000	5 Experts and 5 assistants
5	Equipment and facilities expenses	100,00,000	3,000,000	1,200,000	4,200,000	
6	Experts' expenses (as per requirement)	5,000,000	5,000,000	5,000,000	15,000,000	As per necessity
7	Vehicles	7,200,000	36,000,000	14,400,000		4 vehicles each for a sub unit and one for the team leader
7	Miscellaneous					
	NPR	60,200,000	284,000,000	116,600,000	403,200,000	
	USD	463,077	2,184,615	896,923	3,101,538	

Table 10. 4: Indicative cost for physical mitigation measures during construction

SN	Particulars	Estimate
1	Slope stability and erosion control measures	USD 200,000.00
2	Air Quality mitigation measures	USD 120,000.00
3	Air Quality Monitoring	USD 50,000.00
4	Spring Preservation and monitoring water levels in springs	USD 20,000.00
5	Sediment control measures	USD 100,000.00
6	Solid waste management	USD 25,000.00
7	Compensation of forests	USD 29,48,950.00
8	Nursery Establishment	USD 10,000.00
9	Awareness for forests/NTFPs	USD 10,000.00
10	Ex-site conservation of orchids	USD 5,000.00
11	Forest Fire Control	USD 20,000.00
12	Rescue and Rehabilitation Centre	USD 100,000.00
13	Enforcement of conservation rules and regulations	USD 50,000.00
14	Awareness trainings on biodiversity	USD 50,000.00
15	Avifauna (Habitat restoration measures + Awareness programs)	USD 100,000.00
16	Fish capture and relocation	USD 20,000.00
17	Monitoring of fish populations	USD 10,000.00
18	Temporary relocation of Janata Primary School	USD 200,000.00
19	Agricultural Compensation	USD 200,000.00

SN	Particulars	Estimate
20	Community Support Program (CSP)	USD 900,000.00
21	Skill trainings	USD 50,000.00
22	Awareness trainings on GESI	USD 20,000.00
	Total Cost	USD 52,08,950.00

Note: Details are provided in Environmental Mitigation Measure Matrix

10.5 Environmental Monitoring

Environmental monitoring is important for effective implementation of the EIA. It ensures that the project implementation does not degrade the environmental condition of the project area by keeping track of the project impacts as well as implementation of the mitigation measures as recommended by the EIA report. The monitoring activities may be modified during the project implementation, depending on contractors' performance and analytical results. If the environmental performance of the project is worse than expected, corrective action will be identified, and monitoring activities will need to be adjusted accordingly to help resolve any noncompliance. In addition to quantitative monitoring there will also be supervision and monitoring of EMP implementation, the performance standard being that all EMP measures are implemented in full at the appropriate time.

Three types of environmental monitoring will be carried out: (a) Baseline Monitoring, (b) Compliance Monitoring, (c) Impact Monitoring

In order to improve the implementation of mitigation measures, the following activities will be undertaken in the process of environmental monitoring: (a) determine carefully the indicators to be used in the process of monitoring; (b) collect important and relevant information; (c) apply measurable criteria with regard to prescribed indicators; (d) conduct objective analysis of the information collected; (e) work out clear conclusions based on objective analysis and processed Information; (f) make rational decisions based on the conclusions drawn pursuant to clauses (a) to (e); (g) recommend improved mitigation measures to the implementing agencies;(h) implement corrective actions or new adaptive management programs, as required, if proposed mitigation measures are unable to reduce and/or eliminate potential project-related impacts, or meet the predetermined level of performance

Baseline monitoring will be conducted during the pre-construction phase to fill in baseline data gaps and to update baseline information provided in the EIA report. A Baseline Monitoring is required to compile and maintain a database on environmental conditions prior to the implementation of the project. This is especially important if the project implementation is delayed due to unforeseen circumstances and information given in the EIA needs to be updated. The baseline data recorded before the project implementation will facilitate the comparison of the information obtained during the monitoring activities and in auditing of the project.

Compliance monitoring will be conducted periodically or continue over the duration of construction and operation to ensure project compliance with recommended environmental protection standards. Compliance monitoring will be given priority with focus on ensuring compliance with mitigation actions, which are intended to contribute to the control and management of environmental degradation. The impact monitoring at ambient levels will be conducted as appropriate and required. This type of monitoring employs periodic sampling or continuous recording of specific environmental quality indicators or pollution levels to ensure project compliance with recommended environmental protection standards.

Impact monitoring. The actual impacts caused by Project Implementation should be closely monitored during the construction and operation of the project to examine the sufficiency and effectiveness of the mitigation measures. The ecological, social and economic, and public health parameters within the project area will be measured during the project construction and operation phases in order to detect environmental changes which may have occurred as a result of project implementation.

The Project Management Office with support of the Environmental and Social Management Unit (ESMU) will carry out site inspections jointly with the contractors particularly during prior to construction and at the end of construction at sites when site closing starts. The aim of inspection during prior construction will be to identify and jointly agree with contractors on site-specific environmental conditions and types of safety concerns that need particular attention while implementing work. Based on this information, the contractor will prepare site-specific EMP and OHS plans and submits for employers' approval prior to field mobilization. The aim of site inspection after the work completion will be to ensure the site is properly cleaned of all construction related spoils, landscaped, and well drained, vegetated, and restored to original condition before contractor leaves the site. The inspection during work implementation will be the routine compliance and impact monitoring.

10.5.1 Self-Monitoring

The Environmental Department under the MoFE has introduced a new regulatory requirement. As part of this requirement, the project that initiates construction activities is now obliged to prepare a "Self-Monitoring" report every 6 months. This report must be submitted to the Department of Environment, which is responsible for overseeing environmental compliance and regulations.

In the context of this mandate, the project itself is tasked with fulfilling the obligation to produce and submit these periodic "Self-Monitoring" reports. To ensure the timely and accurate fulfillment of this requirement, the ESMU will assume the responsibility of preparing and submitting this report on behalf of the project.

10.5.2 Reporting Mechanism

The contractors will maintain daily records of the mitigation implementation and monitoring works during the construction phase to demonstrate compliance with the environmental management. The EMSU shall carry out monitoring works with the Supervising Engineers and prepare monthly monitoring reports during construction phase. EMSU will also maintain the records of any corrective actions recommended to the contractor and its performance. The bi-monthly reports produced by EMSU shall be distributed to the stakeholders for their comments and suggestions after the approval by the Project Manager. ESMU will compile the Final Environmental Monitoring Report of the construction phase within 3 months of the construction completion and submit to the Project. The project will distribute the report to stakeholders to get feedback and provide the database of environmental management works of the project for future use

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Table 10. 5: Monitoring Frameworks

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Responsibility**
Baseline monitoring						
Air quality	TSP, PM10, PM2.5, CO2, AQI, CO, SOx, NOx	Air sampling and measurement Comparison of data with ambient standard	In and around construction sites	Measurement during the construction works (4 quarterly measurements in a year)	10,000 USD	Contractor/ ESMU-PMO
Noise level	dBA	Decibel meter	Settlement close to the project components and in major project construction sites	Measurement during the construction works (4 quarterly measurements in a year)	10,000 USD	Contractor/ ESMU-PMO
Water quality	Temperature, pH, conductivity, turbidity TSS, DSS, hardness, Ca, P, Mg, Na, K, As, Fe, Pb, Cu, Hg, Cl, Total N, NH_3 DO, BOD5, COD, planktonic algae,	Sampling and lab analysis	Water bodies in the reservoir area, headworks area, dewatered zone, and powerhouse sites	One measurement every four months before the starting of the construction works	10,000 USD	Contractor/ ESMU-PMO

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
	Chlorophyll, Total Coliforms and Fecal Coliforms					
River Morphology	River flow rate, bank cutting, and river scouring	Discharge measurement, Site observation	In dewatered portion of the river	One measurement every four months before the starting of the construction works and during construction in dry season	USD 20,000	Contrac tor/ ESMU-PMO
Land stability	Landslides along the reservoir area	Observation of the sites	Project area	Quarterly during the construction period	10,000 USD	Contrac tor/ ESMU - PMO
Vegetation	Vegetation density/ biomass Species composition and diversity	Vegetation sampling Biodiversity index Biomass estimation	Samples of forest area close to project components	Once in a year during construction/ operation	20,000 USD per year	Contrac tor/ ESMU - PMO
Wildlife	Wildlife population Wildlife composition and diversity	Camera trapping Observation	Project and its surroundings	Reporting once in a year	50,000 USD per year	Contrac tor/ ESMU - PMO
Avia fauna	Bird population Bird migration	Camera trapping Observation	Area close to project components	Reporting once in a year	30,000 USD per year	Contrac tor/

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
						ESMU - PMO
Fish Population and migration	Types of fish inhabited in Seti River	Fish Sampling and information from locals	Downstream and upstream of barrage	Reporting twice a year	5000 USD per year	EMSU - PMO/ Contractor
Settlements	Trend of growth and expansion of settlement	Observation wards/ municipality records of building permission	Project affected municipality	Once in a year	50,000 USD	EMSU - PMO/ Contractor
Health and Sanitation	Diseases prevailing in the area, outbreak of disease	Discussion with local Records from the local health post and district health office	Project affected municipality	Once in a year		
Consumer prices	Price of local and imported consumer items - food, fuel, hotel fair, labor wage	Market survey and enumeration	Project affected municipalities	Once in a year		
Law and order	Records crime, social nuisance in the project area	Discussion with local people and local police Grievance records with the project (GRM)	Wards related with the project	Quarterly during the construction period		

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Responsibility**
Compliance Monitoring - Construction phase						
Spoil / Hazardous material disposal	Spoil generation and disposal at the site Spoil disposed at the specified spoil disposal site Condition of the spoil disposal site	Inspection of the construction site and spoil disposal sites	Construction site Spoil disposal site	Quarterly during the construction period	Included in the operation costs	ESMU - PMO/ Contractor
Solid waste disposal	Training of the construction workers on waste management Sanitary condition of the construction sites and camps Waste collection bins Waste disposed according to the national and	Review records of the training Inspection of the site and camps Observation of waste management systems Review of the records of waste disposal Effective implementation of CWMP	Construction sites and camps Waste disposal sites	Quarterly during the construction period	10,000 USD	ESMU - PMO/ Contractor

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
	international standards Implementation of Construction Waste Management Plan (CWMP)					
Air and noise	Sprinkling of the site to prevent dust pollution Air pollution from storage and stockpiles Noise from the machinery used Implementation of the construction pollution prevention plan (CPPP) Environmental standards of the	Observation of the sites and construction works Air and noise sampling at the construction sites Review of GRM records for air and noise pollution complaints, particularly from schools Review of CPPP and its effectiveness	Construction sites	Quarterly during the construction period	10,000 USD	ESMU - PMO/ Contrac tor

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Responsibility**
	equipment and vehicles used Speed limits applied for the vehicles in the project area Use of PPE by workers exposed to air pollution sites					
Restoration of the temporary sites	Records of restoration works Condition of restoration sites in compare to original condition of the sites	Review of the records Observation of the sites Consultation with the locals and project workers	Construction sites Temporarily acquired sites - camps, storage sites, spoil disposal sites	Annually after completion of the construction work at those sites	5000 USD per year	ESMU - PMO/ Contractor
Land stability	Slope stability condition at the project sites Measures of slope	Observation of the sites Review of records of slope stability measure applied	Construction sites	Quarterly during the construction period	5,000 USD per year	ESMU-PMO/ Contractor

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
	stabilization applied					
Water quality	Construction works carried out during dry season in the sites close to the major water bodies Implementation of construction pollution prevention plan (CPPP) Prevent sediments entering water bodies from the construction sites Prevention of defecation/ urination by workers or disposal of camp	Observation of the construction sites Review of the construction records using water pollution prevention measures Review of CPPP and effectiveness of its implementation	Construction sites located near to the water bodies	Quarterly during the construction period	10,000 USD	ESMU-PMO/ Contractor

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
	toilet wastes into the water bodies					
Habitat and biodiversity	Forest clearance permissions are obtained Habitat and ecological values of the vegetation/ trees are studied Minimize tree cutting Trees to be cut are marked and recorded in coordination with the DFO Management of felled trees Provide alternative to firewood and timber	Observation Review of the records Consultation with locals, forest users' groups, and DFO officials	Barrage, Tunnel openings, Surge shaft, Powerhouse, Tailrace, access roads, bridges, camps	Quarterly during the construction period	50,000 USD	ESMU-PMO/ Contrac tor/ CFUG/ DFO

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
	Implementation of rules against forest encroachment by workers					
Forest - trees and vegetation	Compensation of forest land/ allocation of budget and its use Compensatory plantation/ allocation of budget and its use	Observation Review of records	Project area Compensatory Plantation sites Nursery	Quarterly during the construction period		ESMU-PMO/ Contractor/ CFUG/ DFO
Forest fragmentation	Conservation of ground vegetation having ethno-botanical and ecologically important species	Observation Review of records	Project area	Quarterly during the construction period		ESMU-PMO/ Contractor/ CFUG/ DFO

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
Rare, endangered and threatened species	Compensatory plantation at the ratio of 1:10 Number of Sal, Bijay Sal, and Sati Sal removed Orchid removed	Review of records Observation Consultation	Compensatory Plantation sites Nursery	Quarterly during the construction period	10,000 USD per year	ESMU-PMO/ Contrac tor/ CFUG/ DFO
Fish Species	Fishing activities by work force	Inspection once every month	Diversion reach	Every month, throughout all years of construction	10,000 USD per year	EMSU - PMO/ Contrac tor
Fish species	Illegal fishing activities	Inspection once every month	Throughout the project area	• Every month, throughout all years of construction (six months) • Every month, during	5000 USD per year	EMSU - PMO/ Contrac tor
• Species richness • Species compositi on • Species distributi on	Fish community composition, size, and distribution	Electrofishing method in May/June and September/October (twice a year)	Locations as per baseline survey of the report	• Pre-construction phase: two years • Construction phase: Throughout all years of construction (six years)	5,000 USD per year	EMSU - PMO/ Contrac tor

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
• Relative abundance of target fish species • Population structure of target fish species • Length and weight of target fish species						
Description of habitat according to flow and substratum size, identification of fish spawning and rearing habitats	Assessment of aquatic habitat	Qualitative study of habitat according to the estimated abundance of flow and substratum size in May/June and September/October (twice a year)	Locations as per baseline survey of the report	• Pre-construction phase: two years • Construction phase: Throughout all years of construction (six years)	5000 USD per year	EMSU - PMO/ Contractor

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
• Species richness • Species composition • Species distribution • Relative abundance	Macroinvertebrates composition and distribution	Applying D- frame net sampling method in March/April	sampling stations	• Pre-construction phase: two years • Construction phase: Throughout all years of construction (six years)	2000 USD per year	EMSU - PMO/ Contractor
Extent of local laborers employed and skill trainings	Employment of local labors during construction	Site observation, discussion, and interview with labors	Residents around the project area	Quarterly	5000 USD per year	Contractor/ESMU/Consultant
Health and sanitation facilities at workers camp and sites	Sanitary condition of Labor camp	Site observation, discussion and interview with labors	At camp sites	Quarterly		Contractor/ESMU/Consultant
Wage paid to laborers not less than wage fixed	Monthly wage paid to laborers	Review of contractor's documents, interview with laborers	Project sites. Contractor's office	Monthly		ESMU/ Consultant

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
by concerned district to both male and female						
Launching of skill training, and public awareness activities	Minutes of trainings, list of participants of trainings	Review of training documents, interview of local people	Project area	Twice per year	10,000 USD per year	ESMU/ Consult ant
Compliance monitoring - operational phase						
Noise pollution	Noise level at construction sites Acoustic barrier if noise sources are close to settlements or schools	Noise measurements Site observation	Construction sites	Quarterly	To be included in the operation works	ESMU/ Consult ant
Solid waste management	Waste disposal practices Segregation of domestic waste	Observation Review of records	Workers camps	Once in a year	To be included in the operation works	ESMU/ Consult ant

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
	from O&M waste Waste collection bins Sanitary condition sites Open burning of waste prevented Existence and operation of compositing facilities, if used Hazardous waste and their management					
Water pollution	Toilet waste disposal Source of waste supply to the substation Equipment used free of	Observation Water quality of water bodies close to sites Review of records and designs	Camp sites	Once in a year	To be included in the operation works	ESMU/ Consult ant

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
	Polychlorinated biphenyls (PCB) Locate transformers, storage areas, septic tanks/soak pits at least 100m away from water bodies Drainage trapping oil leakage to prevent them entering water bodies					
Compensatory plantation in the ratio of 1:10 and its protection	Implementation of plantation program by CFUGs and other responsible bodies	Site observation, discussions with locals	Sites selected for replantation	Monthly	20,000 USD per year	ESMU/ /Consultant/Forest Officer
Care for vegetation in the	Vegetation remaining along the project	Site observation	Within and around project area	Monthly		ESMU/ Consultant

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
project area and its immediate vicinity	footprint and boundaries					
Fish species	Illegal fishing activities	Inspection once every month	Throughout the project area	Every month, during first ten years of operation phase	10,000 USD per year	ESMU/ Consultant
• Species richness • Species composition • Species distribution • Relative abundance of target fish species • Population structure of target fish species • Length and	Fish community composition, size and distribution	Electrofishing method in May/June and September/October (twice a year)	Locations as per baseline survey of the report	Ten years (six monitoring). Every year for the first 4 years of operation and every 3 years after the first four years of operation	5,000 USD per year	ESMU/ Consultant

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
weight of target fish species						
Description of habitat according to flow and substratum size, identification of fish spawning and rearing habitats	Assessment of aquatic habitat	Qualitative study of habitat according to the estimated abundance of flow and substratum size in May/June and September/October (twice a year)	Locations as per baseline survey of the report	Ten years (six monitoring). Every year for the first 4 years of operation and every 3 years after the first four years of operation	5000 USD per year	ESMU/ Consultant
• Species richness • Species composition • Species distribution • Relative abundance	Macroinvertebrates composition and distribution	Applying D- frame net sampling method in March/April	sampling stations	Ten years (six monitoring). Every year for the first 4 years of operation and every 3 years after the first four years of operation	2000 USD per year	ESMU/ Consultant

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
Downstream e-flow	E-flow	Measurement of weekly e-flow downstream of weir in dry season	Headworks area	For 10 years. Weekly in each dry season	10,000 USD/year	ESMU/ Consultant
Enforcement and effectiveness of the hatchery; Data on number and location of fish/fry release in Seti and Trishuli Rivers	Status of fish hatchery, fish stocking program, and catch & haul program	Inspection	Hatchery and fish stocking sites	For 10 years. Once a year	5000 USD per year	ESMU/ Consultant
Living standard and economic status of locals	Use of household facilities, employment, education and monthly earnings	Site observation, discussion with locals, and interview	Settlements in the project area	Twice/year	5000 USD per year	ESMU/ Consultant
Impact monitoring-Construction phase						

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Responsibility**
Compensation of the land use change	Change in land use and pattern of land Residual Impacts Temporary crop loss	Observation Resettlement and Indigenous People's Plan (RIPP) EMP measures Local Topographical adjustment	Disturbed site/Construction site	Once in a year	5000 USD per year	Contractor/PMO/property owners
Landslide and soil erosion	Landslide Flash flood	Incorporated drainage management Reinforcement measures for the stability of slope Re-vegetation and slope maintenance Proper landscaping by following the principles of Bioengineering	Disturbed site/Construction site		5000 USD per year	Contractor
Water pollution	Deterioration on water quality	Construction pollution prevention plan (CPPP)	Intake and PH sites	At least one week before to commencement of any activity	10,000 USD per year	Contractor

Type	Indicator	Methods	Location	Schedule	Cost	Respon sibility
	Erosion by surface water run off Changes in turbidity of water	Conforming the water quality near to the sources within 100 m				
Spring Sources	Number of springs Discharge of springs	Measurement and Observations	Spring locations along the tunnel alignment	Quarterly	5000 USD per year	ESMU-PMO
Air pollution	Air pollution and dust pollution from piling works Implementation of the construction pollution prevention plan (CPPP) TSP, PM10, PM2.5, CO2, AQI, CO, SOx, NOx	Inspection of air quality Prohibition of burning wastes in project area Air sampling and measurement Comparison of data with ambient standard	Access road and construction sites	(monthly)	15, 000 USD per year	ESMU-PMO

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Responsibility**
Noise pollution	Noise from piling works	Good construction management Following IFC EHS General Guidelines for Construction and Demolition Avoiding use of blasting and over vibration	Access road and construction sites	Monthly	1000 USD per year	Contractor
Solid Waste and Construction Waste management	Generation of hazardous, non-hazardous and liquid waste	Waste Management Plan including hazardous waste management	Labor camos and Construction site		1000 USD per year	Contractor/ESMU/PMO/Consultant
Status of forest	Diversity of forest and availability of faunal species	Observation and measurement	Surrounding area of project	Monthly	10,000 USD per year	Contractor/ESMU/PMO/Consultant
Encroachment/degradation of forest	Density of forest and its status	Observation and measurement	Surrounding of project area	Monthly		Contractor/ESMU/P

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
						MO/Consultant
Number of trees felled	Volume of wood trade, location of timber deposit	Records and observation	Project sites, access roads, reservoir	Monthly		Contractor/ESMU/PMO/Consultant
Care for local utilities	Relocation of affected local infrastructures and its use	Observation and interview with locals	Around project area	Monthly		Contractor/ESMU/Consultant
Damage to private properties	Disposal of spoil, destruction of physical structures	Observation and interview with locals	Around project area	Monthly		Contractor/ESMU/Consultant
Impact monitoring - Operation phase						
Solid waste and construction waste management	Prohibition on-site disposal of plastic bottles and adequate waste storage. Promote recycling and	Promoting responsible waste management practices. Educate people about the benefit of recycling and the impact it has on the environment.	Labor camps and Construction sites	Quarterly during the construction period	10,000 USD per year	ESMU/Consultant

Type	Indicator	Methods	Location	Schedule	Cost	Responsibility
	reuse of solid waste. Prohibit dumping of O and M wastes on-site, into drains, rivers, agriculture fields etc.	Observation of sites.				
Prevention of water Pollution	Identify the flood plains. Protection of riverbanks. Liquid storage.	Identifying the floodplain and must be 2m above the maximum flood level of the river crossing. Use of gabion wall and embankment including bioengineer option. Ensuring that liquids storage is locked at all times.	Intake and PH sites	Quarterly during the construction period.	10,000 USD per year	ESMU/ Consultant

Type	**Indicator**	**Methods**	**Location**	**Schedule**	**Cost**	**Respon sibility**
Mitigating the Climate Change impact	Good operational SF6 management. Control of any leak of SF6. Quality checking of gasses.	Education and awareness to all the PMD and staff on the Climate Change impact and risk of SF6. Regular visual and technical inspection of condition and maintenance should be carried out by THL. Keeping the record of all the gas insulated switch gas and transformers if any quantity of SF6 is present or not.	Project area			ESMU/ Consult ant

10.5.3 Cost of Environmental Monitoring

An indicative summary of budget for the Environmental Monitoring are presented in the table below.

Table 10. 6: Summary of Environmental Monitoring Cost

SN	Monitoring Type	Cost
1.	Baseline Monitoring -	215,000.00 USD/year
2.	Compliance Monitoring-Construction Phase	142,000.00 USD/year
3.	Compliance Monitoring-Operation Phase	62,000.00 USD/year
4.	Impact Monitoring-Construction Phase	46,000.00 USD/year
5.	Impact Monitoring-Operation Phase	20,000.00 USD/year
	Total Monitoring Cost	485,000.00 USD/year

10.6 Environmental Auditing

The aim of Environmental Auditing encompasses assessing the efficacy of mitigating environmental and social risks as identified in the EIA study and ensuring compliance with the stipulated Environmental Management Plan. The Environmental Audit is designed to rectify instances of non-compliance but also to establish a foundational dataset for subsequent audits and on-going monitoring endeavors.

The responsibility for conducting the Environmental Auditing of the project during its operational phase will rest with the Ministry of Forests and Environment. In line with its guidelines, the MoFE will undertake their Environmental Auditing after a 2-year period of operation.

10.6.1 Regulatory requirement of Environmental Auditing

The necessity for conducting an Environmental Auditing arises in accordance with Rule-14 outlines in the EPR2020. This rule pertains to projects that necessitate an EIA. It mandates the MoFE to scrutinize the environmental repercussions stemming from the execution of these projects. Moreover, after a span of 2 years following the project's operation, MoFE is tasked with assessing the effectiveness of measures implemented to mitigate these environmental impacts. MoFE is further expected to uphold the responsibility of maintaining an up-to-date audit report.

The Hydropower EIA Manual published by MoFE in 2018 details specific stipulations concerning the Environmental Audits, highlighting the importance of adhering to these regulatory requirements.

"The environmental audit shall be conducted after two years of the operation of the proposal or delivery of service from the proposal/project. The official record and environmental monitoring reports concerning the implementation of environmental protection measures required for environmental audit shall be provided by the proponent to the prescribed environmental auditor."

10.6.2 Environmental Audit Report Documentation

Section 9.7 of the Hydropower EIA Manual specifies the format of an Environmental Audit.

Chapter 1: Executive Summary

Chapter 2: Description of Audit Administrative Activities.
This chapter encompasses interviews carried out at the project site, involving the audit-conducting party, and encompassing the audit area and methodologies. Furthermore, the study must incorporate pertinent data and specifics related to environmental monitoring and the auditing process.

Chapter 3: Full Audit Details.

This chapter entails a comprehensive overview of the audit methodologies employed and the outcomes obtained.

- ***Audit Scope:*** This section entails a depiction of the audit's focal point, encompassing the audit's location, the subject under scrutiny (such as processes, organizational aspects, or operations), and the timeline during which the performance evaluation took place – whether over a month, a year, or since project inception.
- ***Regulatory and Legal Context***: A tabulated summary is provided, outlining Nepal's pertinent regulations, local statutes, and any other applicable environmental and occupational health and safety laws, guidelines, and policies that bear direct relevance to the audit's scope. This segment also encompasses a portrayal of the stipulations outlined within the Environmental Management Plan, as pertinent to this specific Environmental Impact Assessment.
- ***Audit Procedure and Site Investigation***: This section briefly outlines the methodological approach undertaken for conducting the audit. It encompasses a discussion on activities like record review, on-site assessment, and interviews, alongside a delineation of the site sampling scheme and chemical testing plan. Should it be applicable, this section may encompass aspects like field investigations, environmental sampling, chemical analyses, and the methodologies utilized for these endeavors.
- ***Findings and Concern Areas***: A comprehensive discourse is presented, delving into all the facets of environmental and occupational health and safety that raised concern during the audit process. These concerns are discussed both in the context of prevailing facilities and operations, as well as any historical activities that might have led to contamination or damage. Details encompass the impacted mediums, their quality, and recommendations for potential further investigation and remediation, if required. It is suggested that the report might classify findings into distinct categories such as immediate action, mid-term action, and long-term action, for streamlined prioritization.

Chapter 4: Suggestions and Corrective Actions.
To be compiled with regarding the project. This section will include, with respect to each identified area of concern, comprehensive details outlining the precise corrective measures proposed to mitigate these concerns, accompanied by a clear rationale for each recommendation. Additionally, the report should duly highlight the priority levels assigned to each corrective action. The estimation of implementation costs and a timeline for the execution of these corrective actions should also be provided.

Appendices
These should include references, copies of interview forms, any details regarding the audit protocol not already included, and data obtained during the audit.

The cost for the Environmental Auditing is estimated at NPR 50,00,000 *i.e.*, USD 38,461.

10.6.3 Scope of the Environmental Auditing

The Environmental Auditing Report plays a pivotal role in assessing the holistic impact of projects on various aspects of the environment, society, and the economy. These reports encompass a range of critical evaluations that provide insights into the project's effects and its alignment with sustainability goals. The key components included in these reports are as follows:

Pre and Post Project Environmental Conditions –
These reports initiate by establishing a baseline of the natural, social, and economic resources present before the initiation of the project. This baseline serves as a reference point to gauge the project's impact on these resources upon completion of construction activities. By comparing these conditions, the report offers a clear perspective on changes induced by the project.

Impact Verification
A crucial facet of these reports involves verifying the accuracy of the impact predictions made during the Environmental Impact Assessment (EIA). It entails evaluating whether the projected impacts indeed transpired, and if they did, detailing the extent of these effects. This verification is essential to determine the reliability and credibility of the initial projections.

Effectiveness of Mitigation Measures
The reports meticulously assess whether the mitigation and corrective measures that were put in place to manage adverse impacts or enhance beneficial effects have yielded the desired outcomes. This evaluation helps to ascertain the effectiveness of these measures in either curbing detrimental effects or amplifying positive ones.

Comprehensive Scope of Evaluation
The scope of environmental auditing extends across various specific aspects, encompassing but not limited to:

- Slope stability - Evaluating the stability of terrain and landscapes affected by the project's activities.
- Spoil disposal - Examining the disposal methods and impacts of materials removed during construction.
- Quarrying - Assessing the effects of quarrying operations on surrounding ecosystems and communities.
- Local economy - Analyzing economic changes in the local area resulting from the project.
- Reinstatement - Gauging the success of reinstatement efforts aimed at restoring natural conditions.
- Social Attitudes - Understanding societal perspectives and reactions to the project's implementation.

A structured framework for conducting environmental audits is established to ensure consistency and comprehensiveness. This framework guides the process of gathering data, evaluating impacts, and presenting findings. Detailed guidelines, methodologies, and benchmarks are provided in the framework to ensure a systematic and rigorous audit process.

Environmental Auditing Reports are instrumental in offering an evidence-based evaluation of a project's overall impact, assisting stakeholders in making informed decisions, and driving continuous improvement in sustainable project implementation.

Table 10. 7: Environmental Audit Framework for Beneficial Impacts

SN	Parameter	Indicator	Location	Methods	Sources
1	Enhancement of local economy	Income levels of local HHs	Project area	Interview	Locals
		No. of local businesses and service industries	Project area	Interview	Locals
2	Enhancement of skill development	No. of trainings for locals	Project area	Interview and records	Locals and records
		No. of individuals from the project area, SPAF and PAF participating in the trainings	Project area	Interview and records	Locals and records
		No. of SPAF, PAF and locals employed in the project	Project area	Interview and records	Locals and records
3	Improved access	No of settlement connected to the Highway and roads	Project Municipality	Observation	Locals and project maps
4	Habitat formation in the reservoir	Population of different types of birds found in the reservoir	Reservoir	Observation and interview	Locals
		Migratory bird observed in the reservoir	Reservoir	Observation and interview	Locals
5	Reduction in GHG	Number of trees planted	Compensatory plantation area	Observation and record	Records
		Estimate of carbon sequestration by the trees planted	Compensatory plantation area	Record and estimation	Records

Table 10. 8: Environmental Audit Framework for Adverse Impacts – Physical Environment

SN	Parameter	Indicator	Location	Methods	Sources
1	Land use	Land cover change Land acquisition	Project area	Satellite image classification Analysis of land acquisition	Field data, records of land acquisition, interview, and satellite image
2	Land instability	Landslides and disturbed slopes, Slope protection works	Project area	Satellite image analysis, Field observations, Review of slope protection works performed	Field data, satellite image, records
3	Water quality	pH, DO, Temperature, Turbidity, TSS, BOD, COD, Nutrients, Fecal coliforms, E Coli, Ammonia and Nitrate, Oil and Grease	Seti - Reservoir, and Reduced Discharge Stretch, Trishuli - Tailrace	Water sampling and lab analysis Review of monitoring reports	Field data samples, monitoring records
4	Spring sources	No. of spring sources, and discharge of springs	Tunnel alignment	Observation, monitoring records, interview of spring users	Field data, monitoring reports, local residents
5	Air quality	PM2.5, PM10, CO, AQI	Project area	Air sampling, monitoring records, interview of local residents	Field data, monitoring reports, local residents
6	Solid waste	Solid waste generation amount and type. Waste collection – bin and transport Waste segregation practice. Status of the disposal site.	Project area	Observation, monitoring records, interview	Field data, monitoring reports, local residents, resident project staff.

SN	Parameter	Indicator	Location	Methods	Sources
		Compositing, recycling, and reuse. Sanitary condition of camp sites			
7	Sedimentation of the reservoir	Water quality – sediment content. Slope condition in the immediate catchment area Sediment deposition in the reservoir Sediment deposition in the reduced discharge stretch in the Seti River	Reservoir and Seti River	Observation, monitoring records, interview, water sampling and lab analysis	Field data, monitoring reports, local residents, and project staff
8	Environmental Flow	Discharge downstream of the river in the Seti River Discharge contribution by the tributaries	Reduced Flow Stretch of Seti River and Trishuli River	Measurement of discharge, records of energy generation, Eflow records in the monitoring reports, interview	Field data, monitoring report, local residents, project staff
9	Hydropeaking	Discharge from the tailrace. Energy generation log-book. River morphology at the tailrace	Tailrace – Trishuli River	Observation, review of monitoring report, interview of local people	Field data, monitoring report, local residents, and project staff.

Table 10. 9: Environmental Audit Framework for Adverse Impacts – Biological Environment

SN	Parameter	Indicator	Location	Methods	Sources
1	Forest	Forest area acquired permanently and compensated forest area	Project area and area of compensatory plantation	Observation, review of the monitoring records	Field data, interview of locals and CFUG members, DFO, and project staff

SN	Parameter	Indicator	Location	Methods	Sources
		Tree removed and compensatory plantation			
2	Forest Resource – timber and non-timber	NTFP Timber Firewood	Project area	Observation, review of the monitoring records	Field data, interview of locals and CFUG members, DFO, and project staff
3	Forest fire	Forest fire incidents and severity	Project area	Observation and interview	Field data, interview, data of forest fire with Department of Forest and Soil Conservation
4	Forest quality	Encroachment of forest Illegal harvesting of forest resource	Project area	Observation and interview	Field data, interview of locals and CFUG members, DFO, and project staff
5	Disturbance to wildlife	Presence of wildlife and their movement	Project area	Observation and interview	Field data, interview of locals and CFUG members, DFO, and project staff
6	Illegal wildlife poaching	Poacher activities	Project area	Observation and interview	Field data, interview of locals and CFUG members, DFO, and project staff
7	Birds	Birds population and species	Project area	Observation and interview	Field data, interview of locals DFO, and project staff
8	Fish and aquatic fauna	Fish population and migration. Functionality of fish ladder Status of hatchery Status of catch and haul	Tailrace – Trishuli Reduced discharge stretch – Seti River Reservoir – Seti River	Observation and interview	Field data, interview of locals, DFO, and project staff

Table 10. 10: Environmental Audit Framework for Adverse Impacts – Socio-economic Environment

SN	Parameter	Indicator	Location	Methods	Sources
1	Acquisition of land and other properties	Status of compensation No. of displaced HHs, business Condition of displaced HHs Disputes Status of rehabilitated land acquired temporarily	Project area	Observation, review of the monitoring records, records of compensation, SPAF and PAF, displaced HHs, review of Grievance redressal records	Field data, Records, interview of locals, and project staff
2	Migration	No. of local resident employed vs No of migrated workers Migrated HHs and workers settled in the project area	Project area	Observation, review of the monitoring records	Field data, Records, interview of locals, and project staff
3	School	Status relocated schools – academic session, classes, no. of students enrolled and dropped out, facilities in the school	Project area	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, students, and school staff, and project staff
4	Ghats	Status of relocated ghats – infrastructure, facility, use of ghats by the locals.	Project area	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff
5	Temples	Status of slope protection of temples Maintenance of the temple	Project area	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff
6	Community Hall	Status of the community hall – relocated location,	Project area	Observation, review of the monitoring records, records of	Field data, Records, interview of locals, and project staff

SN	Parameter	Indicator	Location	Methods	Sources
		infrastructure, facilities, equipment, frequency of usage		constructions, interviews	
7	Occupational health, community health, Emergency	No. of accidents Incidences of disease outbreak and no of infected individuals Instance of emergency situation Primary medical facility available at the site, and equipment Trained personnel and focal point to address emergency situation	Project sites	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff
8	Gender discrimination	Incidences of gender violence, Women staff Women in skill training program Wages of women	Project sites	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff
9	Law and order	Incidences of crime, fights, and disputes	Project area	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff
10	River use	Eflow status Fishing activities Use of relocated cremation sites in the reduced discharge stretch	Reduced discharge stretch of Seti River	Observation, review of the monitoring records, records of constructions, interviews	Field data, Records, interview of locals, and project staff

10.6.4 Cost for Environmental Auditing

The project will earmark funds for the Environmental Auditing expenses, which represent a singular expenditure occurring two years after the conclusion of the construction works.

Table 10. 11: Indicative budget for the Environmental Auditing.

SN	Particulars	Input	Rate	Amount
1	Sampling and laboratory analysis	LS		15,00,000
2	Consultations and interviews	LS		15,00,000
3	Data procurements	LS		10,00,000
4	Dron survey	LS		15,00,000
5	Transportation	LS		500,000
6	Reporting, logistics, etc	LS		500,000
	Total in NPR			7,500,000
	Total in USD			57,692.00

11 Conclusion and Recommendation

The proposed TSHPP, with a capacity of 126 MW, operates as a Peaking Run of the River (PROR) scheme, yielding an annual electricity output of 520.78 GWh. The main features of this project include a 12.7 km long reservoir and 30 m tall barrage at Sarang Ghat Bandipur Municipality on the Seti River. Water from the reservoir is diverted via a 6.75 km long headrace tunnel to the semi-underground powerhouse at Gai Ghat, Dev Ghat Municipality before released into the Trishuli River through a tailrace.

The TSHPP is a downstream project to the Tanahu HEP, utilizing its tailrace water. With 126 MW, the TSHPP will supplement the Tanahu HEP's 140 MW. These combined initiatives will significantly contribute to Nepal's hydroelectric energy capacity, possibly meeting local demands and assisting neighboring nations. While exporting is possible, the TSHPP is primarily geared towards enhancing domestic supply, expanding capacity, substituting fossil fuel generation, and curbing Nepal's greenhouse gas emissions.

This study was carried out by meeting GoN's requirement as per the Environmental Protection Act 2019 and Environmental Protection Regulations 2020 as well as Asian Development Bank's Safeguard Policy Statement (SPS 2009), International Finance Corporation Performance Standard on Environment and Social Sustainability (2012) and other associated guidelines.

A total land of 271.45 ha will be acquired by the project (61.15 ha temporarily and 210.30 ha permanently) for the construction of headworks, Powerhouse complex, Reservoir, and other project ancillary facilities. A total of 437 land parcels will be acquired. Among these parcels, 285 HHs is expected to be affected, both permanently and temporarily. Besides these HHs, land of a private resort (Care and Downey) will also be acquired encompassing a total area of 0.96 ha. 13.82 ha of government land will also be acquired for the project.

There will be a loss of 40.069 ha of agricultural lands that will result in the loss of about 50.58 MT of cereal crops from permanently acquired agricultural lands and 43.1176 MT from temporarily acquired agricultural lands per year. The total income loss from these lands' accounts for a total of NRS 35,09,302.03 per year.

248 privately built structures on the titled land will also be impacted by the project. Government structures such as Shree Seti Ganga Basic School in Bandipur-6, Janata Primary School & Community Hall in Devghat-4will be displaced. Creation of reservoir U/S of dam will inundate 7.28 km of Buddha Sing Marga at different stretches and suspension bridge located at Bandipur-6.

There will be a loss of 19,115 trees of 27 species belonging to 15 Community forests, and 5 leasehold forests. *Shorea robusta*, *Dalbergia latifolia*, *Cymbidium alifolium and Dioscorea deltoides* are the plant species of conservation significance.

Similarly, the project area harbors 38 species (10 amphibians, 13 lizards, 2 turtles and 13 snakes) of herpetofauna and 29 species of mammals. No endemic, migratory or invasive species of herpetofauna and mammals were recorded in the project area. Likewise, TSHPP is surrounded by five Important Bird and Biodiversity Areas. 83 species of bird was recorded during the study that comprised of 45 forest birds, 12 raptors, 10 riparian, 8 urban birds, and 7 farmland birds. Among these, 48 species are resident while 18 species of birds are full migrant residents and 10 species exihibit altitudinal migration. 8 species of birds exhibited congregatory behavior. 16 bird species, including vultures, owls, eagles and buzzards are of conservation significance. 68 fish species was recorded during the study. Out of these, 22 species were migratory. 5 species were listed as threatened species by Global IUCN Red list and 2 species wee considered as endemic species.

Land use change, land instability, air, noise and water quality degradation, solid waste generation, habitat destruction, loss of biodiversity, land acquisition, displacement of HHs and loss of productive agricultural lands are the possible impacts likely to occur during the construction phase. The operation phase impacts include land use change in the reservoir, dewatering of 12 km river section, reduced flow, obstacle to fish migration, loss of structures such as schools, roads and bridges etc.

The TSHPP will produce 520.78 GWh of clean energy annually to meet the electricity demands of the country. This will also make a significant contribution to the reduction of greenhouse gas emissions. The project will employ 1,293 full time workers over a 5-year period, where qualified persons from SPAFs especially women and other marginalized/traditionally excluded groups will be encouraged. The project will provide ample opportunities for local business contributing to the economic growth of the area. The project will construct new roads and bridges and upgrade existing Buddha Sing Road which will improve the access within the project area.

The major mitigation measures recommended to minimize the adverse impacts are use of bioengineering techniques for land protection, E-flow release of 5.08 m3/sec, construction, and operation of “fish hatchery” & “catch and haul program”, establishment of “Rescue and Rehabilitation Centers” for Wildlife, Proper compensation for land and forests, establishment of nursery, water quality protection measures and various awareness trainings related to Wildlife, Biodiversity and GBV.

Baseline, impact, and compliance monitoring are suggested during construction and operation phase of the project.

Based on the comprehensive EIA study, it has been determined that the project will have significant impact on the physical, biological, social, economic, and cultural environment. However, the project also offers substantial benefits to the government, and local population. Hence, it will be very critical that the proposed mitigation measures to offset negative impacts and enhancement measures to enrich beneficial impacts is implemented appropriately.

By effectively executing the environmental management plan, the project can adequately handle its impact. It's strongly advised that the project moves forward with a robust implementation of the EMP. Any additional impacts encountered during implementation will be addressed at the project's expense.

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