

EXECUTIVE SUMMARY

Manang Marsyangdi Hydro-electric Project (MMHEP) is located on the Marsyangdi River in Manang district of Province-4 of the Federal Democratic Republic of Nepal. It is a PRoR project with an installed capacity of 135MW being studied in the upper reaches of Marsyangdi River and adopts diversion type development. The water from the tailrace of MMHEP will be utilized by Lower Manang Marsyangdi Hydro-electric Project (LMMHPP).

In July 2016 Manang Marsyangdi Hydro Power Company P. Ltd. submitted a feasibility study report. According to this report, the Project development scheme was to dam the river 500m downstream of the confluence with Nar khola near Koto village and divert water through a 7.27 km long headrace tunnel to the surface powerhouse on the Left Bank terrace of Marsyangdi River, which would be 500m upstream of the confluence of China Khola with the Marsyangdi River. The powerhouse had an installed capacity of 144 MW (3 units) with 38 m³/s discharge utilizing 454m water head. However, the feasibility study carried out by QYEC at the current stage has several changes in the project features with respect to the previous study of MMHEP which have been summarized further.

The project area of MMHEP is about 65 km from the nearest city Besisahar and about 235 km from capital city Kathmandu. The project lies between the project boundary of 28° 32' 05" N to 28°33'37" N and 84°15'38" E to 84°20'00" E. The project components of MMHEP are located in Chame and Nashong Rural Municipalities of Manang district, encompassing the villages Koto, Chitipu, Thanchok, Timang, Syarku and Danakyu. The headworks components of the project are proposed near Koto Village approximately 500 m downstream of the confluence of Nar Khola and Marsyangdi River, Chame Rural Municipality-4. The surface powerhouse is located at the left-bank terrace of the Marsyangdi River, approximately 1.4 km upstream of the confluence of China Khola and Marsyangdi River at Bagarchhap Village, Nashong Rural Municipality wards- 1 and 3. The access road from Powerhouse to headworks site is nearly 13 km.

MMHEP is PRoR type project with daily peaking of 1.66 hours during the dry season. The design discharge (Q40.8 percentage exceedance) of the project is 36.78 m³/s, and the gross head is 430.2m. The diversion structure is a non-overflow concrete gravity dam with gated spillway. The proposed dam is 24m high. The water diverted from Marsyangdi River will be conveyed through a 6075m long HRT to the surface powerhouse on the left bank terrace of Marsyangdi River which is approximately 1.4 km upstream of the confluence of China Khola and Marsyangdi River at Bagarchhap village. The tailrace of MMHEP will be connected with LMMHPP headworks at the downstream end.

The Marsyangdi River is one of the main tributaries of the Gandaki River which meets with the Ganges River in India. The catchment originates at the Himalays in western Nepal and sources from Tilicho Tal which lies at about 5000 masl. The catchment area at the dam axis is 1635 km², of which the area of 901 km² is above 5000 masl. The catchment area at Powerhouse is 1693 km² of which 909 km² is above 5000 masl, a small part of this catchment area also belonging within the Annapurna Peak Natural Reserve. The Marsyangdi Basin has a humid-temperate climate with temperature as well as rainfall intensity varying with altitude. The average annual precipitation in the Marsyangdi river basin is 426 mm at the intake site and 444 mm at the powerhouse site. The long-term mean monthly flow calculated at the intake site has the minimum discharge of 10.62 m³/s in February and the maximum flow of 157.94 m³/s in August. The design flood is taken for 50-year return period and its value is 692 m³/s, while the check flood is taken as 500-year return period and its value is 1053 m³/s.

Geologically, gneiss and sandstone are the main rock types found throughout the project area. Besides these rock types, project area consists of colluvial and alluvial deposits. The left side of the dam axis is on bedrock while the right side has deposits of alluvium; hence bank protection works might be required at the right bank. The settling basin is proposed in the old alluvial deposit at dry cultivated land at the right bank of the River. There is steep rock dipping towards the hill side of the settling basin therefore slope stability problems are not expected. The headrace is a river-crossing just downstream of the settling basin which discharges into the HRT that runs from the left bank of the

river. The major rock type along the HRT is gneiss. The dominant rock type in surge chamber is also gneiss creating favorable chamber-forming conditions. The penstock lies in fractured gneiss with poor rock quality, requiring supports. The surface powerhouse is located on left bank of Marsyangdi River on the rocky hill slopes of mainly gray-grayish-white gneiss.

The diversion structure is a non-overflow type concrete gravity dam with gated spillway having a total crest length of 89.5m. It has two gated-spillway bays and one undersluice bay provided to safely regulate the flow during floods. The dam deck level is at 2584 masl. The Full Supply Level (FSL) is 2582 masl and the Minimum Operation Level is 2579 masl. The invert level of the spillway and undersluice bottom slab and crest is 2563 masl while the original bed level of the river is 2560 masl. The size of spillway gates and openings is 8 x 8.5 (wxh) m and that of the undersluice gate and opening is 3 x 8.5 m (wxh). The dam has been designed to safely pass the flood of 500 years return period i.e. 1053 m³/s of which the two spillway bays and undersluice pass 887 m³/s and 166 m³/s respectively. At times other than floods, the sediments, debris and boulders accumulated in front of the intake is flushed out from time to time through the undersluice.

The side intake structure is provided at the right bank adjacent to the undersluice bay with two openings of size 6 x 5 m (w x h). Coarse trashrack is provided to prevent trash and large size floating debris from entering the orifices. Discharge is conveyed to the settling basin from the intake through a single approach channel of width 10m and height of side walls 6-6.4 m with a top level fixed at 2583 masl. Double-chambered surface settling basin further divided into two flat-bed hoppers in each chamber has been designed to settle suspended sediments of size 0.1 mm with a trapping efficiency of 86.6%. The hydraulic dimensions of the settling basin are 160 x 14 x 13.6 (LxBxH) m. The flushing arrangement is provided at the end of each bay to flush the settled sediments back into the river through a flushing culvert. Intermittent gravity flushing system has been adopted.

The water from settling basin will be conveyed to the headrace tunnel through a power culvert, 3.5x3.5 m and 51.327m in length, from the head pond provided at the outlet of the settling basin. This power culvert also comprises of a river crossing structure to convey the discharge from the settling basin at right bank to the HRT at the left. The length of headrace tunnel is 6075.5 m from tunnel inlet to surge chamber. The surge chamber consists of vertical shaft and upper chamber. The vertical shaft is 6m in diameter and 83.30 m height, the invert of the upper chamber is at 2586 masl which is 74 m from the invert of vertical shaft and HRT intersection which is at 2512 masl. The upper chamber is 180 m in length and divided into two sections each having a length of 90 m with the longitudinal gradient of 1% inclining towards the shaft and a D shape cross section 4.5m width and 5.2-6.1 m in height.

Water is conveyed to the powerhouse through a penstock conduit consisting of three horizontal sections and two vertical-shaft sections. The length of penstock pipe up to the first bifurcation point is 965.42m including bell-mouth and surge shaft offset length, which through two numbers of bifurcated pipes feeds water to two sets of Pelton turbine units housed in the surface powerhouse located at left bank of Marsyangdi River. The bifurcated length of penstocks is 47.08m and the diameter before and after bifurcation is 3.3m and 2.2m respectively. The size of powerhouse is 66 x 25 x 35 (LxBxH) m. The water released from the tailrace of the powerhouse feeds into the HRT of the LMMHPP. The size of the tailrace canal (covered) is 6 x 6 m and 80 m in length. The tailwater level is 2147 masl.

The Manang Marsyangdi Hydro-electric Project will generate a total average energy of 751 GWh annually. Energy generated during the dry and wet seasons is 229 GWh and 522 GWh respectively with 30.5% dry energy in 6 months (December-May). The project is able to sustain a minimum of 1.66 hours of daily peak energy production throughout the dry season months.

The project cost was estimated after detailed rate analysis and quantity estimation for each of the components. The project life has been taken as 30 years, the debt-equity ratio is 80:20, interest rate is 6.8% and an inflation rate of 4% has been considered. The tariff rates of NRs. 8.5 and 8.4 /kWh for dry energy during peaking and non-peaking time, and NRs. 4.8 /kWh for wet energy has been taken. The IRR on total investment is 8.6% and that on equity is 10.4%.

To summarize, MMHEP is found environmentally friendly, technically feasible and financially viable.