



# Carbon Management Assessment (CMA)

## *Maduru Oya Left Bank Main Canal at 24+140 Drop 9 Mini Hydro Power Project*

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# 1. Description of Project Activity

## 1.1. Introduction of Project Activity

The proposed project is located in Pollonnaruwa district, Dimbulagala Divisional Secretariat Division. The Maduru Oya Left Bank Irrigation System is fed by a lined main with several Branch Canals to release water for seasonal crops. Maduru Oya Reservoir is a major reservoir managed by Mahaweli Authority having a Project Manager and site level technical staff for Operation and Maintenance of the system. Proposed Project is located in the Left Bank Main Canal Regulator 09, at 24 + 140 taking into consideration of the available drop.

Location	Capacity	Energy Production	Costs of the Project
Regulator cum drop structure 9, at 24 + 140 of LB Main Canal	2000 kW	8.32 GWh/yr	130 MSLRs

The project is technically feasible and economically viable. The Internal Rate of Return (IRR) for the project is more than 16% after paying a royalty (27%) to MASL.

The project will not cause any adverse environmental impacts as canal water is using for power generation. Due to proposed versatile equipment and automatics, there will be no interruptions to the canal flow and the water issue directive by the PM will be adhered.

Mahaweli Authority of Sri Lanka will have unfettered access to check the project during construction and operations on proper usage of the assets.

**The project area is not environmentally sensitive since it already has been disturbed by human activities since the inception of the Mahaweli irrigation system. The environment of the area is a disturbed grassland and secondary forest vegetation. No unique flora or fauna exist in the area.**



Maduru oya drop 9 project is located at the 24+240 m location of the left bank main canal. Discharge of the location is approximately 22.0 m<sup>3</sup>/sec and a fixed head of 11.0 meters. Capacity of the project is 2.0 MW, and the output in average is 8.32GWh annually.

Existing drop structure is having 2 regulator gates for water level operations of the canal for a given discharge.

LB canal is a well maintained concrete lined canal

**Completed the Project in December 2013 and in operation**

## Parameters related to the Proposed Power Project

### Hydrology

Maximum discharge observed	19.3 cumecs
Minimum discharge observed	1.01 cumecs
Average mean discharge	11.55 cumecs
Rainfall	1000 – 4000 mm

### Canal regulator cum drop head

Maximum	11.5 m
Designed head	11.0 m
Outlet canal water level	78.0 m

### Proposed power plant

Installed Capacity	2 MW (as proposed in LOI)
Expected Energy Output	8.32 GWh annually
Type of the turbine	Dual operation Kaplan – Vertical Bulb turbine or K-tec
Efficiency of the flow variation	60%
Generation	Synchronous/semi umbrella type
Generating Voltage	6.6 kV
Frequency	50 Hz
Line of connectivity and Voltage	500 m/ 33 kV

### Cost and financial status

Total Project Cost	130 m SLRs
Equity of the Project Proponent	40 %
Lending Banks	60 %
Internal Rate of Return	> 18.46%
Royalty to MASL	27 % from generated power

### Operational Conditions

Water operations	as per MASL seasonal operating plans/RPM sys 'B' directives
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## Project Objectives

Objectives of the project can be summarized as follows;

- To harness the maximum potential of power from the regulator cum drop 09 at Maduru Oya LB main canal, considering the water supply for irrigation system to meet the power demand.
- Pay an annual royalty to maintain the canal structures and the canal to improve the operational efficiency of the irrigation water supply
- Protect the environment by implementing an Environmental Action Plan.

## Scope of work

Following items have been identified for the preparation of technical feasibility report. Each of these items has been prepared by experienced consultants to meet the objectives of the Projects.

### Detailed field Survey

- Including access roads, physical situation of the terrain and other important features
- Contours at 0.5 meter interval and where necessary 0.25 meter interval to identify the area
- Incorporation of the project structural features after designs
- Comprehensive plan of the project area including all above at 1:1000 scale for the lease agreement

### Detailed geological survey

- Foundation and sub surface condition of all the proposed structures
- Geological analysis report on stability of structures and slopes
- Drilling and analyzing core samples where necessary
- Soil conservation and drainage protection measures
- Preparation of all geological drawings which will be based for designs

### Detailed hydrological survey

- Computation of daily flow discharges at various sequences
- Flow duration curves for normal and critical flow variations
- Maximum and minimum flow discharges and its duration and variations
- Compute all required flow patterns for turbine designs to obtain the maximum energy output at the highest efficiency
- Flood and drought flow analysis

### Selection of Electrical and Mechanical equipments

- Finalization of turbine/generator systems with hydrological information with head variations
- Other ancillary equipments
- All basic parameters and drawings for the commence of civil drawings
- Efficiency, protection systems, general specification standards for the acceptability to CEB regulations

### Conceptual civil designs and drawings

- Designs of the Power House, inlet outlet canals and other features using above data 1, 2, 3 and loading systems
- Preparation of conceptual drawings considering the E & M components
- Computation of quantities
- Unit rate analysis considering the variation trends

### Cost, financial and economic calculations and analysis

- Projected costs with price variations and dollar fluctuations
- Equity partnerships, banks loans, any other funding arrangements with interests, dividend and other arrangements

- IRR and Cost Benefit ratios for various situations and sensitivity analysis
- Analysis on sensitivity of debt service cover
- Analysis of tax benefits, insurance cover, royalties, discounted rates, bank rates and tariff rate variations
- Comprehensive financial report with economic benefits

**Project Management** with issuing guide lines, supervision and coordinating all consultancy works including analysis according to RFP and other state requirements and preparation of final reports

- Rate analysis for all civil works, taking out quantities for the preparation of cost estimates for structural components separately
- Preparation of contract documentations for out sourcing contracts with agreements
- Progress monitoring with quality control assurance of all the items of project
- Certification of payments cost variation, additional works identifications and project criticality analysis
- All co-ordination of activities with MASL, CEB, CEA, and other relevant organizations to perform the functions.

### **Irrigation water supply**

Left Bank sluice provides water to an extent of 18,000 Ha of land at present for seasonal irrigational crops. Water provision is through a lengthy lined Main Canal and several sub canals to meet the gravity water supply to farm lands owned by farm families. At 24 + 140 km of the main canal, proposed project received water after distributing to several Branch Canals viz., LBL1, LBR1, LBL2, LBL3, and LBR2. Due consideration will be given not to interrupt the water supply to feed irrigation sub canal system.

### **Irrigation canal distribution system**

There is a commitment by the MASL to provide timely irrigation water for seasonal crops agreed with farmer organizations. Seasonal water operational plans prepared by the Water Management Division of MASL with the concurrence of farmers and relevant officials will be strictly adhered to meet the economy and the livelihood of farm families. Traditionally there will be two irrigation seasons viz., Yala and Maha. Yala season prevails from April to August and Maha from October to March. These seasons are aligned with South West (April/June) and North East (November/February) monsoons. The average rainfall varies from 1000 mm to more than 5000 mm per year in the project area. Temperature is moderately high above 30 C and humid.

For last 20 years since completion the Project is in operation without any draw back supplying the required water for irrigation facilities. Water supply is assured for many years to come as the project is expanding to meet the irrigation facilities for 24,000 Ha at the full development. Reservoir water supply is assured, as in addition to the catchment water during monsoons, a firm diversion is made from Ulhitiya – Rathkinda reservoir to Maduru Oya through a link tunnel.

### **Hydrological and Power analysis**

Maduru Oya LB canal is fed by Maduru Oya reservoir having a catchment area of 453 Km<sup>2</sup>. The reservoir has an active storage reservoir volume of 473.5 mcm for irrigation water usage. In addition to the natural catchment, there is also a tunnel, which diverts water from the River Mahaweli Ganga, through Ulhitiya –Rathkinda to Maduru Oya Reservoir. This link tunnel has a maximum capacity of 34m<sup>3</sup>/s. Total inflow to Maduru Oya is approximately 550 mcm for a year.

The Left Bank Canal has been designed to carry maximum of 56 m<sup>3</sup>/s of water to irrigate 27.000 Ha of existing and new land under the command of Maduru Oya LB canal. However, approximately 18000 Ha have been developed so far and water release are limited and not reached the

maximum. As the records of the canal flow a maximum of 21.66 m<sup>3</sup>/sec is being discharged for irrigation of the land from the proposed location and present average is 11.55 m<sup>3</sup>/s.

### Design Flow of the proposed location

The main purpose of the reservoir operation and canal flows are for irrigation. Therefore, water flow pattern and flow rates cannot be altered to suit electrical power generation. What is to be done is to optimize the proposed electrical power plant under the irrigation flow constraints.

Daily records of water flow through the Maduru Oya Left Bank Sluice were obtained from the Mahaweli Authority of Sri Lanka, the Mahaweli Water Management in Colombo. Daily flow records were available for the period January 1995 to October 2006.

During the field investigations the discharges, in Branch Canals were obtained from the RPM staff to analyse the balance water available at the proposed location. Observed that the canal water level has to be maintained at a desired head to divert water to Branch canals.

### Irrigation facilities in LB Canal system

As per original designs, it was anticipated to provide water for 46,750 Ha of new lands and 3,750 Ha of existing lands for irrigation in System B of Mahaweli Project from Maduru Oya reservoir. At present the LB irrigation development has been completed to a substantial amount and approximate irrigation development is 18,000 Ha. Several branch canals are off taking from the LB main canal to meet the water demand in farm lands owned by individual farm families. Water distribution in this intricate canal system is a complex one and the Project is managed by a Resident Project Manager and supporting staff for operation and maintenance purposes.

Zones	Zone centre	Br-Canals/Main Canal	Land under irrigation / Ha	Present situation
Zone 1	Ellawewa Dimbulagala	LB L1, LB L2, LB L3, LB L4	6100	Developed
Zone 2	Sevanapitiya Senapura	LB L 5	4600	Developed
Zone 3	Sinhapura	LB L 6	2900	Developed
Zone 4A	Aselapura Sapumalpura Ransaratenna	LB R5, LB R6 LB R7, LB L6	6800	Partly developed
Zone 4B	-		2100	Not developed
Zone 5	Damminna Vijayabapura	LB R1, LB R2, LB R3, LB R4	5500	Developed
			~28,000 Ha	~ 18,000 Ha

As per above schedule of irrigation infrastructure facilities, Project water requirement is not at full scale yet. At the full development and the present development water discharge parameters at the sluice are as follows; Observed minimum flows are for domestic purposes during the canal maintenance period.

#### MADURU OYA LB CANAL AT 24+140 AVERAGE WATER DISCHARGES

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Avg
Mean	19.88	20.03	12.1	15	30.6	29.89	29	22.58	7.31	9.67	19.3	19.8	19.6

LBR1, LBL1, LBL2, LBR2 & LBL3  
canals water discharges

LBR1	1.24	1.34	1.45	0.5	2.64	3.54	2.47	2.3	1.01	0.28	1.97	1.16	1.7
LBL1	2.61	2.78	2.43	0.5	2.65	3.67	3.07	3.54	1.28	0.19	2.67	0.89	2.25
LBL2	1.51	1.41	1.42	0.1	0.83	1.08	1.22	0.54	0.23	0.08	1.78	0.74	0.98
LBR2	1.59	1.64	0.56	0.3	3.21	1.89	1.19	1.16	0.23	0.11	2.87	1.44	1.34
LBL3	1.24	2.14	4.04	0.1	1.98	2.17	3.44	2.13	0.62	0.27	2.36	1.04	1.78
Total	11.87	9.31	9.9	1.5	11.3	12.35	11.4	9.67	3.37	0.93	11.65	5.27	8.05

AVERAGE DISCHARGES AT 24+140

Drop 9	8.01	10.72	2.2	13	19.3	17.54	17.6	12.91	3.94	8.74	7.65	14.5	11.5
												3	5

Characteristic flow values at the sluice for the period are as follows;

Mean monthly flow	19.55	m <sup>3</sup> /s
Highest monthly flow	36.11	m <sup>3</sup> /s
Minimum daily flow	1.06	m <sup>3</sup> /s

At the drop 24+140, flow is less on several Branch Canals are taking off water from main canal. Branch canals are LBR 1, LBL 1, LBL 2, LBR 2, LBL 3. In average 40% of the flow absorb by these canals.

Available mean monthly flow	11.55	m <sup>3</sup> /sec
Available maximum mean flows during (May, June, July)	18.14	m <sup>3</sup> /sec
Considering to obtain the Proposed install capacity of Design flow is	17.20	m <sup>3</sup> /sec

**Left Bank Main Canal at 24+140 water releases**

LB Main Canal at 24+140 will discharge maximum of 33.69 m<sup>3</sup>/sec and due to partial development of the irrigation system, it is observed that the maximum discharge so far delivered is 21.66 m<sup>3</sup>/sec. Water releases form the sluice are made according to a seasonal operating plan prepared by the MASL to provide crop water requirements during Yala and Maha seasons. As paddy being cultivated to a greater extent with some other cash crops in a scattered manner, observed that the water releases are according to an established pattern related to paddy cultivation.

Yala and Maha seasons are in the months of April to September and October to March respectively. Water issue calendars are finalized with the concurrence of farmer organizations by RPM and water issues are made accordingly to crop water requirements. For paddy cultivation water requirements are varies from initial ploughing period, growing, flowering and riping periods. At the tail end of the cultivation season water issues are made on rotational basis. Each season end, there is a closure period for canal maintenance maximum of one month period. However domestic water requirements are made on farmer organizations requests during maintenance periods. It is expected to generate power as per water releases according to a seasonal operating plan prepared by the MASL.

**Data of water issues during 2005/2006 as per Seasonal Operational Plan of MASL**

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
LB issues												



mcm	46.2	55.1	n/a	18.2	88.2	88.5	86.2	78.8	17.7	22.1	6.3	67.0
Average In m <sup>3</sup> /sec												
End storage In mcm	355.5	396.5	n/a	490.3	412.8	338.4	226.2	142.4	128.1	213.3	216.5	209.1
Rain fall In mm	494.5	155.3	68.6	123.0	76.4	29.0	-	62.0	167.9	276.8	324.3	60.7

Above table explains the water issues and reservoir storages during last Yala and Maha cultivation seasons. During North East monsoon the inflows are high and reasonable inflows expect during South West monsoon to the reservoir. In addition to the inflow from the Maduru Oya reservoir catchment, Mahaweli water divert from the Uihitiya/Rathkinda reservoirs to Maduru Oya through a link tunnel. This amount is a substantial quantity to meet the irrigation water requirements in downstream. Mahaweli Authority reserves the right to change the water distribution patterns according to the situations, such as unexpected rain may tend to reduce the canal flows to save water in the reservoir.

### Water releases for last 10 years

Water issue data obtained from the WMS of MASL, EIC of Headworks division Maduru Oya Project was analyzed to check the maximum, minimum, mean and average flows for last 10 years. Flow pattern has been following to an established sequences and observed that From April, there is a steady increase in water releases reaches maximum during May, June and July and observed the minimum during September and October. These issues are for traditional Yala cultivation issues. Then there is a steady increase during November, December, January and February. This pattern has to follow for power generation.

### Maduru Oya LB Drop 24+140 Issue (M3 /sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1995	13.46	13.46	13.7	9.762	16.88	17.88	18.49	15.4	7.86	10.29	14.22	15.38
1996	13.62	10.79	4.88	11.5	16.45	15.3	16.74	10	3.25	15.7	17.93	13.91
1997	15.97	13.75	2.61	12.25	17.72	15.45	15.54	8.65	2.16	0.606	12.93	10.06
1998	11.71	11.19	8.93	18.45	18.19	17.33	18.26	11.2	5.68	16	18.61	14.92
1999	8.741	10.72	4.36	13.08	21.67	20.3	20.22	17.5	5	4.222	14.54	13.12
2000	13.83	14.47	5.95	6.016	19.74	19	20.12	17.9	7.54	3.391	2.53	8.132
2001	6.984	9.859	12.2	1.616	15.08	18.1	7.104	1.56	0.64	1.141	8.743	11.56
2002	10.68	11.35	8.61	2.87	17.31	18.58	19.21	19.9	5.08	1.231	11.09	8.38
2003	8.991	9.787	6.39	7.069	20.04	17.97	18.03	16.4	5.21	4.363	12.76	14.73
2004	15.27	14.8	4.85	5.866	20.47	18.96	19.36	17	1.45	1.1	2.148	8.296
Mean	11.93	12.02	7.25	8.848	18.35	17.89	17.31	13.5	4.39	5.805	11.55	11.55
Max	15.97	14.8	12.2	18.46	21.67	20.3	20.22	19.9	7.87	16	18.66	15.38
Min	6.984	9.786	2.61	1.614	15.08	15.31	7.104	1.56	0.64	0.606	2.148	8.13
StDv	2.844	1.806	4.13	4.872	1.95	1.47	3.666	5.33	2.32	5.622	5.364	2.784

	Maximum flow	Mean flow	Minimum flow m <sup>3</sup> /sec
Present situation	21.66 m <sup>3</sup> /sec	11.55 m <sup>3</sup> /sec	1.01 m <sup>3</sup> /sec
At the full development	33.69 m <sup>3</sup> /sec	24.81 m <sup>3</sup> /sec	2.11 m <sup>3</sup> /sec

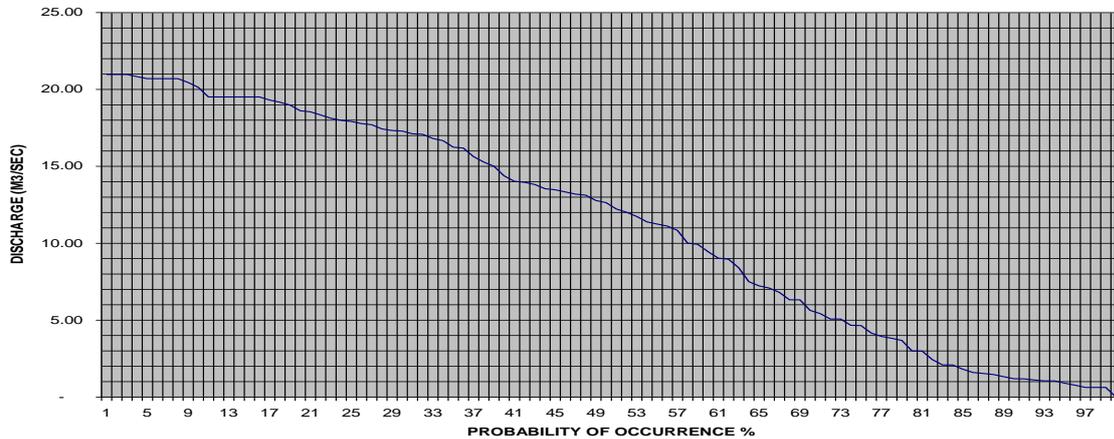
Designed discharge	48.00 m <sup>3</sup> /sec		
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### Flow duration curve

Flow duration curve has been prepared studying last 10 years flow records at Maduru Oya LB Main Canal at 24+140. As per the present development of the irrigation system flow duration curve explains that maximum of 36 m<sup>3</sup>/sec has been issued for a short period and minimum of 1 m<sup>3</sup>/sec during the closed seasons. Following data explains the probability of occurrence of water issues at the sluice.

Probability	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Discharge m <sup>3</sup> /sec	31.0	29.0	26.0	23.5	19.0	14.0	9.0	5.0	2.5	1.0
Number of days	36	72	108	144	180	216	252	288	324	360

MADURU OYA LEFT BANK MAIN CANAL DROP STRUCTURE AT 24+140 OUTFLOW DURATION CURVE



### Design head

According to field surveys it is found that there is a maximum head of 11.5 meters. As there is a fixed head, no head variation is possible except limiting to the canal water depth. Only variable factor is discharge. However, the canal water level may vary during the operations. Kaplan turbine, bulb turbine generator or K-tec turbine-generator system is suited for the location. Design head of the power plant is 11.0 meters.

### Probable Installed Capacities & Generated Power

#### Design Flow

Using the Flow Duration Curves developed from the hydrological analysis flow at 30% probability of occurrence is 17.2 m<sup>3</sup>/s and is found to be maximum flow could be used for most economical power generation. Plant factor is 0.59 for this designed flow.

#### Design head

According to the field surveys carried out the most viable & environmentally accepted head available for power generation is 11 m. This figure has been taken for computations.

### **Selection of optimal installed capacity**

On computation of flow duration with available head the optimal installed capacity is identified as 1.60 MW.

### **Computation of energy Generation**

The computation of energy generation was carried out on above factors and obtained 8.32 GWh is the most economically viable mean annual power generation.

### **Computation of energy generation**

Power generation is computed for different plant factors. Following Table presents the Installed Capacity for different plant factors.

<b>Maduru Oya Left Bank Main Canal Drop Structure at 24 + 140</b>		<b>Head 11m</b>		
<b>Probability of Occurrence %</b>	<b>Discharge (m3/sec)</b>	<b>Plant Factor</b>	<b>Installed Capacity (MW)</b>	<b>Energy (GWh)</b>
100	0.1	1	0.01	0.08
95	0.9	0.96	0.08	0.7
90	1.1	0.95	0.1	0.85
85	1.8	0.91	0.17	1.34
80	3	0.87	0.28	2.13
75	4.5	0.83	0.42	3.05
70	5.5	0.8	0.51	3.62
65	7.1	0.77	0.66	4.47
60	9.2	0.73	0.86	5.5
55	11.1	0.7	1.04	6.36
50	12.5	0.68	1.17	6.93
45	13.5	0.66	1.26	7.3
40	14.2	0.65	1.33	7.53

35	16.2	0.61	1.51	8.1
30	17.2	0.59	1.60	8.32
25	17.9	0.58	1.67	8.49
20	18.2	0.57	1.7	8.54
15	19.5	0.54	1.82	8.7
10	20	0.53	1.87	8.74
5	20.7	0.52	1.94	8.77
0	21	0.51	1.96	8.77
<b>mean annual power generation- 8.32 GWh</b>				
On computation of flow duration with available head the optimal installed capacity is 1600 kW				

### Monthly Maximum Power Production on Daily Records

MADURU OYA LEFT BANK MAIN CANAL DROP STRUCTURE AT 24+140 - POSSIBLE  
POWER PRODUCTION  
MAXIMUM POWER PRODUCTION BASED ON DAILY RECORDS OF FLOW

All figures in GWh

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	0.734	0.734	0.75 5	0.53 2	0.92 1	0.97 5	1.00 9	0.8 4	0.4 3	0.56 1	0.77 6	0.83 9	9.86
1996	0.743	0.588	0.2 7	0.62 7	0.89 7	0.83 5	0.91 3	0.5 5	0.1 8	0.85 6	0.97 8	0.75 8	8.87
1997	0.871	0.75	0.1 4	0.66 8	0.96 6	0.84 3	0.84 8	0.4 7	0.1 2	0.03 3	0.70 5	0.54 9	7.55
1998	0.639	0.61	0.4 9	1.00 7	0.99 2	0.94 5	0.99 6	0.6 1	0.3 1	0.87 3	1.01 5	0.81 4	10.1
1999	0.477	0.584	0.2 4	0.71 3	1.18 2	1.10 7	1.10 3	0.9 5	0.2 7	0.23	0.79 3	0.71 5	9.06
2000	0.754	0.789	0.3 2	0.32 8	1.07 7	1.03 7	1.09 8	0.9 7	0.4 1	0.18 5	0.13 8	0.44 4	8.19
2001	0.381	0.538	0.6 7	0.08 8	0.82 2	0.98 7	0.38 7	0.0 8	0.0 3	0.06 2	0.47 7	0.63	5.59
2002	0.582	0.619	0.4 7	0.15 7	0.94 4	1.01 3	1.04 8	1.0 9	0.2 8	0.06 7	0.60 5	0.45 7	7.94
2003	0.49	0.534	0.3 5	0.38 6	1.09 3	0.98	0.98 3	0.8 9	0.2 8	0.23 8	0.69 6	0.80 3	8.38
2004	0.833	0.807	0.2 6	0.32	1.11 6	1.03 4	1.05 6	0.9 3	0.0 8	0.06	0.11 7	0.45 2	7.66
Average	0.65	0.655	0.4	0.48 3	1.00 1	0.97 6	0.94 4	0.7 4	0.2 4	0.31 7	0.63	0.64 6	8.32

### Computation of energy Generation

The computation of energy generation was carried out on above factors and obtained 8.32 GWh is the most economically viable mean annual power generation.

Based on available data of water flow and water level in Maduru Oya Reservoir, the energy production is calculated from daily records. The results are shown in detail in

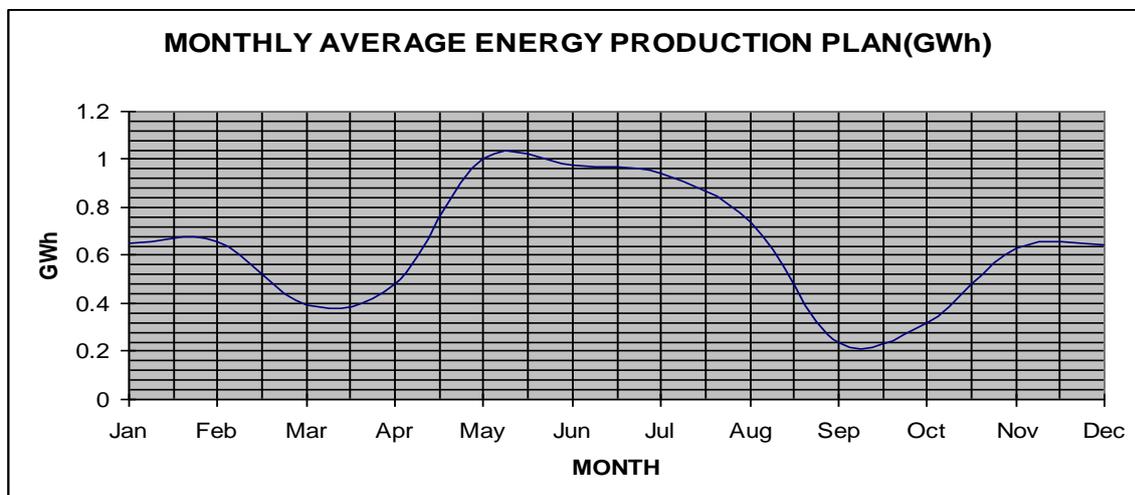
The combined efficiency of turbine, generator and transformer are set to 90%. The average calculated possible production is 8.32 GWh/year (see Table 4.4), vary from 5.58 to 10.06 GWh/year and referred to 33kv bus bar outside the powerhouse.

Due to uncertainty in available head and possible operation disturbance the annual production is reduced with 10% to **8.32 GWh/year**.

### **MADURU OYA LEFT BANK MAIN CANAL AT 24+140-POSSIBLE POWER PRODUCTION MONTHLY GENERATED POWER**

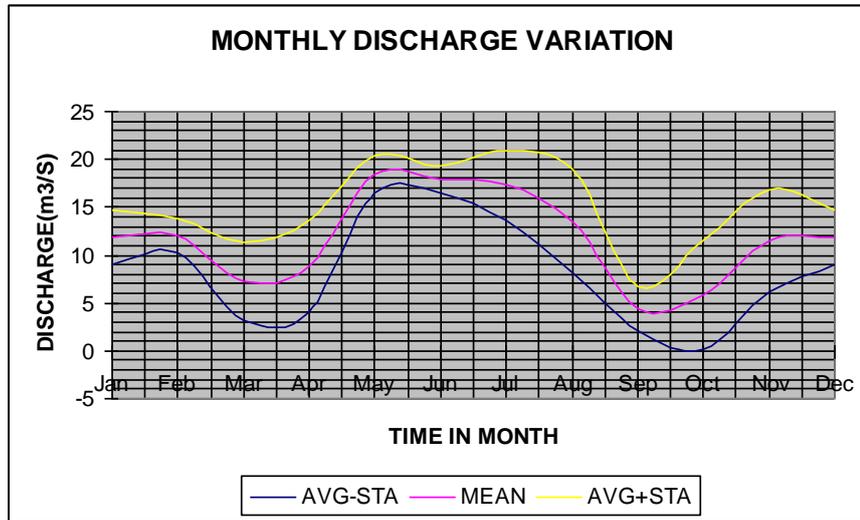
MONTH	GENERATED POWER
January	0.65
February	0.655
March	0.411
April	0.483
May	1.001
June	0.976
July	0.944
August	0.74
September	0.24
October	0.317
November	0.63
December	0.646

### **CALCULATED MONTHLY AVERAGE ENERGY PRODUCTION PLAN**



Above graph explains the monthly average power generation for a year considering last 10 years water releases.

### Monthly Water Discharge Variation



Above Graph explains the monthly water issues with maximum and minimum water issues considering the standard deviation for last 10 years.

### Water regulation in LB Main canal

Maduru Oya LB main conveyance is a lined canal designed and constructed to meet the water discharges at various flow conditions having maximum of 56 m<sup>3</sup>/sec discharge capacity. Lined canal has following features at the chainage 24 + 140.

Maximum discharge	48	m <sup>3</sup> /sec
Canal bed width	3.66	m
Canal slope	0.000167	
Velocity	1.38	m/sec

From sluice upto the proposed location, there are 4 Branch Canal off-takes drawing water for irrigation purposes. Mean discharges of the flows are as follows;

Branch Canal	Chainage	Mean Discharge m <sup>3</sup> /sec
1. LBR 1		1.70
2. LBL1		2.25
3. LBL2		0.98
4. LBR2		1.34

There is an advantage of having a lengthy intake canal to the proposed Power House, which will take the surges at sudden closes for regulation. Sudden regulations on closures of discharges at the turbine produce a water wave or surcharge which moves upstream. Free-board of the canal is 0.75 m and beyond is a compacted earth embankment with turfing. Canal sections are sufficient to take a surge and also arrangements will be made at the existing regulation gate at drop to function on automation during power house closure. The arrangement proposed will not have any unusual surge in the canal.

In the approach canal;

1. Positive surge results from turbine gate closure
2. Negative surge releases from increase in turbine opening

In tail race canal;

1. Positive surge results due to the turbine gate opening
2. Negative surge results due to turbine gate closure

Water releases as per Mahaweli System B Project Managers directives is mandatory. Power House turbine arrangements will be adjusted to meet these requirements, without interrupting the flows in Branch Canals. Consultants have proposed to conduct detailed designs on automation of the entire canal gates to meet the smooth water releases for irrigation waters. Automation will be at;

1. Existing Maduru Oya Sluice gate
2. All Branch canal offtakes; LBR 1, LBL1, LBL 2, LBL 3
3. Regulator cum drop gate at 24 + 140

## 1.2. Sectoral Scope and Project Type

Sectoral scope 1, Type I, AMS-I.D "Grid connected renewable electricity generation"

## 1.3. Project Proponent

Organization Name	Eagle Power (Pvt) Ltd
Contact Person	Kapila Wijesekara
Address	No: 09, Industrial Zone, Panadura, Sri Lanka
Title	Director / General Manager
Telephone	0773822454
Fax	0384282780
E-mail	<a href="mailto:kapila@ethimale.lk">kapila@ethimale.lk</a>

## 1.4. Other Entities Involved in the Project

Organization Name	<i>Anunine Holdings (Pvt) Ltd</i>
Role in the project	<i>Mother company of Eagle power (Pvt) Ltd</i>
Contact Person	<i>G.A. Sithara Sewwandi</i>

Address	77, Sri Saranankara Rd, Dehiwala-Mount Lavinia.
Title	Sustainability Analyst
Telephone	0703672748
Fax	-
E-mail	sithara@anunine.com

### 1.5. Location of Project Activity

Project falls within System B of Mahaweli Project and;

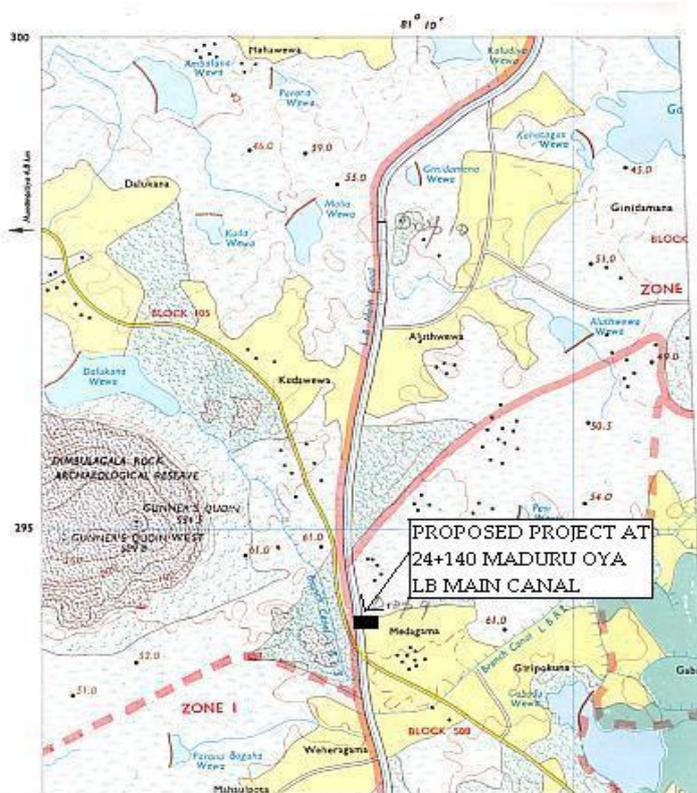
- Authorised Officer - Resident Project Manager (System B)
- Mahaweli Unit Manager office – Medagama
- Mahaweli Block Manager office – Sevanapitiya & the general information is as;
- Province – North Central Province
- District – Polonnaruwa
- DS office – Dimbulagala
- GN office – 256, Medagama
- Village – Medagama

The project site is located at 324 km from Colombo.

Location of Project Activity	Maduru Oya Left Bank Main Canal Sluice
Province	North Central Province
District	Pollonnaruwa
DS Division	Maduru Oya
City/Town	Aralaganwilla
Community	Medagama
Coordinates	Latitudes 7 <sup>0</sup> 86' 11 52" N Longitudes 81 <sup>0</sup> 16' 37" E



**Figure 1: Location Map**  
Source : Google map



**Figure 2 : Location Map**  
Source : Survey Department

### 1.6. Project Ownership

The project is fully owned by Eagle Power (Pvt) Ltd.

### 1.7. Project Fundings

No any funds capitalized on the development of this project.

### 1.8. Project Start Date

Starting date of the Maduru Oya Left Bank Main Canal Drop at 24+140 small-scale Hydropower project activity is **12<sup>th</sup> August 2008** (This was the date when first real action was taken by PP and Letter of Award for construction of access road to the power house was made along with the advance payment to the contractor)

### 1.9. Project Commissioning Date

The project was successfully commissioned on 19<sup>th</sup> December 2013

### 1.10. Project Track

The Maduru Oya Left Bank Main Canal at 24+140 Drop 9 Mini Hydropower project intends to be registered under track II and issued carbon credits from project will only be used for internal offsetting of emissions.

### 1.11. Project Crediting Period

The project crediting period is 1<sup>st</sup> of March 2021 to 1<sup>st</sup> of March 2027 and totally 7 years renewable.

### 1.12. Scale of Project and Estimated Emission

<i>Project Scale</i>	
Small	✓
Large	

Year	Estimated GHG emission reductions or removals (tCO <sub>2</sub> e)
2021	7765
2022	7765
2023	7765
2024	7765
2025	7765
2026	7765
2027	7765
Total estimated ERs	36,850.8
Total number of crediting years	07
Average annual ERs	54355

### 1.13. Description of the Project Activity

This project has introduced new proven environmentally safe technology imported from England. Therefore, this project will help transfer the technology from eastern countries to the country.

This project has been using an environmentally safe and sound technology while contributing the improvement of the environment through reducing the emissions from thermal power plants such as SO<sub>x</sub> and NO<sub>x</sub> pollution in addition to the reduction of CO<sub>2</sub> emission.

Most of the equipment such as turbine, alternator, electrical switchgear etc. has been imported from Germany. All civil works were carried out using locally available materials.

### 1.14. Conditions Prior to Project Initiation

In the pre-project scenario, there were no any hydropower plant belonging to project participant in that region and this plant is "Greenfield" plant. Therefore, electricity producing by new power plant should have to be produced using fossil fuel consumed power plants since further exploitation of large-scale hydro resources are difficult due to social, economic and environmental impacts associated with the development.

The baseline in the absence of the construction of the new hydropower plants is electricity from grid.

The main purpose of investing for this project activity by Eagle Power (Pvt) Ltd to offset the GHG emission within the Anunine Group of Companies. Korean SPA Packaging (Pvt) Ltd, Atire (Pvt) Ltd Korean SPA Accessories (Pvt) Ltd and Ethimale Plantation (Pvt) Ltd is subsidiary under the group of Anunine Holdings willing to offset their carbon emissions from Sri Lankan Certified Emission Reduction units (SCERs) received from Eagle Power (Pvt) Ltd hydropower project.

#### 1.15. Compliance with Laws, Statutes and Other Regulatory Frameworks

In terms of regulations in Sri Lanka, small scale hydropower projects require approval from the Central Environment Authority (CEA) which looks at both environment and social aspects. In order to get the approval developer should prepare an Environmental Impact Assessment (EIA) report and submit to the CEA. This EIA report corresponds to a TOR provided by the CEA and CEA visits the site with a team of experts and grants approval for the project if they are satisfied, after obtaining all necessary clarifications.

The project developer has already obtained Environmental Clearance from the CEA. The preliminary findings of the EIA reflect that the adverse environment impacts of this project are negligible. No significant mitigatory measures are required for this project.

#### 1.16. Participation under Other GHG Programs

The project has not been registered, or is seeking registration under any other GHG programs.

#### 1.17. Other forms of Credit

The project has not sought or received another form of GHG-related environmental credit, including renewable energy certificates.

#### 1.18. Sustainable Development

This renewable electricity generation facility is able to reduce the contribution from thermal electricity generation to meet the electricity demand. Unlike in thermal power plants, this project will positively contribute to the electricity demand without compromising the ability of future generations to meet their own needs. Therefore, this renewable energy project is a positive step toward sustainable development. The national sustainable development criteria are,

##### 1) Environmental well-being

- 2) Economic well-being
- 3) Social well-being
- 4) Technological well-being

### **Environmental well-being**

The project contributes to an improvement of the local environment through reducing emissions such as SO<sub>x</sub> and NO<sub>x</sub> from thermal power plants which have to be operated to generate an equal amount of power using thermal sources if this project is not implemented.

### **Economic well-being**

Discontinuing the use of fossil fuel saves foreign exchange since the entire quantity of fossil fuel requirement is imported to the country.

### **Social well-being**

Good amount of employment opportunities had been created for the local workforce during the project construction phase. The project after implementation provides employment opportunities for the local populace in a sustained manner over the project life time. The enhanced employment opportunities created by this project activity will lead to alleviation of poverty, and eradicate unemployment.

### **Technological well-being**

This power plant has been erected as a fully automated power plant. The project activity has used of the reliable and proven technology available locally to ensure that an environmentally safe technology is only being implemented in this project activity.

## **1.19. Leakage Management**

There is no any fossil fuel consumed operation at the plant during project activity and no any equipment or material transferring from outside for this project.

## **1.20. Commercially Sensitive Information**

No commercially sensitive information has been included in this project scope.

## 2. Environment Impacts

### 2.1. Analysis of environmental impacts

In terms of regulations in Sri Lanka, small hydropower projects require approval from the Central Environmental Authority (CEA) which looks at both environmental and social aspects. Developers should prepare an Environmental Assessment Report and submit to the CEA for approval. CEA grants approval for the project if they are satisfied, after obtaining all necessary clarifications.

Then this project has received the Environmental Clearance from the CEA.

Hydropower plant	Capacity rating (MW)	Date of environment approval received from CEA
Maduru Oya drop at 24+140	2	31 <sup>st</sup> December 2007

These clearances by CEA reflect the finding that the environment impacts of this projects is negligible.

The general and specific conditions of approvals of the EAs are in most instances generic, i.e., guidance on minimizing impacts of site preparation. Also, all projects require an environmental monitoring plan that covers surface water (not relevant in practice for run-of-river projects), flora and fauna within the river and below the diversion point, river bank erosion, and sediments upstream of the weir.

The noteworthy specific condition to the project site is summarized below.

- No damage to the rock boulder deposits in the upstream area from the weir
- Maintain the downstream in proper condition, a continuous uninterrupted flow of 30 litres/sec shall be maintained
- Adhere to the approved trace of the transmission line route identified by the CEB
- Solid waste associated with the work force shall be disposed of in consultation with the local authority
- Shall adapt appropriate conservation methods to stabilize any disturbed slopes
- Sediments collected at the weir site and accumulated in the setting basin should be disposed in controlled manner
- Soil conservation techniques should be adapted in controlled manner
- Should be incorporated in the design at the mouth of intake to prevent entry of fish into conveyances system and build overpass of the open head race canal to facilitate movement of small terrestrial animals

## 2.2. Environmental impact assessment

The environmental impacts of this project are not considered significant.

# 3. Local Stakeholder Consultation

## 3.1. Stakeholder Consultation Process

There should be some public involvement to ensure that critical issues are identified and that local information about the project area is gathered and that alternative ways of achieving the project objectives are considered. Public involvement could be used to avoid biases inaccuracies in analysis to identify local values and preferences to assist in the consideration of mitigation measures and to select the best practicable alternative.

Eagle Power (Pvt) Ltd had expressed their plan to develop the proposed 2 MW grid connected project and called for the suggestions/comments of the local stakeholders. In line with the public notice, a meeting was held on 7<sup>th</sup> November 2008. Stakeholder consultation for the project activity has been conducted to account for the views of the people impacted either directly or indirectly due to the project activity as well as impact to the environment. This has been carried out at all levels of stakeholders

The stakeholder consultation process of Maduru Oya LB Main Canal Drop at 24+140 Hydropower project started with the identification of most relevant stakeholders to the project. It was found that the several types of stakeholders with different social status were interested in the project.

## 3.2. Summary of Comments Received

Director and consultant of Eagle Power (Pvt) Ltd. made a detailed description of the project activity. A series of questions were raised by the participants and majority of them were focused on the possible environmental impacts. In response to them, consultant of project activity described the actions planned to be taken to prevent possible negative environmental impacts. Further the participants were presented with the credentials of stipulated environmental clearance obtained from the relevant authorities. Then villagers were more curious in knowing the advantages and benefits of the project. The participant were convinced that job creation and infrastructure development would be a key outcome of this project. With that insight, participants did not raise any objection against the development and implementation of the project.

## 3.3. Consideration of Comments Received

Not Applicable

## 4. Eligibility Criteria

### 4.1. General Criteria

Sub Section	Eligibility Criteria	Project Activity	Yes/No
4.1.1	The project activity shall be a new project, which will reduce/absorb GHG emissions or the project activity shall be a project, which was implemented on or after 2010 in order to offset GHG emission within the organization.	The project was implemented after 2010 and SCERs are used to offset in-house GHG emission.	Yes
4.1.2	The project activity shall be located in Sri Lanka.	The project is located in Sri Lanka	Yes
4.1.3	The project activity shall not happen in the absence of benefits received from trading Sri Lanka Certified Emission Reduction units (SCERs). (This is not applicable Track II)	SCERs are used for in-house offset	Not applicable
4.1.4	The project shall be implemented voluntarily by the project owner but not implemented based on legislation or regulations in the country	This was a voluntarily implemented project activities and no any legislation from the country to implement this project activities	Yes
4.1.5	The project activity satisfies environmental standard and regulations of the country	This project was implemented as per the environment regulations in Sri Lanka.	Yes
4.1.6	The project shall not have been registered under any other national or international scheme. However, if a registered project under other scheme is willing to register with SLCCS, then, such project shall be deregistered	This projects has not been registered under any other national or International Schemes.	Yes

from the other scheme in order to be eligible

#### 4.2. Bundling Criteria

This project is not identified as a bundle project. Hence, this section is not applicable.

### 5. Application of Methodology

#### 5.1. Title and Reference of Methodology

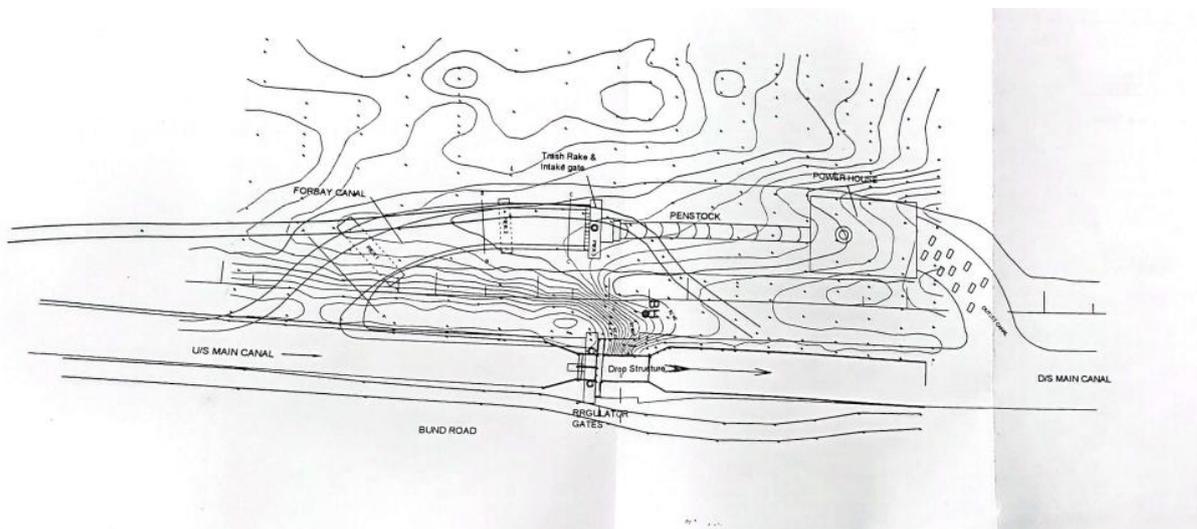
AMS-1.D "Grid connected renewable electricity generation" Version 18.0

#### 5.2. Applicability of Methodology

The project that is introduced in this report is a new hydro power project that is applicable under "clause 4 (a) Install a Greenfield plant" of the AMS I.D./Version 18/EB 81.

#### 5.3. Project Boundary

The project boundary of Maduru Oya Left Bank Main Canal Drop At 24+140 hydropower plant encompasses the physical, geographical site of the power plant and associated physical structure. The project boundary which includes, penstock, turbine and generator, control panel, transformer and national electricity grid of power plant pictorially presented below.



**Figure 3:** Contour Plan & the general arrangement

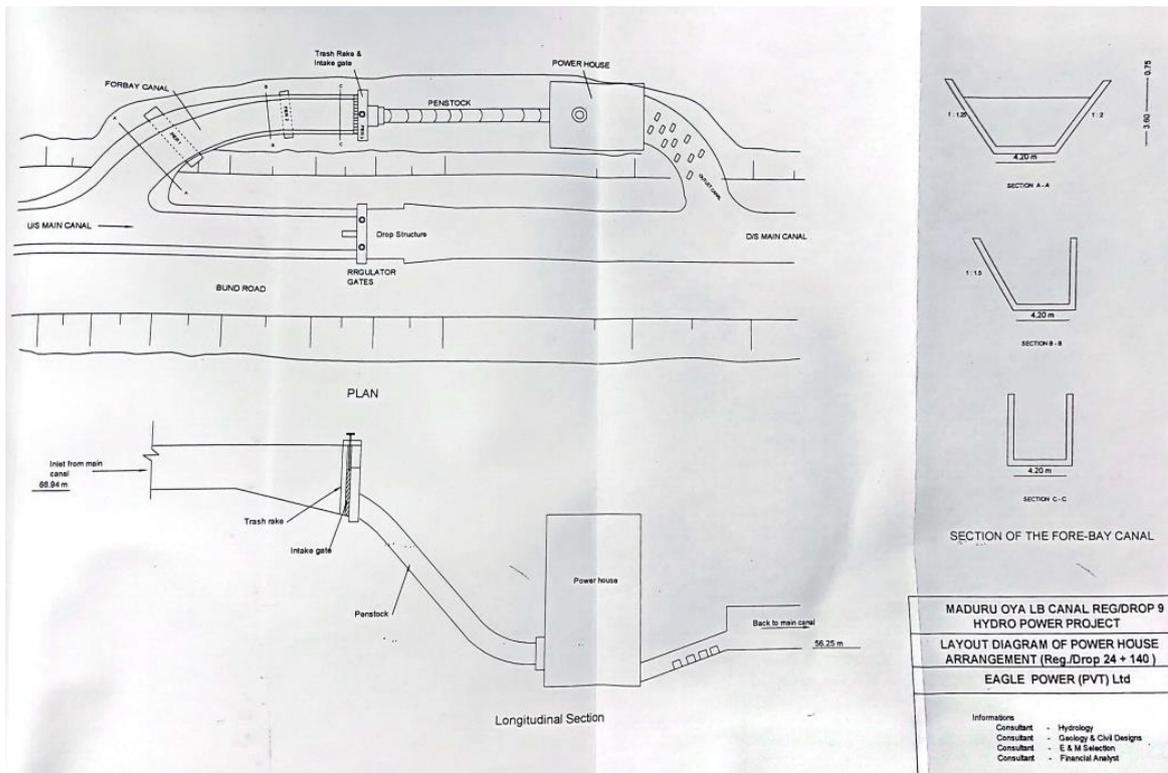


Figure 4 : layout diagram of power house arrangement

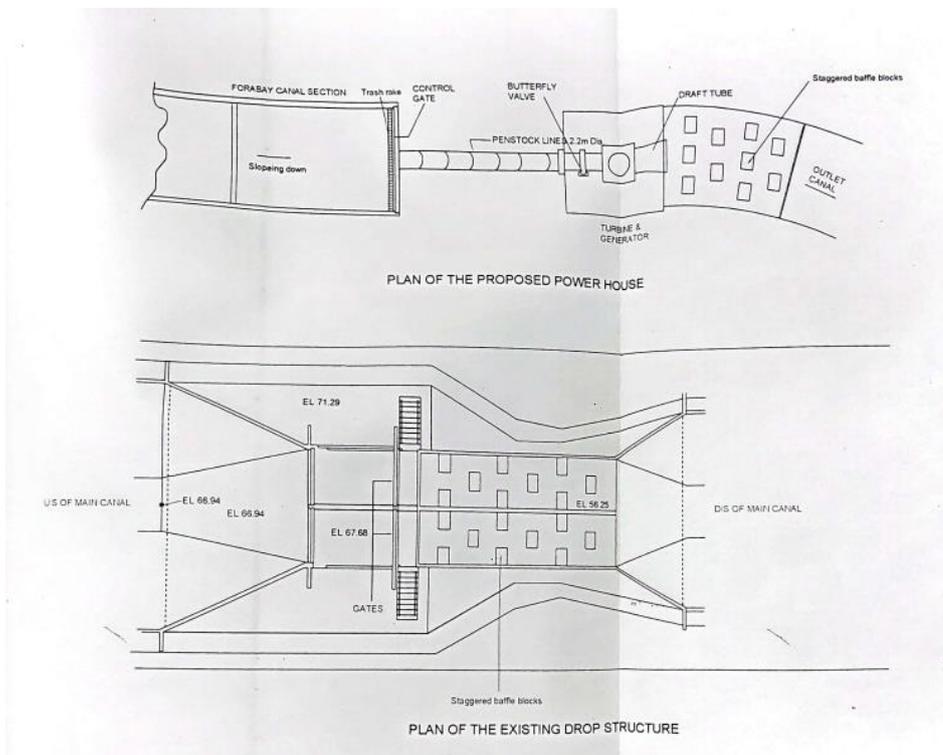


Figure 5 : Plan of the existing drop structure

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from fossil fuel fired power plants connected to National Grid of Sri Lanka	CO <sub>2</sub>	Yes	Main emission source
		CH <sub>4</sub>	No	Minor emission source
		N <sub>2</sub> O	No	Minor emission source
		Other	No	Minor emission source
Project	Hydropower generation activity	CO <sub>2</sub>	No	Minor emission source
		CH <sub>4</sub>	No	Minor emission source
		N <sub>2</sub> O	No	Minor emission source
		Other	No	Minor emission source

#### 5.4. Baseline Scenario

Prior to this project activity there was no hydropower plant at that location hence this is a greenfield plant. Absence of this project, the amount of electricity generated by the project should be produced using fossil fuel fired power plants connected to national grid. So the baseline is electricity produced by power plant connected to national grid.

#### 5.5. Additionality

The project is intended to be registered under track II. Therefore, additionality is not necessary to be demonstrated.

#### 5.6. Methodology Deviations

Not Applicable

## 6. Quantification of GHG Emission Reductions and Removals

### 6.1. Baseline Emissions

The baseline emissions are the product of electrical energy baseline  $EG_{Bl,y}$  expressed in MWh of electricity produced by the renewable generating unit multiplied by the grid emission factor.

$$BE_y = EG_y * EF_y$$

Equation (1)

Where,

$BE_y$  = Baseline Emissions in year y (tCO<sub>2</sub>)

$EG_y$  = Quantity of net electricity supplied to the grid as a result of the implementation of the CDM project activity in year y (MWh)

$EF_y$  = CO<sub>2</sub> Emission factor of the grid in year y (tCO<sub>2</sub>/ MWh)

### Calculation of baseline emission factor

As per paragraph 22 of AMS I.D. Ver18.0, for project activities that do not displace captive electricity generated by an existing plant but displace grid electricity import and/or supply electricity to a grid, the emission factor of the grid shall be calculated as per the procedures detailed in AMS-I.D.

As per AMS I.D, the grid emission factor was calculated using the latest approved version of “Tool to calculate the emission factor for an electricity system” CDM methodology. The grid emission factor<sup>1</sup> calculated and published by the Sustainable Energy Authority in Sri Lanka is used.

## 6.2. Project Emissions

Project emissions to be considered as per paragraph 39 & 40 of AMS I.D. Ver18.0 and discussion of their relevance for the project are presented in below.

There is one standby generator or other equipments use for the project activity. But it is only use emergency cases.

As a result, the project does involve a standby generator which project emissions as per AMS I.D. Ver18.0. Project emission is 0.54 tonnes of CO<sub>2</sub>e, and following mention the relevant formula need to be considered.

$$\text{Emission} = \text{Consumption of diesel (in liters)} * \text{Emission Factor} * \text{GWP}$$

<b>EMISSION CALCULATION</b>		
Fuel (Diesel Consumption)	200.00	L/Year
	0.2	m <sup>3</sup> /Year
Density	840	kg/m <sup>3</sup>
Fuel (Mass)	0.00017	Gg

<sup>1</sup><http://www.info.energy.gov.lk/>

Net Calorific Value	43	TJ/Gg
Energy	0.007224	TJ
CO <sub>2</sub> Emission	0.535	t CO <sub>2</sub> -e/Year
CH <sub>4</sub> Emission	0.0006	
N <sub>2</sub> O Emission	0.0012	
<b>Total Emission (tons of CO<sub>2</sub> equivalent)</b>	<b>0.54</b>	<b>tCO<sub>2</sub>-e/Year</b>
<b>Rounded to the nearest highest value</b>	<b>1</b>	<b>tCO<sub>2</sub>-e/Year</b>

$$PE_y = 1$$

Overview of project emissions as per paragraph 39 & 40 of AMS I.D. Ver18.0 and their relevance for the project

Para 39 & 40 of AMS I.D. Ver18.0: Project emissions include:	Relevance for project activity
<p>For most renewable energy project activities, <math>PE_y=0</math>. However, for the following categories of project activities, project emissions have to be considered following the procedure described in the most recent version of ACM0002.</p> <ul style="list-style-type: none"> <li>○ Emissions related to the operation of geothermal power plants (e.g. non condensable gases, electricity/fossil fuel consumption);</li> <li>○ Emissions from water reservoirs of hydropower plants.</li> </ul>	<p>Project activity is hydropower plant with Maduru Oya LB Main Canal Drop At 24+140</p>
<p>CO<sub>2</sub> emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of the tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion.</p>	<p>No No onsite fossil fuel consumption due to project activity</p>

### 6.3. Leakage

As per the paragraph 40 of selected methodology CO<sub>2</sub> emissions from on-site consumption of fossil fuels due to the project activity shall be calculated using the latest version of the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion”.

No fossil fuels consumption for the project activity.  
Hence,

$$LE_y = 0$$

#### 6.4. Net GHG Emission Reductions and Removals

Emissions reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Since  $LE_y = 0$ ;  $PE_y = 0$ ;

$$ER_y = BE_y - PE_y$$

Summary of emission reduction calculation

Parameter	Value	Units	Source
Plant Factor	59	%	Professional judgement
Plant Capacity	2	MW	Proposed capacity
Average Energy Output	10336.8	MWh/year	Calculated
Emission Factor	0.7512	tCO <sub>2</sub> e/MWh	Energy Balance-2020, SLSEA
Emission Reduction	7765	tCO <sub>2</sub> e/year	Calculated

Year	Estimated baseline emissions or removals (tCO <sub>2</sub> e)	Estimated project emissions or removals (tCO <sub>2</sub> e)	Estimated leakage emissions (tCO <sub>2</sub> e)	Estimated net GHG emission reductions or removals (tCO <sub>2</sub> e)
2021	7765	1	0	7764
2022	7765	1	0	7764
2023	7765	1	0	7764
2024	7765	1	0	7764
2025	7765	1	0	7764
2026	7765	1	0	7764
2027	7765	1	0	7764
<b>Total</b>	<b>54355</b>	<b>7</b>	<b>0</b>	<b>54,348</b>
<b>Total number of crediting years</b>	7 years			
<b>Annual over the crediting period</b>	<b>7765</b>	<b>1</b>	<b>0</b>	<b>7764</b>

## 7. Monitoring

### 7.1. Data and Parameters Available at Validation

The responsibilities of various personnel in the organization in keeping records as follow,

Small hydropower operators monitor plant operation including energy generated and exported to the CEB grid by taking at least daily readings of generation levels and recording them on site. The monthly invoice sent to CEB by the small hydropower developers are cross checked by the CEB with the meter reading taken by the CEB staff and payment made accordingly. These data are also archived at Eagle Power (Pvt) Ltd. office in Panadura as well as the power station sites. The verifier will also be welcome to visit the power station sites and the office in Panadura to confirm the status of operations.

No leakage effects are applicable to the plant's operation as the equipment at the plant has not been moved from any other operational location

Data / Parameter	$EF_{CM,Grid,y}$
Data unit	tCO <sub>2</sub> e/MWh
Description	Combined margin CO <sub>2</sub> emission factor for grid connected power generation in year y
Source of data	Energy balance 2020 - Sri Lanka Sustainable Energy Authority
Value applied	0.7512 tCO <sub>2</sub> e/MWh
Justification of choice of data or description of measurement methods and procedures applied	Methodological tool published by UNFCCC to calculate the emission factor for an electricity system
Purpose of Data	Calculate the emission reduction
Comments	-

### 7.2. Data and Parameters Monitored

Data / Parameter	$EG_{import,y}$
Data unit	MWh/year

Description	Quantity of net electricity import form the grid for the plant start-up and during shutdown as a result of the implementation of the proposed project activity in the year y
Source of data	This parameter will be continuously monitored and recorded.  Monthly electricity import voucher issued by CEB can use to recheck.
Description of measurement methods and procedures to be applied	This parameter will be continuously monitored by project participants using an electronic meter supplied by CEB
Frequency of monitoring/recording	Daily and monthly
Value applied	
Monitoring equipment	Energy meter Accuracy class of the meter- class 01  The metering equipment is tested annually by the CEB and 2018 is the year of last calibration. Meter has 25 years validity period from the date of commissioning.
QA/QC procedures to be applied	The meter will be properly calibrated and maintained in order to ensure accuracy.  Testing/Calibration interval : Annually by CEB  Cross checking of the data with the cheque received from CEB for import electricity to the grid
Purpose of data	Calculate baseline emission
Calculation method	N/A
Comments	The recorded data will be checked periodically by the Manager of VS hydropower

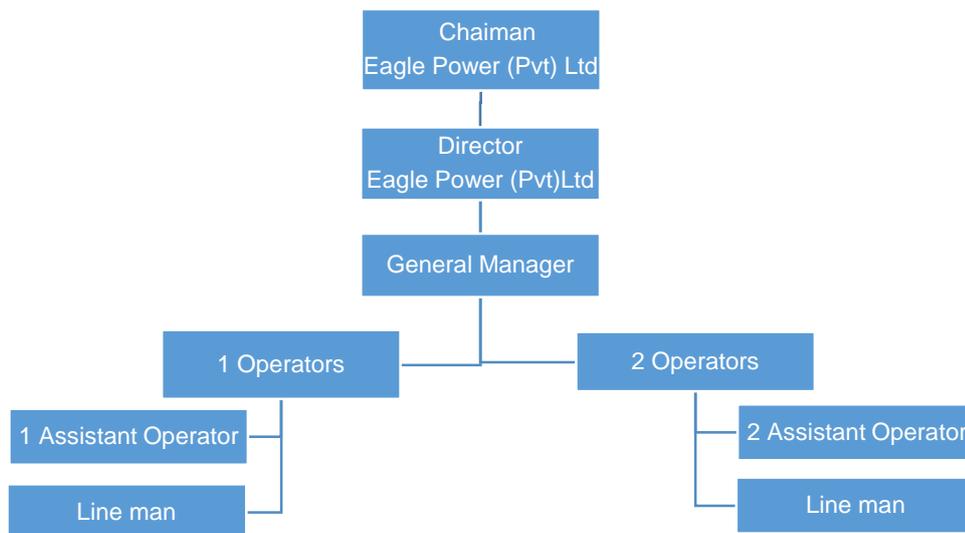
### 7.3. Monitoring Plan

The authority and responsibility for registration and overall monitoring would rest with the Director of the Eagle Waverly Power (Pvt) Ltd. Power plant operational staff team is headed by a Director from VS hydropower, works as consultant for the project, would continue their services, in the capacity of operational and maintenance supervisors after commissioning of the plant. VS hydropower consists an experienced team in various disciplines and would undertake periodic inspections to ensure the quality of the data collected by the team and initiate steps in case of any abnormal conditions.

The Plant Manager is assisted by operators and labourers. Power house operating staff shall operate the plant safely and shall keep records of plant operations. The

responsibility of review, storage and archiving of information in good condition would lie with the Plant Manager. Also it is the responsibility of the Plant Manager to make sure that routine maintenance of plant equipments are carried out in line with the instructions given in operations and maintenance manuals provided by the suppliers of respective equipments and recorded in given formats. Plant assistant operating staff is assisted by senior operators whose primary responsibility is to attend to day-to-day works.

### Organization Structure



### Parameters Requiring Monitoring

The monitoring of all parameters indicated in section 6.2 of the CMA would be monitored under this plan. Necessary documents required for verification of the data would be maintained for later archiving. Using the power exported to the grid, emission reductions would be calculated as illustrated in Section 5.4. Export & Import readings of main meter shall be taken on monthly basis at appointed day & hour (time) by authorized officer and would be reported to the Director.

### Training of monitoring person

The project would employ qualified and experienced persons for plant operations. The project would maintain standard log sheets and formats to record the monitoring parameters. The plant staff would be given proper training to maintain the plant records. The Plant operator would be the designated person to verify, compile and archive all the monitored data. The parameters to be monitored during the crediting period would be provided in a tabular format to the designated person. The Plant operators would be provided with necessary training with respect to maintenance of the relevant monitoring records to enable him/her to deal the monitoring independently. The training would be provided to the monitoring personnel for monitoring of the following parameters:

- Electricity Export
- Electricity Import
- Gross electricity generated
- Parameter of the plant, such as bearing temperature, electrical properties, etc
- Fault/Breakdown recording

### **Procedures for documentation and storage**

Recorded data in monitoring sheets carried out by operators need to be checked by the Plant manager to identify any abnormalities. If any abnormality is noticed, Plant In Charge as well as operators need to take appropriate actions to rectify it. All the abnormalities need to be recorded in the log book maintained at the power house. In addition, regular maintenance work needs to be recorded in the given log books for each section. The day-to-day records are verified by Plant manager and internal monthly report would be prepared for review by the Director. Internal reports are the basic documents for the monitoring and storage of plant operational data. CEB will prepare monthly bills at the end of each month, based on export and import meter reading. CEB has the facility to monitor the readings through online metering system.

### **Procedures for Corrective actions**

The parameters to be monitored during a crediting period would be compiled as internal report for every month of each crediting year and submitted to the Designated Director for review. The parameters include the Gross generation, Auxiliary consumption, Energy export and Import. The Designated Director would discuss and recommend necessary mechanism to improve the operational efficiency of the plant and directs the respective person to rectify the problem with the consultation from operator team.

### **QA & QC Procedures**

The projects would employ such equipment or instruments that would measure, record, report, monitor and control of various key parameters of the plant. These monitoring and controls would be the part of the Control Systems of hydroelectric plant. For measuring the energy exported / imported main meter and a check meter as required would be in service. The check meter reading will be used to measure electricity export/import in case of failure of the main meter. The CEB officials will replace the main meter immediately on PP request. The meter would be calibrated and sealed at least once a year as per the CEB standard. Records of these test certificates would be maintained for verification. Hence, high quality is ensured with the above parameters. Delivery records would be used and kept for checking the consistency of the recorded data.

### **Data Storage & Archiving**

Export & Import readings from main meter will be collected under the supervision of the Plant Manager. Export and Import data would be recorded and stored in logs as well as in electronic form. The records are checked periodically by the Plant Manager. The period of storage of the monitored data will be 2 years after the end of crediting period or till the last issuance of CERs for the project activity whichever occurs later. The baseline emission factor would be adopted from the CEB published generation data for the latest available year for the CEB grid and the same would be used for the future projection and would be reviewed each year based on data published by the CEB. The monitored data would be presented to an independent verification agency or DOE to whom verification of emission reductions is assigned.

### **Maintenance of Equipment**

All the equipments used in the project activity will undergo scheduled maintenance as specified in the operational manual of the equipment supplier. If meters are found to be defective, it would be tested and calibrated immediately. The defective meters will be replaced immediately by a new meter. The plant Manager is responsible to oversee the maintenance activity on periodic basis.

## **8. Appendix**



## Document Information

<b>Title of document</b>	<b>Carbon Management Assessment</b>
Document No	SLCCS-CMA-FRM
Document Type	Form
Business Function	Registration of Project Activity
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## Revisions

<b>Version</b>	<b>Date</b>	<b>Description</b>
01.0	21-08-2019	Initial issuance
02.0	02-02-2021	Editorial changes