



INVESTMENT GRADE ENERGY AUDIT REPORT

Nagar Nigam Mathura- Vrindavan, Uttar Pradesh

Submitted by

Energy Efficiency Services Limited

Submitted To

Nagar Nigam Mathura- Vrindavan

September, 2017

ACKNOWLEDGMENT

We are sincerely thankful to the Ministry of Urban Development, Government of India for including energy audits to achieve energy efficiency under the reforms of Atal Mission for Rejuvenation and Urban Transformation (AMRUT). We are also extremely thankful to the “Department of Urban Development (DUD) Uttar Pradesh” for taking up the reform on priority basis with Energy Efficiency Services Limited (EESL) and signing the agreement on 09th Feb 2017 for preparation of Investment Grade Energy Audit (IGEA) reports for its AMRUT Mission and Smart Mission for Cities & Towns. We acknowledge the support and guidance provided by the following Central and State Government officials:

- Shri Durga Shankar Mishra, Secretary (Urban Development, AMRUT), Ministry of Urban Development, Govt. of India
- Shri. Shiv Das Meena, Joint Secretary (AMRUT) Ministry of Urban Development, Govt. of India
- Shri G. Ravinder, Deputy Secretary, Ministry of Urban Development, Govt. of India
- Shri R K Mishra, Director of Urban Local Bodies, Department of Urban Development (DUD), Govt. of Uttar Pradesh, Lucknow
- Vishal Bhardwaj, Additional Director. Directorate of Urban Local Bodies, Govt. of Uttar Pradesh

We would also like to thank the officials of the “Nagar Nigam Mathura- Vrindavan” for their support during the field studies and preparation of the Investment Grade Energy Audit (IGEA) Report. We acknowledge the support and guidance provided by the following officials of Nagar Nigam Mathura- Vrindavan during the survey and detailed energy audit.

- Shri Ashish Kumar Yadav, JE, Water Works Department, Mathura
- Shri Kuwarpal Singh, JE, Water Works Department, Mathura
- Shri Chhatrapal Singh, JE, Water Works Department, Mathura

We are also thankful to the officers, engineers, operators, technicians and other personnel for their continuous support and guidance in undertaking this exhaustive task of detailed energy audit. The field study would not have been completed on time without their interaction and timely support. We are grateful for their co-operation during the entire process.

We would also like to thank the officials of “URS Verification Pvt Ltd” for carrying out the energy audit and preparation of the IGEA report. We acknowledge the efforts put in by the following officials of URS during the energy audit.

- Shri Rakesh Sharma, Energy Auditor (EA-10080)
- Shri Pushpendra Yadav, Team Member
- Shri Mukesh Kumar Bharti, Team Member

On Behalf of Energy Efficiency Services Limited

Mr. Tarun Tayal, Regional Manager, EESL – Uttar Pradesh



Executive Summary

Background of the Project

The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched by Prime Minister of India in June 2015 with the objective of providing basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities which will improve the quality of life for all.

To facilitate market transformation and replicate Municipal Energy Efficiency Programme on a large scale in India, Ministry of Urban Development (MoUD), Government of India signed a Memorandum of Understanding (MoU) with Energy Efficiency Services Limited (EESL), a joint venture under Ministry of Power, Government of India on 28th September 2016 under AMRUT. This will enable replacement of inefficient pump sets in Public Water Works & Sewerage Systems (PWW&SS) with energy efficient pump sets with no upfront cost to the Municipal Bodies. The investment will be recovered in form of fixed annuity.

Energy audit and optimizing energy consumption are mandatory reforms under AMRUT. EESL and Department of Urban Development (DUD), Government of Uttar Pradesh have jointly entered into an agreement on 9th February, 2017 in order to provide an overarching framework to facilitate engagement between State Government and various ULBs (covered under AMRUT) of Uttar Pradesh. Under this agreement, EESL is undertaking the project to replace old inefficient pump sets by energy efficient pump sets in Mathura, city of Uttar Pradesh.

Description of Facilities

Mathura is a city in the North Indian state of Uttar Pradesh. It is located approximately 50 kilometres north of Agra, and 145 kilometres south-east of Delhi; about 11 kilometres from the town of Vrindavan, and 22 kilometres from Govardhan. It is the administrative centre of Mathura District of Uttar Pradesh. The 2011 census of India estimated the population of Mathura to be 441,894.

Main source of water for the city of Mathura is ground water. There are 141¹ Nos. of pumps installed to cater the water needs of Mathura City. These 141 nos. of submersible pumps are used to supply water directly to the users. Out of 141 Nos. of water supply pumps, 121 Nos. were in operation during energy audit and 20 Nos. of pumps were under maintenance. Apart from water distribution pump sets, 35 Nos. of pump sets are also installed in the sewage water pumping system to transfer the sewage water to the sewage treatment plant. Out of 35 Nos. of pump, 21 Nos. of pumps were in operation during energy audit and 14 Nos. of Pump sets were under maintenance.

¹ As per LOA, there were 143 pumps (water), however in LOA list, there was repetition of two pump sets. Therefore, total pump at Mathura, in IGEA, is considered as 141.

Description of facility and water storage capacity

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of/ Reservoir/Clarifier	No. of OHT
1	Bhuteshwar Campus TW No.2	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
2	Bhuteshwar Campus TW No.5	Ground Water	1	0.06	Direct User	No Reservoirs	No OHTs
3	Bhuteshwar Campus TW No.7	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
4	Nagar Palika TW No.15	Ground Water	1	0.34	Direct User	No Reservoirs	No OHTs
5	Bangali Ghat TW No.16	Ground Water	1	0.32	Direct User	No Reservoirs	No OHTs
6	Police Line TW No.25	Ground Water	1	0.71	Direct User	No Reservoirs	No OHTs
7	Bhuteshwar Campus TW No.27	Ground Water	1	0.08	Direct User	No Reservoirs	No OHTs
8	District Jail TW No.29	Ground Water	1	0.46	Direct User	No Reservoirs	No OHTs
9	Govind Nagar Sec. A	Ground Water	1	0.36	Direct User	No Reservoirs	No OHTs
10	Kushak Gali-1	Ground Water	1	0.32	Direct User	No Reservoirs	No OHTs
11	Shyam Ghat	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
12	Vishram Ghat	Ground Water	1	0.41	Direct User	No Reservoirs	No OHTs
13	Chatta Bazar	Ground Water	1	0.58	Direct User	No Reservoirs	No OHTs
14	Rampal Gali	Ground Water	1	0.28	Direct User	No Reservoirs	No OHTs
15	Vrindavan Gate	Ground Water	1	0.42	Direct User	No Reservoirs	No OHTs
16	Theknarnol	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
17	Dwarkeshpuri	Ground Water	1	0.06	Direct User	No Reservoirs	No OHTs
18	Unth Gali	Ground Water	1	0.17	Direct User	No Reservoirs	No OHTs
19	Naya Nagla Gali No.8	Ground Water	1	0.08	Direct User	No Reservoirs	No OHTs
20	Chah Kathoti	Ground Water	1	0.17	Direct User	No Reservoirs	No OHTs
21	Agra Hotel	Ground Water	1	0.56	Direct User	No Reservoirs	No OHTs
22	Dhruv Ghat	Ground Water	1	0.56	Direct User	No Reservoirs	No OHTs
23	Maholi Ki Paur	Ground Water	1	0.31	Direct User	No Reservoirs	No OHTs
24	Gaja Paysa	Ground	1	0.25	Direct	No	No

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Cl arifier	No. of OHT
		Water			User	Reservoirs	OHTs
25	Radhika Vihar	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
26	Dholi Pyau	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
27	Thateran Gali	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
28	Tulsi Chabutra	Ground Water	1	0.23	Direct User	No Reservoirs	No OHTs
29	Bairag puri	Ground Water	1	0.11	Direct User	No Reservoirs	No OHTs
30	Bhargva Gali	Ground Water	1	0.71	Direct User	No Reservoirs	No OHTs
31	Gandhi Park Pump-1	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
32	Megha Gali	Ground Water	1	0.03	Direct User	No Reservoirs	No OHTs
33	Bhadurpura	Ground Water	1	0.12	Direct User	No Reservoirs	No OHTs
34	Chaganpura	Ground Water	1	0.10	Direct User	No Reservoirs	No OHTs
35	Krishna Vihar NH-2	Ground Water	1	0.09	Direct User	No Reservoirs	No OHTs
36	Askunda	Ground Water	1	0.49	Direct User	No Reservoirs	No OHTs
37	Mahavidya Face-2	Ground Water	1	0.28	Direct User	No Reservoirs	No OHTs
38	Dalpat Khidki	Ground Water	1	0.16	Direct User	No Reservoirs	No OHTs
39	Gopalpura	Ground Water	1	0.13	Direct User	No Reservoirs	No OHTs
40	Shanti Nagar	Ground Water	1	0.36	Direct User	No Reservoirs	No OHTs
41	Laxmi Nagar-1	Ground Water	1	0.53	Direct User	No Reservoirs	No OHTs
42	Laxmi Nagar-2	Ground Water	1	0.32	Direct User	No Reservoirs	No OHTs
43	Laxmi Nagar-4	Ground Water	1	0.31	Direct User	No Reservoirs	No OHTs
44	Naya Nagla, Koyla Gali	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
45	Maholi Yojna-1	Ground Water	1	0.22	Direct User	No Reservoirs	No OHTs
46	Maholi Yojna-3	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
47	Sheetla Ghati	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
48	Manas Nagar	Ground Water	1	0.26	Direct User	No Reservoirs	No OHTs

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Cl arifier	No. of OHT
49	Ratan Kund	Ground Water	1	0.17	Direct User	No Reservoirs	No OHTs
50	Gau Ghat	Ground Water	1	0.26	Direct User	No Reservoirs	No OHTs
51	Arjunpura	Ground Water	1	0.06	Direct User	No Reservoirs	No OHTs
52	Officer Colony	Ground Water	1	0.23	Direct User	No Reservoirs	No OHTs
53	Badpura Colony	Ground Water	1	0.50	Direct User	No Reservoirs	No OHTs
54	Narayan Puri	Ground Water	1	0.58	Direct User	No Reservoirs	No OHTs
55	Jhigurpura	Ground Water	1	0.19	Direct User	No Reservoirs	No OHTs
56	Raigarpura	Ground Water	1	0.40	Direct User	No Reservoirs	No OHTs
57	Gupta Kunj	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
58	Radha Nagar	Ground Water	1	0.26	Direct User	No Reservoirs	No OHTs
59	Manoharpura	Ground Water	1	0.07	Direct User	No Reservoirs	No OHTs
60	Krishna Nagar	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
61	Heja Hospital	Ground Water	1	0.10	Direct User	No Reservoirs	No OHTs
62	Laxmi Nagar	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
63	Maholi Yojna-2	Ground Water	1	0.23	Direct User	No Reservoirs	No OHTs
64	Antapada	Ground Water	1	0.32	Direct User	No Reservoirs	No OHTs
65	Rani Mandi	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
66	Kutta Paysa	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
67	Gali Ravaliya	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
68	Gali Rajkumar	Ground Water	1	0.35	Direct User	No Reservoirs	No OHTs
69	Gandhi Park-2	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
70	Arjunpura-2	Ground Water	1	0.09	Direct User	No Reservoirs	No OHTs
71	Theknarnol-2	Ground Water	1	0.31	Direct User	No Reservoirs	No OHTs
72	Madhav Puri	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
73	Dholi Pyau Tiraha-New	Ground	1	0.40	Direct	No	No

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Cl arifier	No. of OHT
	Construction	Water			User	Reservoirs	OHTs
74	Ahilyabai Park Dampier Nagar MVDA	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
75	Ramlila Ground Krishna Nagar MVDA	Ground Water	1	0.11	Direct User	No Reservoirs	No OHTs
76	Kankali Temple Dwarikapuri MVDA	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
77	Machli Mandi Bharatpur Gate	Ground Water	1	0.37	Direct User	No Reservoirs	No OHTs
78	Nai Basti W.No.	Ground Water	1	0.22	Direct User	No Reservoirs	No OHTs
79	Andi Kuiya	Ground Water	1	0.47	Direct User	No Reservoirs	No OHTs
80	Kathoti Kua Chaupal	Ground Water	1	0.18	Direct User	No Reservoirs	No OHTs
81	Kathoti Kua Masjid	Ground Water	1	0.09	Direct User	No Reservoirs	No OHTs
82	Gupta Kunk WNo.7	Ground Water	1	0.20	Direct User	No Reservoirs	No OHTs
83	Sadar Dhobi Pada W.No8	Ground Water	1	0.55	Direct User	No Reservoirs	No OHTs
84	Gandhi Nagar W.No. 9	Ground Water	1	0.10	Direct User	No Reservoirs	No OHTs
85	Laxmi Nagar W.No. 9	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
86	Bains Bhora Kotwali W.No.14	Ground Water	1	0.22	Direct User	No Reservoirs	No OHTs
87	Radhey Shyam Ashram W.No.16	Ground Water	1	0.28	Direct User	No Reservoirs	No OHTs
88	Om Nagar W.No.17	Ground Water	1	0.26	Direct User	No Reservoirs	No OHTs
89	Om Nagar-2 W.No.17	Ground Water	1	0.31	Direct User	No Reservoirs	No OHTs
90	Antapara behind Gurudwara W.No.18	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
91	Jogi Gali Antapada W.No.18	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
92	Khateek Mohalla Balmiki Basti W.No.19	Ground Water	1	0.28	Direct User	No Reservoirs	No OHTs
93	Guru Nanak Nagar W.No.19	Ground Water	1	0.05	Direct User	No Reservoirs	No OHTs
94	Krishnapuram-1 Ward-24	Ground Water	1	0.11	Direct User	No Reservoirs	No OHTs
95	Krishnapuram-2 Ward-24	Ground Water	1	0.12	Direct User	No Reservoirs	No OHTs
96	Balmiki Basti Dholi Pyau Ward-27	Ground Water	1	0.17	Direct User	No Reservoirs	No OHTs
97	Mahavidya Park Ward-28	Ground Water	1	0.26	Direct User	No Reservoirs	No OHTs

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Cl arifier	No. of OHT
98	Hanuman Teela Ward-33	Ground Water	1	0.07	Direct User	No Reservoirs	No OHTs
99	Kashmiri Gali Ward-34	Ground Water	1	0.18	Direct User	No Reservoirs	No OHTs
100	Mission Teela Sadar Bazar Ward-35	Ground Water	1	0.41	Direct User	No Reservoirs	No OHTs
101	Matia Gate Ward-37	Ground Water	1	0.32	Direct User	No Reservoirs	No OHTs
102	Subhash Nagar Nala Ward-38	Ground Water	1	0.15	Direct User	No Reservoirs	No OHTs
103	Manshapuri Ward-39	Ground Water	1	0.12	Direct User	No Reservoirs	No OHTs
104	Rampal Gali Ward-40	Ground Water	1	0.22	Direct User	No Reservoirs	No OHTs
105	Theknarnol Ward-40	Ground Water	1	0.31	Direct User	No Reservoirs	No OHTs
106	Lala Ganj Ward-42	Ground Water	1	0.14	Direct User	No Reservoirs	No OHTs
107	Kashiram Yojna-3	Ground Water	1	0.15	Direct User	No Reservoirs	No OHTs
108	Kashiram Yojna-4	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
109	Satranghi Garden Ward-8	Ground Water	1	0.48	Direct User	No Reservoirs	No OHTs
110	Ambedkar Pratima Ward-10	Ground Water	1	0.21	Direct User	No Reservoirs	No OHTs
111	Naya Nagla Ward-11	Ground Water	1	0.27	Direct User	No Reservoirs	No OHTs
112	Ambedkar Nagar Ward-12	Ground Water	1	0.16	Direct User	No Reservoirs	No OHTs
113	Mali Mohalla Sadar Ward-13	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
114	Naya Bans Ward-15	Ground Water	1	0.08	Direct User	No Reservoirs	No OHTs
115	Machli Gate Ward-19	Ground Water	1	0.05	Direct User	No Reservoirs	No OHTs
116	Bhim Nagar S.B.I. Ward-27	Ground Water	1	0.29	Direct User	No Reservoirs	No OHTs
117	Motikunj Extension	Ground Water	1	0.33	Direct User	No Reservoirs	No OHTs
118	Rani Mandi Balmiki Basti Ward-6	Ground Water	1	0.24	Direct User	No Reservoirs	No OHTs
119	Matia Gate Joshiyan Garden	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
120	Sanjay Nagar Nala	Ground Water	1	0.30	Direct User	No Reservoirs	No OHTs
121	Balmiki Basti Ward-1	Ground Water	1	0.22	Direct User	No Reservoirs	No OHTs
122	Bhuteshwar Campus	Ground	1	Under	Direct	No	No

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Cl arifier	No. of OHT
	TW No.20	Water		Maintenance	User	Reservoirs	OHTs
123	Bhuteshwar Campus	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
124	Bhuteshwar Campus TW No.24	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
125	Bhuteshwar Campus TW No.26	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
126	Goalpada	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
127	Gujrana Gali	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
128	Halan Ganj	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
129	Chaubachcha	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
130	Radhey Shyam Ashram	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
131	State Bank TW No.19	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
132	Gopalpura-2	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
133	Kucha Sunaran Ward-38	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
134	Radha Nagar-2	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
135	Shamshan Ghat MVDA	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
136	Bhuteshwar Garden W.No.20	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
137	Patiram Gali Ward-40	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
138	Satgada Ward-45	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
139	General Ganj Ward-16	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
140	Ambakhar	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
141	Pani Ki Tanki Ward-17	Ground Water	1	Under Maintenance	Direct User	No Reservoirs	No OHTs
	Total (Water Supply Pumps)		141				

Description of Sewage Pumping Stations

S. No	Facility Name & Location	Source of water	Number of pumps	MLD Capacity	Type of Storage	Number of Reservoir/Clarifier	No. of OHT
1	Diary Farm SPS	Municipal Water	6	16.00	Sump	No Reservoirs	No OHTs
2	Masani Nala SPS	Municipal Water	5	13.59	Sump	No Reservoirs	No OHTs
3	Bangali Ghat SPS	Municipal Water	5	14.50	Sump	No Reservoirs	No OHTs
4	Cantt. Nala SPS	Municipal Water	5	NA	Sump	No Reservoirs	No OHTs
5	Vrindavan Gate SPS	Municipal Water	4	NA	Sump	No Reservoirs	No OHTs
6	Krishna Ganga SPS	Municipal Water	3	NA	Sump	No Reservoirs	No OHTs
7	Swami Ghat SPS	Municipal Water	3	NA	Sump	No Reservoirs	No OHTs
8	Chinta Haran SPS	Municipal Water	3	NA	Sump	No Reservoirs	No OHTs
9	Dhruv Ghat SPS	Municipal Water	1	NA	Sump	No Reservoirs	No OHTs
	Total		35				

Summary of Performance Evaluation of Pump sets

Based on the measurement and analysis carried out during the energy audit, the pump and pump set efficiencies for all pumping stations have been estimated. The summary of results is provided in the table below.

Pump Range and Efficiency Evaluation Matrix

S. No.	Pump Type	Pump No	Pump Capacity Range (kW)	Weighted Average Pump Efficiency (%)	Weighted Average Pump Set Efficiency (%)
Water Supply					
1	Submersible	15	3.34 kW – 6.97 kW	44.6	37.9
2	Submersible	75	7 kW – 10 kW	39.6	33.7
3	Submersible	31	10 kW – 13 kW	33.7	28.6
Sewage					
4	Non Clog Submersible	7	10 kW - 24 kW	29.1	26.2
5	Non Clog Submersible	5	36 kW – 46 kW	37.5	33.8
6	Non Clog Submersible	5	67 kW – 80.4 kW	36.0	32.4
7	VT	4	8.9 kW – 87.9 kW	16.2	14.6

Performance Indicators

Along with estimation of efficiency of pump sets, performance indicators such as specific energy consumption was also evaluated for pump of Nagar Nigam Mathura- Vrindavan. Details of performance indicators and other operating parameters are provided in the tables below:

Performance Indicators for Mathura Water Supply Pumps

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m ³ /hour)	Estimated annual operating hours (hour/annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/KL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Bhuteshwar Campus TW No.2	Working	50	8.6	24.7	2920	72124	25200	0.349	45.8%	39.0%
Bhuteshwar Campus TW No.5	Working	56	11.5	28.2	730	20593	8406	0.408	44.0%	37.4%
Bhuteshwar Campus TW No.7	Working	50	8.9	27.1	3285	88859	29094	0.327	48.9%	41.6%
Nagar Palika TW No.15	Working	44	9.6	17.2	7300	125852	70177	0.558	25.3%	21.5%
Bangali Ghat TW No.16	Working	37	7.5	16.1	7300	117749	54799	0.465	25.5%	21.7%
Police Line TW No.25	Working	42	13.1	35.4	7300	258566	95387	0.369	36.5%	31.0%
Bhuteshwar Campus TW No.27	Working	61	9.6	10.2	2920	29842	27935	0.936	20.9%	17.7%
District Jail TW No.29	Working	30	12.8	33.0	5110	168528	65459	0.388	24.7%	21.0%
Govind Nagar Sec. A	Working	52	10.1	33.1	4015	132696	40601	0.306	54.5%	46.3%
Kushak Gali-1	Working	27	11.7	22.5	5110	115077	59821	0.520	16.6%	14.1%
Shyam Ghat	Working	48	6.1	8.9	5840	51801	35819	0.691	22.2%	18.9%
Vishram Ghat	Working	39	12.1	34.3	4380	150234	53042	0.353	35.4%	30.1%
Chatta Bazar	Working	46	12.5	36.4	5840	212634	72766	0.342	43.1%	36.6%
Rampal Gali	Working	53	8.8	23.0	4380	100609	38756	0.385	44.1%	37.5%
Vrindavan Gate	Working	46	11.1	26.0	5840	151606	64882	0.428	34.4%	29.3%
Theknarnol	Working	70	12.4	21.4	5110	109405	63415	0.580	38.7%	32.9%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Dwarkeshpuri	Working	59	12.2	15.3	1460	22382	17793	0.795	23.8%	20.2%
Unth Gali	Working	62	9.5	10.4	5840	60619	55538	0.916	21.7%	18.4%
Naya Nagla Gali No.8	Working	39	8.7	11.5	2555	29255	22101	0.755	16.5%	14.1%
Chah Kathoti	Working	46	8.1	19.4	3285	63729	26565	0.417	35.4%	30.1%
Agra Hotel	Working	46	11.9	28.1	7300	204911	86675	0.423	34.8%	29.6%
Dhruv Ghat	Working	36	7.6	27.8	7300	202940	55196	0.272	42.4%	36.0%
Maholi Ki Paur	Working	58	8.9	25.7	4380	112741	38963	0.346	53.8%	45.7%
Gaja Paysa	Working	72	8.5	24.6	3650	89827	31013	0.345	66.8%	56.8%
Radhika Vihar	Working	52	9.5	24.7	2920	72066	27867	0.387	43.1%	36.6%
Dholi Pyau	Working	50	8.4	24.9	4380	108931	36846	0.338	47.4%	40.3%
Thateran Gali	Working	49	10.3	17.6	4380	77000	45070	0.585	26.8%	22.8%
Tulsi Chabutra	Working	58	6.5	23.3	3650	85191	23579	0.277	67.1%	57.1%
Bairag puri	Working	35	6.1	14.2	2920	41406	17890	0.432	26.0%	22.1%
Bhargva Gali	Working	55	11.1	39.2	6570	257544	73027	0.284	62.1%	52.8%
Gandhi Park Pump-1	Working	47	8.0	25.0	2920	72942	23456	0.322	46.8%	39.8%
Megha Gali	Working	48	3.3	6.9	1460	10118	4883	0.483	31.9%	27.1%
Bhadurpura	Working	45	11.2	15.6	2920	45406	32762	0.722	20.0%	17.0%
Chaganpura	Working	47	7.7	24.1	1460	35171	11291	0.321	46.9%	39.9%
Krishna Vihar NH-2	Working	51	8.5	11.0	2920	32178	24917	0.774	21.1%	17.9%
Askunda	Working	45	10.0	32.4	5475	177609	54695	0.308	46.8%	39.8%
Mahavidya Face-2	Working	59	12.1	17.6	5840	102609	70859	0.691	27.4%	23.3%
Dalpat Khidki	Working	53	7.1	19.8	2920	57728	20829	0.361	47.1%	40.0%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Gopalpura	Working	59	12.8	18.2	2555	46475	32593	0.701	27.0%	22.9%
Shanti Nagar	Working	57	9.3	33.1	4015	133057	37299	0.280	65.1%	55.4%
Laxmi Nagar-1	Working	23	6.9	29.4	6570	193289	45289	0.234	31.4%	26.7%
Laxmi Nagar-2	Working	42	8.9	31.8	3650	116216	32449	0.279	48.2%	41.0%
Laxmi Nagar-4	Working	26.5	7.0	39.2	2920	114552	20352	0.178	47.8%	40.6%
Naya Nagla, Koyla Gali	Working	47	7.0	20.9	3650	76395	25667	0.336	44.8%	38.1%
Maholi Yojna-1	Working	46	8.8	27.0	2920	78928	25550	0.324	45.5%	38.7%
Maholi Yojna-3	Working	49	10.0	36.9	2920	107748	29103	0.270	58.1%	49.4%
Sheetla Ghati	Working	70	6.0	14.1	5110	71847	30830	0.429	52.3%	44.4%
Manas Nagar	Working	47	6.2	23.5	4015	94393	24948	0.264	57.0%	48.4%
Ratan Kund	Working	59	5.5	11.9	5110	60809	28139	0.463	40.8%	34.7%
Gau Ghat	Working	39	7.7	23.3	4015	93389	30768	0.329	37.9%	32.2%
Arjunpura	Working	61	9.5	12.3	1825	22484	17350	0.772	25.3%	21.5%
Officer Colony	Working	23	9.1	19.1	4380	83789	40070	0.478	15.4%	13.1%
Badpura Colony	Working	39	9.0	33.3	5475	182318	49147	0.270	46.4%	39.4%
Narayan Puri	Working	46	12.0	29.0	7300	211919	87843	0.415	35.6%	30.2%
Jhigurpura	Working	49	7.9	15.8	4380	69073	34777	0.503	31.2%	26.5%
Raigarpura	Working	43	9.1	33.0	4380	144452	40004	0.277	49.7%	42.3%
Gupta Kunj	Working	49	7.6	17.9	2920	52180	22314	0.428	36.7%	31.2%
Radha Nagar	Working	46	9.0	20.1	4745	95375	42863	0.449	32.8%	27.9%
Manoharpura	Working	78	8.1	14.2	1825	25897	14752	0.570	43.9%	37.3%
Krishna Nagar	Working	52	8.6	18.0	2920	52472	25135	0.479	34.8%	29.6%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Heja Hospital	Working	61	8.3	16.8	2190	36704	18082	0.493	39.7%	33.7%
Laxmi Nagar	Working	25	9.5	19.9	4380	87031	41614	0.478	16.8%	14.2%
Maholi Yojna-2	Working	50	9.7	28.6	2920	83512	28207	0.338	47.4%	40.3%
Antapada	Working	37	9.5	26.4	4380	115763	41698	0.360	32.9%	28.0%
Rani Mandi	Working	44	11.7	17.7	2920	51626	34261	0.664	21.2%	18.1%
Kutta Paysa	Working	54	9.7	19.9	3650	72745	35466	0.488	35.5%	30.2%
Gali Ravaliya	Working	51	6.3	20.1	3650	73292	23092	0.315	51.9%	44.1%
Gali Rajkumar	Working	63	12.6	29.4	4380	128816	55130	0.428	47.2%	40.1%
Gandhi Park-2	Working	42	8.9	17.9	4380	78183	38821	0.497	27.1%	23.0%
Arjunpura-2	Working	55	8.6	15.4	2190	33770	18878	0.559	31.5%	26.8%
Theknarnol-2	Working	60	8.8	25.5	4380	111734	38427	0.344	55.9%	47.5%
Madhav Puri	Working	51	8.1	21.6	4015	86604	32366	0.374	43.7%	37.2%
Dholi Pyau Tiraha-New Construction	Working	54	11.9	20.1	7300	147022	87113	0.593	29.2%	24.8%
Ahilyabai Park Dampier Nagar MVDA	Working	43	9.9	24.7	4380	108186	43570	0.403	34.2%	29.1%
Ramlila Ground Krishna Nagar MVDA	Working	41	9.9	18.6	2190	40690	21608	0.531	24.7%	21.0%
Kankali Temple Dwarikapuri MVDA	Working	50	7.6	18.7	4015	74960	30403	0.406	39.5%	33.6%
Machli Mandi Bharatpur Gate	Working	59	8.8	30.6	4380	133809	38602	0.288	65.5%	55.7%
Nai Basti W.No.	Working	50	10.6	27.9	2920	81351	30835	0.379	42.3%	35.9%
Andi Kuiya	Working	54	10.6	31.2	5475	171039	58181	0.340	50.9%	43.2%
Kathoti Kua Chaupal	Working	50	9.4	18.5	3650	67416	34188	0.507	31.6%	26.9%
Kathoti Kua Masjid	Working	56	12.9	18.6	1825	33890	23470	0.693	25.9%	22.0%
Gupta Kunk WNo.7	Working	49	7.3	22.6	3285	74241	23976	0.323	48.6%	41.3%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Sadar Dhobi Pada W.No8	Working	25	10.3	39.2	5110	200057	52429	0.262	30.6%	26.0%
Gandhi Nagar W.No. 9	Working	45	8.2	16.7	2190	36551	18031	0.493	29.2%	24.8%
Laxmi Nagar W.No. 9	Working	50	9.6	17.2	5110	88045	48869	0.555	28.9%	24.5%
Bains Bhora Kotwali W.No.14	Working	53	9.1	27.6	2920	80650	26437	0.328	51.8%	44.0%
Radhey Shyam Ashram W.No.16	Working	42	11.9	17.5	5840	102142	69710	0.682	19.7%	16.8%
Om Nagar W.No.17	Working	45	9.2	21.6	4380	94564	40426	0.427	33.7%	28.7%
Om Nagar-2 W.No.17	Working	50	8.5	17.1	6570	112281	55714	0.496	32.3%	27.4%
Antapara behind Gurudwara W.No.18	Working	43	7.8	35.0	2190	76562	17065	0.223	61.8%	52.5%
Jogi Gali Antapada W.No.18	Working	44	8.5	23.1	2190	50545	18699	0.370	38.1%	32.4%
Khateek Mohalla Balmiki Basti W.No.19	Working	53	9.1	20.1	5110	102864	46369	0.451	37.7%	32.0%
Guru Nanak Nagar W.No.19	Working	46	8.0	9.5	2007.5	19031	16060	0.844	17.5%	14.8%
Krishnapuram-1 Ward-24	Working	39	10.7	28.4	1460	41508	15648	0.377	33.1%	28.2%
Krishnapuram-2 Ward-24	Working	43	10.2	29.3	1460	42705	14879	0.348	39.5%	33.6%
Balmiki Basti Dholi Pyau Ward-27	Working	50	9.0	13.4	4745	63346	42863	0.677	23.7%	20.1%
Mahavidya Park Ward-28	Working	54	6.5	21.8	4380	95353	28676	0.301	57.5%	48.9%
Hanuman Teela Ward-33	Working	54	7.5	17.9	1460	26090	10909	0.418	41.4%	35.2%
Kashmiri Gali Ward-34	Working	37	7.0	18.3	3650	66905	25428	0.380	31.2%	26.5%
Mission Teela Sadar Bazar Ward-35	Working	38	10.9	29.3	5110	149774	55495	0.371	32.9%	27.9%
Matia Gate Ward-37	Working	64	9.0	22.8	5110	116661	45915	0.394	52.1%	44.3%
Subhash Nagar Nala Ward-38	Working	49	11.4	18.2	2920	53173	33385	0.628	25.0%	21.3%
Manshapuri Ward-39	Working	47	9.4	15.3	2920	44588	27583	0.619	24.3%	20.7%
Rampal Gali Ward-40	Working	49	6.9	24.4	3285	80055	22557	0.282	55.7%	47.4%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Water Supply Pumps										
Theknarnol Ward-40	Working	53	7.5	21.8	5110	111551	38146	0.342	49.7%	42.2%
Lala Ganj Ward-42	Working	62	7.8	17.0	2920	49698	22763	0.458	43.4%	36.9%
Kashiram Yojna-3	Working	48	7.0	14.7	3650	53473	25550	0.478	32.2%	27.4%
Kashiram Yojna-4	Working	53	11.3	20.6	3650	75227	41245	0.548	31.0%	26.3%
Satrangi Garden Ward-8	Working	21	6.9	31.8	5475	174324	37978	0.218	30.9%	26.3%
Ambedkar Pratima Ward-10	Working	47	9.1	35.7	2190	78117	19912	0.255	59.1%	50.2%
Naya Nagla Ward-11	Working	44	7.9	22.5	4380	98419	34435	0.350	40.3%	34.2%
Ambedkar Nagar Ward-12	Working	49	8.8	32.7	1825	59732	15974	0.267	58.7%	49.9%
Mali Mohalla Sadar Ward-13	Working	50	10.8	24.2	3650	88184	39483	0.448	35.8%	30.4%
Naya Bans Ward-15	Working	62	7.9	16.5	1825	30094	14472	0.481	41.3%	35.1%
Machli Gate Ward-19	Working	50	7.6	10.7	1825	19601	13809	0.705	22.7%	19.3%
Bhim Nagar S.B.I. Ward-27	Working	50	6.6	24.4	4380	106741	28774	0.270	59.4%	50.5%
Motikunj Extension	Working	47	8.6	27.4	4380	120143	37722	0.314	48.0%	40.8%
Rani Mandi Balmiki Basti Ward-6	Working	49	9.6	24.5	3650	89316	34990	0.392	40.1%	34.1%
Matia Gate Joshayan Garden	Working	59	9.1	25.3	4380	110989	39954	0.360	52.5%	44.6%
Sanjay Nagar Nala	Working	48	8.1	25.2	4380	110245	35469	0.322	47.8%	40.6%
Balmiki Basti Ward-1	Working	52	9.4	18.2	4380	79585	41085	0.516	32.3%	27.4%
Sub Total (A)			1100.9	2745.6	476508	11,086,806	4,397,513			

Performance Indicators for Mathura Sewage Pumping station Pumps

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m ³ /hour)	Estimated annual operating hours (hour/annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Sewage Pumping Stations										
Masani Nala SPS Pump 1	Five Pumps, one pump is operating at a time on rotational basis	25	39.3	236.7	1460	345533	57310	0.166	49.1%	41.7%
Masani Nala SPS Pump 2		31	45.9	262.1	1460	382666	67018	0.175	58.4%	49.7%
Masani Nala SPS Pump 3		27	67.5	398.7	1460	582053	98588	0.169	52.6%	44.7%
Masani Nala SPS Pump 4		33	45.3	215.2	1460	314197	66165	0.211	51.7%	44.0%
Masani Nala SPS Pump 5		26	68.6	389.0	1460	567891	100111	0.176	48.7%	41.4%
Krishna Ganga SPS Pump 2	Three Pumps, 2W + 1 NW, pump operated on rotational basis	22	10.4	52.3	1825	95508	19037	0.199	48.0%	40.8%
Krishna Ganga SPS Pump 3		24	10.4	54.3	1825	99158	19037	0.192	42.0%	35.7%
Chinta Haran SPS Pump 1	Three Pumps, 2W + 1 NW, pump operated on rotational basis	25	13.0	66.4	1095	72712	14288	0.196	42.0%	35.7%
Chinta Haran SPS Pump 3		24	13.8	66.1	1095	72328	15082	0.209	38.0%	32.3%
Swami Ghat SPS Pump 1	Three Pumps, 2W + 1 NW, pump operated on rotational basis	12	12.5	122.8	3650	448342	45713	0.102	37.2%	31.6%
Swami Ghat SPS Pump 2		11	12.4	119.5	3650	436053	45285	0.104	33.4%	28.4%
Cantt. Nala SPS Pump 1	Five Pumps, 1W + 4NW	25	23.9	39.9	4380	174908	104726	0.599	13.8%	11.7%
Dairy Farm SPS Pump 1	Six Pumps, 5W + 1 NW, one pump is operating at a time on rotational basis	26	80.4	293.7	1460	428851	117373	0.274	31.3%	26.6%
Dairy Farm SPS Pump 2		18	36.4	110.3	1460	160970	53211	0.331	18.0%	15.3%
Dairy Farm SPS Pump 3		26	78.2	302.9	1460	442283	114169	0.258	32.8%	27.9%
Dairy Farm SPS Pump 4		19	36.1	111.2	1460	162333	52708	0.325	19.3%	16.4%
Dairy Farm SPS Pump 5		25	76.2	312.3	1460	455909	111252	0.244	33.8%	28.7%
Vrindavan Gate SPS Pump 1	Three Pumps, 2W + 1	5	9.1	55.1	1825	100618	16632	0.165	10.6%	8.5%

Pump Reference	Operating Pattern	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated quantity pumped per annum (KL)	Estimated annual power consumption (kWh/ annum)	Estimated SEC (kW/kL)	Pump efficiency (%)	Pump set efficiency (%)
Sewage Pumping Stations										
Vrindavan Gate SPS Pump 2	NW, pump operated on rotational basis	8	9.0	51.8	1825	94462	16368	0.173	16.2%	13.0%
Bangali Ghat SPS Pump 1	Five Pumps, 2W + 3 NW, pump operated on rotational basis	20	41.3	212.9	1825	388451	75304	0.194	36.2%	28.9%
Bangali Ghat SPS Pump 5		22	44.0	236.8	1825	432160	80243	0.186	41.5%	33.2%
Sub Total (B)			773.7	3709.9	39420	6,257,387	1,289,619			
Total (A+B)			1874.6	6455.5	515928	17,344,193	5,687,132			

Summary of Project Cost Benefit Analysis

The energy saving has been calculated on the basis of energy audit activity conducted at Mathura. Consequently, feasibility of individual projects has been discussed with ULB officials and different pump manufactures. The energy saving of this project has been calculated on the basis of the technical information shared by the manufacturers (for the recommended equipment) and operating information shared by pumping station personnel. The estimated energy saving is provided in the table below:

Summary of Energy Saving Measures Identified During the Audit

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
Water Supply Pumps					
1	Bhuteshwar Campus TW No.2	7344	1.3	0.6	27
2	Bhuteshwar Campus TW No.5	2896	1.5	0.2	77



Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
3	Bhuteshwar Campus TW No.7	7095	1.3	0.6	28
4	Nagar Palika TW No.15	41177	1.2	3.3	4
5	Bangali Ghat TW No.16	31535	1.2	2.5	6
6	Police Line TW No.25	43502	1.5	3.5	5
7	Bhuteshwar Campus TW No.27	18214	1.2	1.4	10
8	District Jail TW No.29	40425	1.3	3.2	5
9	Govind Nagar Sec. A	7633	1.5	0.6	29
10	Kushak Gali-1	43230	1.2	3.4	4
11	Shyam Ghat	22276	1.1	1.8	8
12	Vishram Ghat	25048	1.5	2.0	9
13	Chatta Bazar	26034	1.5	2.1	9
14	Rampal Gali	12354	1.3	1.0	16
15	Vrindavan Gate	30351	1.3	2.4	7
16	Theknarnol	26825	1.5	2.1	8
17	Dwarkeshpuri	10877	1.2	0.9	17
18	Unth Gali	35469	1.2	2.8	5
19	Naya Nagla Gali No.8	15887	1.1	1.3	11
20	Chah Kathoti	11212	1.2	0.9	16
21	Agra Hotel	40003	1.4	3.2	5
22	Dhruv Ghat	19022	1.3	1.5	11
23	Maholi Ki Paur	7721	1.5	0.6	29
24	Radhika Vihar	9311	1.3	0.7	21
25	Dholi Pyau	9877	1.3	0.8	20
26	Thateran Gali	25310	1.2	2.0	7
27	Bairag puri	9997	1.1	0.8	17

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
28	Bhargva Gali	7645	1.6	0.6	31
29	Gandhi Park Pump-1	6481	1.3	0.5	31
30	Megha Gali	2238	1.1	0.2	75
31	Bhadurpura	21852	1.2	1.7	8
32	Chaganpura	3106	1.3	0.2	64
33	Krishna Vihar NH-2	15979	1.1	1.3	10
34	Askunda	16510	1.5	1.3	13
35	Mahavidya Face-2	40883	1.3	3.3	5
36	Dalpat Khidki	5680	1.3	0.5	35
37	Gopalpura	19016	1.3	1.5	11
38	Laxmi Nagar-1	21550	1.2	1.7	8
39	Laxmi Nagar-2	8280	1.3	0.7	24
40	Laxmi Nagar-4	5322	1.3	0.4	38
41	Naya Nagla, Koyla Gali	7888	1.3	0.6	25
42	Maholi Yojna-1	7573	1.3	0.6	26
43	Maholi Yojna-3	4313	1.6	0.3	55
44	Sheetla Ghati	5928	1.3	0.5	34
45	Manas Nagar	2981	1.3	0.2	67
46	Ratan Kund	8981	1.2	0.7	19
47	Gau Ghat	11694	1.2	0.9	16
48	Arjunpura	10167	1.2	0.8	18
49	Officer Colony	29978	1.2	2.4	6
50	Badpura Colony	13940	1.3	1.1	14
51	Narayan Puri	39575	1.4	3.1	5
52	Jhigurpura	17051	1.2	1.4	11

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
53	Raigarpura	10327	1.5	0.8	22
54	Gupta Kunj	8923	1.2	0.7	20
55	Radha Nagar	19887	1.2	1.6	9
56	Manoharpura	4750	1.3	0.4	42
57	Krishna Nagar	10845	1.2	0.9	17
58	Heja Hospital	6996	1.3	0.6	29
59	Laxmi Nagar	29763	1.1	2.4	6
60	Maholi Yojna-2	8257	1.5	0.7	27
61	Antapada	20489	1.3	1.6	10
62	Rani Mandi	22365	1.2	1.8	8
63	Kutta Paysa	16015	1.3	1.3	12
64	Gali Ravaliya	4584	1.3	0.4	44
65	Gali Rajkumar	17025	1.6	1.4	14
66	Gandhi Park-2	21624	1.2	1.7	8
67	Arjunpura-2	9151	1.2	0.7	20
68	Theknarnol-2	6397	1.5	0.5	35
69	Madhav Puri	10496	1.3	0.8	19
70	Dholi Pyau Tiraha-New Construction	47803	1.4	3.8	4
71	Ahilyabai Park Dampier Nagar MVDA	20536	1.3	1.6	10
72	Ramlila Ground Krishna Nagar MVDA	12871	1.2	1.0	14
73	Kankali Temple Dwarikapuri MVDA	10774	1.2	0.9	17
74	Nai Basti W.No.	11401	1.5	0.9	20
75	Andi Kuiya	14053	1.5	1.1	16
76	Kathoti Kua Chaupal	16535	1.2	1.3	11
77	Kathoti Kua Masjid	14072	1.3	1.1	14

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
78	Gupta Kunk W.No.7	5964	1.3	0.5	34
79	Sadar Dhobi Pada W.No.8	27664	1.3	2.2	7
80	Gandhi Nagar W.No. 9	9417	1.2	0.7	19
81	Laxmi Nagar W.No. 9	25813	1.2	2.1	7
82	Bains Bhora Kotwali W.No.14	6015	1.5	0.5	37
83	Radhey Shyam Ashram W.No.16	47243	1.2	3.8	4
84	Om Nagar W.No.17	19355	1.3	1.5	10
85	Om Nagar-2 W.No.17	26312	1.2	2.1	7
86	Jogi Gali Antapada W.No.18	7687	1.3	0.6	26
87	Khateek Mohalla Balmiki Basti W.No.19	19374	1.3	1.5	10
88	Guru Nanak Nagar W.No.19	11292	1.1	0.9	15
89	Krishnapuram-1 Ward-24	7633	1.3	0.6	26
90	Krishnapuram-2 Ward-24	5786	1.3	0.5	35
91	Balmiki Basti Dholi Pyau Ward-27	25950	1.2	2.1	7
92	Mahavidya Park Ward-28	3181	1.3	0.3	63
93	Hanuman Teela Ward-33	3933	1.3	0.3	51
94	Kashmiri Gali Ward-34	12210	1.2	1.0	14
95	Mission Teela Sadar Bazar Ward-35	27314	1.3	2.2	7
96	Matia Gate Ward-37	10243	1.5	0.8	22
97	Subhash Nagar Nala Ward-38	19740	1.2	1.6	9
98	Manshapuri Ward-39	16393	1.2	1.3	11
99	Rampal Gali Ward-40	3134	1.3	0.2	64
100	Theknarnol Ward-40	8872	1.3	0.7	23
101	Lala Ganj Ward-42	7506	1.3	0.6	27
102	Kashiram Yojna-3	11844	1.2	0.9	15

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
103	Kashiram Yojna-4	21503	1.3	1.7	9
104	Satrangi Garden Ward-8	18430	1.2	1.5	9
105	Naya Nagla Ward-11	12993	1.3	1.0	15
106	Mali Mohalla Sadar Ward-13	17651	1.3	1.4	11
107	Naya Bans Ward-15	5234	1.3	0.4	38
108	Machli Gate Ward-19	8471	1.1	0.7	20
109	Motikunj Extension	9762	1.3	0.8	21
110	Rani Mandi Balmiki Basti Ward-6	13320	1.3	1.1	15
111	Matia Gate Joshayan Garden	8668	1.5	0.7	26
112	Sanjay Nagar Nala	9267	1.3	0.7	22
113	Balmiki Basti Ward-1	19412	1.2	1.5	9
	Sub- Total (A)	1,805,761	147	144	12
Sewage Pumping Station					
114	Masani Nala SPS Pump 1	20759	5.3	1.7	39
115	Masani Nala SPS Pump 2	14790	5.4	1.2	55
116	Masani Nala SPS Pump 3	25499	7.1	2.0	42
117	Masani Nala SPS Pump 4	21116	5.4	1.7	38
118	Masani Nala SPS Pump 5	40653	7.0	3.2	26
119	Krishna Ganga SPS Pump 2	4582	2.2	0.4	73
120	Chinta Haran SPS Pump 1	4284	2.2	0.3	78
121	Chinta Haran SPS Pump 3	5200	2.2	0.4	64
122	Swami Ghat SPS Pump 1	21039	2.1	1.7	15
123	Swami Ghat SPS Pump 2	23374	2.1	1.9	14
124	Cantt. Nala SPS Pump 1	68629	2.7	5.5	6
125	Dairy Farm SPS Pump 1	67619	6.6	5.4	15

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
126	Dairy Farm SPS Pump 2	38931	3.6	3.1	14
127	Dairy Farm SPS Pump 3	64189	6.6	5.1	16
128	Dairy Farm SPS Pump 4	36281	3.4	2.9	14
129	Dairy Farm SPS Pump 5	61731	6.6	4.9	16
130	Bangali Ghat SPS Pump 1	41099	9.2	3.3	34
131	Bangali Ghat SPS Pump 5	38383	9.2	3.1	36
	Sub- Total (B)	598,158	89	47.6	22.5
	Net Total (A+B)	2,403,919	236	191	15

Under maintenance pump sets, which were not repaired during energy audit period, were not taken up for measurement, analysis and subsequent implementation in this report.

Implementation of the energy efficiency measures on pumping system may result in annual energy savings of 2,403,919 kWh per year which is 44.33% of the existing electricity consumption. This energy saving is equivalent to 206.7 toe and results in reduction 1,971 tCO₂² per year.

² Estimated using average grid emission factor provided in Central electricity authority report titled “CO₂ Baseline Database for the Indian Power Sector” version 11.

Project Financials and proposed Business Model

Total Project cost (CAPEX)

The following are the key components considered while arriving at the total project cost:

- Cost of pump, motor and other accessories (like NRV and gate valve), discovered through a transparent bidding process;
- Cost of dismantling, installation and commissioning including testing charges, discovered through a transparent bidding process;
- Project Establishment and Supervision charges of EESL at 5% of total cost of equipment including installation;
- Cost of preparation of IGEA, as per actual tendered cost, plus EESL's service charge at 15%;
- All applicable goods and services tax as on actual basis; and
- Capitalized interest during the Project Implementation Period.

Details of project capital cost is provided in the table below:

Project Capital Cost

Capital Cost Related assumption	Unit	Value
Number of Pumps	No.	131
Total Cost of Equipment including installation, commissioning and testing	INR lakhs	235.55
Cost of pump including motor	INR lakhs	125.17
Cost of NRV	INR lakhs	39.04
Cost of Gate valve	INR lakhs	50.72
Cost of Web based dashboard	INR lakhs	10.06
Installation and Commissioning Cost including testing charges	INR lakhs	10.55
EESL's administrative and establishment charge	%	5
Cost of preparation of IGEA report including EESL service charges and applicable GST	INR lakhs	10.49
Total Project Cost w/o Capitalized interest	INR lakhs	257.82
Commissioning Details		
Total Months for Commissioning	months	9
Capitalized interest	INR lakhs	14.45
Total Project Cost	INR lakhs	272.27

Operating Costs (OPEX)

The following are the key components considered while arriving at the operating cost for the project

- Project Establishment and Supervision charges of EESL at 4% of total project cost, with annual escalation of 5%; and
- Actual incurred Repair & Maintenance charges, discovered through a transparent bidding process.

Details about project operating cost is provided in the table below.

Project Operating Cost

Operational Details	Unit	Value
EESL's administrative and establishment charges	%	4%

Financing Terms and other tax related assumptions

The following are the key financial assumptions used in developing the model. Financing terms and tax related assumptions are provided in the table below:

Financing terms and tax related assumptions

Parameters	Unit	Value
Term of the project	Years	7
Financing Details		
Debt Percentage	%	70%
Cost of Debt	%	11%
Equity Percentage	%	30%
Cost of Equity (post- tax)	%	16%
Tax Details		
Corporate Tax	%	34.61%
Goods and Services Tax	%	18%

Output - Annuity Payment to EESL

Based on the cost parameters and assumptions mentioned above, the annuity payment to EESL was computed. Details of annuity payment to EESL are provided in the table below.

Annuity Payment to EESL

Year		1	2	3	4	5	6	7	Total
Calculations of annuity payment									
Total Debt to be repaid	INR lakh	47.07	44.07	41.08	38.08	35.09	32.09	29.10	266.59
Principal Repayment	INR lakh	27.23	27.23	27.23	27.23	27.23	27.23	27.23	190.59
Interest	INR lakh	19.84	16.85	13.85	10.86	7.86	4.87	1.87	76.00
Total Equity Repayments	INR lakh	30.58	27.73	24.87	22.02	19.16	16.31	13.45	154.13
Recovery of equity investment	INR lakh	11.67	11.67	11.67	11.67	11.67	11.67	11.67	81.68
Return on equity	INR lakh	18.91	16.06	13.20	10.35	7.49	4.64	1.78	72.45
R&M Charges	INR lakh	0.00	5.89	17.67	22.38	27.09	35.33	42.40	150.75
EESL's administrative and establishment charge	INR lakh	10.89	11.44	12.01	12.61	13.24	13.90	14.59	88.67
Annuity Payment to EESL	INR lakh	88.54	89.13	95.62	95.09	94.58	97.63	99.54	660.13
Goods and Services Tax on annuity payment	INR lakh	15.94	16.04	17.21	17.12	17.02	17.57	17.92	118.82
Annuity Payment to EESL incl. all applicable taxes	INR lakh	104.48	105.17	112.84	112.20	111.60	115.21	117.5	778.96

Year		1	2	3	4	5	6	7	Total
ULB Savings									
Total Savings	<i>INR lakh</i>	191.11	195.52	199.79	203.88	207.74	211.35	214.7	1424.1
Profit to ULB	<i>INR lakh</i>	86.63	90.36	86.95	91.67	96.14	96.15	97.20	645.10
% of savings with ULBs	%								45.3%

Sensitivity analysis

The sensitivity analysis has been conducted to determine the impact of change in capital cost and change in savings on the percentage of monetary share of accrued savings retained by the ULB. Project sensitivity analysis is provided in the table below.

Project sensitivity analysis

Change in Capital Cost	% of savings retained by the utility
-10%	49.52%
-5%	47.41%
0%	45.30%
5%	43.19%
10%	41.08%
Change in Interest (ROE, Interest, D/E ratio)	% of savings retained by the utility
-10%	39.22%
-5%	42.42%
0%	45.30%
5%	47.90%
10%	50.27%

Key facts of IGEA

Key facts of the project are as follows:

Particular	Unit	Value
Total number of pump sets as per LOA	Nos.	176
Total number of pump sets under maintenance	Nos.	30
Total number of pump sets where measurement was not possible	Nos.	4
Total number of pump sets audited	Nos.	142
Total numbers of pumps sets considered for replacement	Nos.	131
Estimated present annual energy consumption (for 131 pump sets)	kWh	5,422,877
Estimated annual energy consumption with proposed EEPS (for 131 pump sets)	kWh	3,018,958
Percentage energy saving potential	%	44.33
Total project cost (including IGEA cost and capitalized interest)	Rs. Lakhs	272.27

Pre – implementation annual energy consumption (baseline) and post implementation annual energy consumption will be estimated based proposed Measurement and Verification (M & V methodology).

Rated and operating parameters of pump sets to be installed under this project along with other accessories are provided in the table below:

Key Facts of the Pumps to Be Replaced

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Water Supply Pump										
Bhuteshwar Campus TW No.2	36	65	9.3	24.7	50	8.6	45.85%	Yes	Yes	Yes
Bhuteshwar Campus TW No.5	-	65	9.3	28.2	56	11.5	43.96%	Yes	Yes	Yes
Bhuteshwar Campus TW No.7	30	65	9.3	27.1	50	8.9	48.93%	Yes	Yes	Yes
Nagar Palika TW No.15	-	65	9.3	17.2	44	9.6	25.28%	Yes	Yes	Yes
Bangali Ghat TW No.16	24	65	9.3	16.1	37	7.5	25.47%	Yes	Yes	Yes
Police Line TW No.25	36	65	9.3	35.4	42	13.1	36.48%	Yes	Yes	Yes
Bhuteshwar Campus TW No.27	36	65	9.3	10.2	61	9.6	20.88%	Yes	Yes	Yes
District Jail TW No.29	24	65	9.3	33.0	30	12.8	24.75%	Yes	Yes	Yes
Govind Nagar Sec. A	36	65	9.3	33.1	52	10.1	54.45%	Yes	Yes	Yes
Kushak Gali-1	30	65	9.3	22.5	27	11.7	16.64%	Yes	Yes	Yes
Shyam Ghat	18	65	7.5	8.9	48	6.1	22.24%	Yes	Yes	Yes
Vishram Ghat	18	65	9.3	34.3	39	12.1	35.39%	Yes	Yes	Yes
Chatta Bazar	18	65	9.3	36.4	46	12.5	43.07%	Yes	Yes	Yes
Rampal Gali	18	65	9.3	23.0	53	8.8	44.08%	Yes	Yes	Yes
Vrindavan Gate	18	65	9.3	26.0	46	11.1	34.44%	Yes	Yes	Yes
Theknarnol	18	65	9.3	21.4	70	12.4	38.69%	Yes	Yes	Yes
Dwarkeshpuri	18	65	9.3	15.3	59	12.2	23.78%	Yes	Yes	Yes
Unth Gali	18	65	9.3	10.4	62	9.5	21.68%	Yes	Yes	Yes
Naya Nagla Gali No.8	18	65	7.5	11.5	39	8.7	16.54%	Yes	Yes	Yes
Chah Kathoti	15	65	7.5	19.4	46	8.1	35.36%	Yes	Yes	Yes
Agra Hotel	18	65	9.3	28.1	46	11.9	34.84%	Yes	Yes	Yes
Dhruv Ghat	24	65	9.3	27.8	36	7.6	42.41%	Yes	Yes	Yes

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Maholi Ki Paur	24	65	9.3	25.7	58	8.9	53.77%	Yes	Yes	Yes
Radhika Vihar	24	65	9.3	24.7	52	9.5	43.09%	Yes	Yes	Yes
Dholi Pyau	24	65	9.3	24.9	50	8.4	47.36%	Yes	Yes	Yes
Thateran Gali	21	65	9.3	17.6	49	10.3	26.82%	Yes	Yes	Yes
Bairag puri	24	65	9.3	14.2	35	6.1	25.95%	Yes	Yes	Yes
Bhargva Gali	18	65	9.3	39.2	55	11.1	62.15%	Yes	Yes	Yes
Gandhi Park Pump-1	18	65	7.5	25.0	47	8.0	46.83%	Yes	Yes	Yes
Megha Gali	15	65	4.5	6.9	48	3.3	31.86%	Yes	Yes	Yes
Bhadurpura	18	65	9.3	15.6	45	11.2	19.98%	Yes	Yes	Yes
Chaganpura	18	65	7.5	24.1	47	7.7	46.91%	Yes	Yes	Yes
Krishna Vihar NH-2	24	65	9.3	11.0	51	8.5	21.10%	Yes	Yes	Yes
Askunda	18	65	7.5	32.4	45	10.0	46.82%	Yes	Yes	Yes
Mahavidya Face-2	18	65	9.3	17.6	59	12.1	27.37%	Yes	Yes	Yes
Dalpat Khidki	18	65	7.5	19.8	53	7.1	47.06%	Yes	Yes	Yes
Gopalpura	15	65	9.3	18.2	59	12.8	26.95%	Yes	Yes	Yes
Laxmi Nagar-1	18	65	9.3	29.4	23	6.9	31.45%	Yes	Yes	Yes
Laxmi Nagar-2	18	65	9.3	31.8	42	8.9	48.19%	Yes	Yes	Yes
Laxmi Nagar-4	18	65	7.5	39.2	26.5	7.0	47.79%	Yes	Yes	Yes
Naya Nagla, Koyla Gali	18	65	7.5	20.9	47	7.0	44.82%	Yes	Yes	Yes
Maholi Yojna-1	24	65	9.3	27.0	46	8.8	45.53%	Yes	Yes	Yes
Maholi Yojna-3	24	65	9.3	36.9	49	10.0	58.12%	Yes	Yes	Yes
Sheetla Ghati	18	65	7.5	14.1	70	6.0	52.26%	Yes	Yes	Yes
Manas Nagar	18	65	7.5	23.5	47	6.2	56.97%	Yes	Yes	Yes

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Ratan Kund	18	65	7.5	11.9	59	5.5	40.85%	Yes	Yes	Yes
Gau Ghat	18	65	7.5	23.3	39	7.7	37.93%	Yes	Yes	Yes
Arjunpura	18	65	9.3	12.3	61	9.5	25.33%	Yes	Yes	Yes
Officer Colony	18	65	9.3	19.1	23	9.1	15.41%	Yes	Yes	Yes
Badpura Colony	15	65	9.3	33.3	39	9.0	46.35%	Yes	Yes	Yes
Narayan Puri	30	65	9.3	29.0	46	12.0	35.55%	Yes	Yes	Yes
Jhigurpura	18	65	7.5	15.8	49	7.9	31.18%	Yes	Yes	Yes
Raigarpura	15	65	9.3	33.0	43	9.1	49.75%	Yes	Yes	Yes
Gupta Kunj	18	65	7.5	17.9	49	7.6	36.71%	Yes	Yes	Yes
Radha Nagar	24	65	9.3	20.1	46	9.0	32.79%	Yes	Yes	Yes
Manoharpura	24	65	9.3	14.2	78	8.1	43.87%	Yes	Yes	Yes
Krishna Nagar	24	65	9.3	18.0	52	8.6	34.78%	Yes	Yes	Yes
Heja Hospital	24	65	9.3	16.8	61	8.3	39.67%	Yes	Yes	Yes
Laxmi Nagar	18	65	9.3	19.9	25	9.5	16.75%	Yes	Yes	Yes
Maholi Yojna-2	18	65	9.3	28.6	50	9.7	47.43%	Yes	Yes	Yes
Antapada	24	65	9.3	26.4	37	9.5	32.91%	Yes	Yes	Yes
Rani Mandi	24	65	9.3	17.7	44	11.7	21.24%	Yes	Yes	Yes
Kutta Paysa	24	65	9.3	19.9	54	9.7	35.49%	Yes	Yes	Yes
Gali Ravaliya	24	65	9.3	20.1	51	6.3	51.86%	Yes	Yes	Yes
Gali Rajkumar	24	65	9.3	29.4	63	12.6	47.16%	Yes	Yes	Yes
Gandhi Park-2	24	65	9.3	17.9	42	8.9	27.10%	Yes	Yes	Yes
Arjunpura-2	24	65	9.3	15.4	55	8.6	31.52%	Yes	Yes	Yes
Theknarnol-2	24	65	9.3	25.5	60	8.8	55.90%	Yes	Yes	Yes

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Madhav Puri	21	65	9.3	21.6	51	8.1	43.72%	Yes	Yes	Yes
Dholi Pyau Tiraha-New Construction	24	65	9.3	20.1	54	11.9	29.20%	Yes	Yes	Yes
Ahilyabai Park Dampier Nagar MVDA	27	65	9.3	24.7	43	9.9	34.21%	Yes	Yes	Yes
Ramlila Ground Krishna Nagar MVDA	18	65	9.3	18.6	41	9.9	24.74%	Yes	Yes	Yes
Kankali Temple Dwarikapuri MVDA	18	65	7.5	18.7	50	7.6	39.50%	Yes	Yes	Yes
Nai Basti W.No.	18	65	9.3	27.9	50	10.6	42.26%	Yes	Yes	Yes
Andi Kuiya	18	65	9.3	31.2	54	10.6	50.86%	Yes	Yes	Yes
Kathoti Kua Chaupal	18	65	9.3	18.5	50	9.4	31.59%	Yes	Yes	Yes
Kathoti Kua Masjid	18	65	9.3	18.6	56	12.9	25.91%	Yes	Yes	Yes
Gupta Kunk WNo.7	18	65	9.3	22.6	49	7.3	48.61%	Yes	Yes	Yes
Sadar Dhobi Pada W.No8	18	65	9.3	39.2	25	10.3	30.56%	Yes	Yes	Yes
Gandhi Nagar W.No. 9	18	65	9.3	16.7	45	8.2	29.23%	Yes	Yes	Yes
Laxmi Nagar W.No. 9	18	65	9.3	17.2	50	9.6	28.86%	Yes	Yes	Yes
Bains Bhora Kotwali W.No.14	18	65	9.3	27.6	53	9.1	51.80%	Yes	Yes	Yes
Radhey Shyam Ashram W.No.16	18	65	9.3	17.5	42	11.9	19.72%	Yes	Yes	Yes
Om Nagar W.No.17	18	65	9.3	21.6	45	9.2	33.73%	Yes	Yes	Yes
Om Nagar-2 W.No.17	18	65	9.3	17.1	50	8.5	32.28%	Yes	Yes	Yes
Jogi Gali Antapada W.No.18	18	65	9.3	23.1	44	8.5	38.11%	Yes	Yes	Yes
Khateek Mohalla Balmiki Basti W.No.19	18	65	9.3	20.1	53	9.1	37.67%	Yes	Yes	Yes
Guru Nanak Nagar W.No.19	18	65	9.3	9.5	46	8.0	17.46%	Yes	Yes	Yes
Krishnapuram-1 Ward-24	18	65	9.3	28.4	39	10.7	33.14%	Yes	Yes	Yes
Krishnapuram-2 Ward-24	18	65	9.3	29.3	43	10.2	39.54%	Yes	Yes	Yes
Balmiki Basti Dholi Pyau Ward-27	18	65	9.3	13.4	50	9.0	23.67%	Yes	Yes	Yes

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Mahavidya Park Ward-28	18	65	9.3	21.8	54	6.5	57.53%	Yes	Yes	Yes
Hanuman Teela Ward-33	18	65	9.3	17.9	54	7.5	41.38%	Yes	Yes	Yes
Kashmiri Gali Ward-34	18	65	9.3	18.3	37	7.0	31.19%	Yes	Yes	Yes
Mission Teela Sadar Bazar Ward-35	18	65	9.3	29.3	38	10.9	32.86%	Yes	Yes	Yes
Matia Gate Ward-37	18	65	9.3	22.8	64	9.0	52.10%	Yes	Yes	Yes
Subhash Nagar Nala Ward-38	18	65	9.3	18.2	49	11.4	25.00%	Yes	Yes	Yes
Manshapuri Ward-39	18	65	9.3	15.3	47	9.4	24.34%	Yes	Yes	Yes
Rampal Gali Ward-40	18	65	9.3	24.4	49	6.9	55.72%	Yes	Yes	Yes
Theknarnol Ward-40	18	65	9.3	21.8	53	7.5	49.66%	Yes	Yes	Yes
Lala Ganj Ward-42	18	65	9.3	17.0	62	7.8	43.37%	Yes	Yes	Yes
Kashiram Yojna-3	18	65	9.3	14.7	48	7.0	32.19%	Yes	Yes	Yes
Kashiram Yojna-4	18	65	9.3	20.6	53	11.3	30.97%	Yes	Yes	Yes
Satrangi Garden Ward-8	18	65	9.3	31.8	21	6.9	30.88%	Yes	Yes	Yes
Naya Nagla Ward-11	18	65	9.3	22.5	44	7.9	40.29%	Yes	Yes	Yes
Mali Mohalla Sadar Ward-13	18	65	9.3	24.2	50	10.8	35.78%	Yes	Yes	Yes
Naya Bans Ward-15	18	65	9.3	16.5	62	7.9	41.31%	Yes	Yes	Yes
Machli Gate Ward-19	18	65	9.3	10.7	50	7.6	22.74%	Yes	Yes	Yes
Motikunj Extension	18	65	9.3	27.4	47	8.6	47.96%	Yes	Yes	Yes
Rani Mandi Balmiki Basti Ward-6	18	65	9.3	24.5	49	9.6	40.07%	Yes	Yes	Yes
Matia Gate Joshayan Garden	18	65	9.3	25.3	59	9.1	52.51%	Yes	Yes	Yes
Sanjay Nagar Nala	18	65	9.3	25.2	48	8.1	47.80%	Yes	Yes	Yes
Balmiki Basti Ward-1	18	65	9.3	18.2	52	9.4	32.27%	Yes	Yes	Yes
Sewage Pumping Station										

Pump Identification	Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Pump Reference	Flow (m3/hour)	Head (m)	Motor rating (kW)	Flow (m3/hour)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Masani Nala SPS Pump 1	270	36	30	236.7	25	39.3	49.1%	Yes	Yes	Yes
Masani Nala SPS Pump 2	270	36	30	262.1	31	45.9	58.4%	Yes	Yes	Yes
Masani Nala SPS Pump 3	540	36	90	398.7	27	67.5	52.6%	Yes	Yes	Yes
Masani Nala SPS Pump 4	270	36	30	215.2	33	45.3	51.7%	Yes	Yes	Yes
Masani Nala SPS Pump 5	540	36	90	389.0	26	68.6	48.7%	Yes	Yes	Yes
Krishna Ganga SPS Pump 2	108	20	11	52.3	22	10.4	36.4%	Yes	Yes	Yes
Chinta Haran SPS Pump 1	270	20.5	19	66.4	25	13.0	42.0%	Yes	Yes	Yes
Chinta Haran SPS Pump 3	270	20.5	19	66.1	24	13.8	38.0%	Yes	Yes	Yes
Swami Ghat SPS Pump 1	-	-	7	122.8	12	12.5	37.2%	Yes	Yes	Yes
Swami Ghat SPS Pump 2	-	-	7	119.5	11	12.4	33.4%	Yes	Yes	Yes
Cantt. Nala SPS Pump 1	72	25	19	39.9	25	23.9	13.8%	Yes	Yes	Yes
Dairy Farm SPS Pump 1	338.4	35	75	293.7	26	80.4	31.3%	Yes	Yes	Yes
Dairy Farm SPS Pump 2	165.6	28	30	110.3	18	36.4	18.0%	Yes	Yes	Yes
Dairy Farm SPS Pump 3	338.4	35	75	302.9	26	78.2	32.8%	Yes	Yes	Yes
Dairy Farm SPS Pump 4	165.6	28	30	111.2	19	36.1	19.3%	Yes	Yes	Yes
Dairy Farm SPS Pump 5	338.4	35	75	312.3	25	76.2	33.8%	Yes	Yes	Yes
Bangali Ghat SPS Pump 1	349.2	24	45	212.9	20	41.3	36.2%	Yes	Yes	Yes
Bangali Ghat SPS Pump 5	349.2	24	45	236.8	22	44.0	41.5%	Yes	Yes	Yes
Total				6055.6		1780.7				

Table of Contents

Executive Summary	iii
Background of the Project	iii
Description of Facilities.....	iii
Summary of Performance Evaluation of Pump sets	x
Performance Indicators	xi
Summary of Project Cost Benefit Analysis	xviii
Project Financials and proposed Business Model.....	xxv
Total Project cost (CAPEX).....	xxv
Operating Costs (OPEX).....	xxv
Financing Terms and other tax related assumptions	xxvi
Output - Annuity Payment to EESL	xxvi
Sensitivity analysis.....	xxvii
Key facts of IGEA	xxviii
1 Introduction.....	1
1.1 Background of the Project.....	1
1.2 Stakeholders Involved.....	2
1.3 Objective of the IGEA	3
1.4 Methodology adopted for Energy Audit	5
2 Interaction with Facilities/ Key Personnel.....	7
2.1 Interaction with Pump Manufacturers.....	7
3 Project area and Facility description	8
3.1 General information about the city	8
3.2 Accessibility to city from Metro cities & State capital	8
3.3 Pumping Stations in the Mathura.....	9
3.4 Historical Water Pumped and Energy Consumption Analysis	14
3.5 Power Failure Data	15
3.6 Rainfall and Climate data.....	15
3.7 Ground Water Profile.....	15
3.8 Reservoir Levels at Different Seasons	15
3.9 Water Cost Estimation	16
4 Pumping Stations Performance Evaluation.....	17
4.1 Connected load at pumping stations	17
4.2 Mathura Pumping Station	23
5 Baseline Assessment.....	52

5.1	Definition of possible and operating combinations	52
5.2	Key measurements for determining baseline or pre implementation level	52
5.3	Baseline.....	54
6	Energy Efficiency Measures.....	61
6.1	Summary of Energy Efficiency Measures	61
6.2	Detailed Energy Efficiency Measures.....	67
7	Repair & Maintenance Measures.....	88
7.1	Present R&M and O&M expenses.....	88
8	Project Financials and Business model	89
8.1	Total Project cost (CAPEX).....	89
8.2	Operating Costs (OPEX).....	90
8.3	Financing Terms and other tax related assumptions	91
8.4	Output - Annuity Payment to EESL	91
8.5	Sensitivity analysis.....	92
8.6	Payment Security Mechanism.....	92
9	Key Observations and Suggestions.....	94
9.1	Observation	94
9.2	Recommendations	94
10	Measurement and Verification (M&V).....	95
10.1	Definition of possible and operating combinations	95
10.2	Flow of activities under M & V process	95
10.3	Pre and post implementation assessment	96
10.4	Correction Factors and adjustments	97
10.5	Determination of Savings.....	98
11	Risk Responsibility Matrix & Risk Mitigation.....	99
12	Project Implementation Schedule.....	104
12.1	Execution Strategy	104
12.2	Proposed schedule.....	104
13	Annexures	106

LIST OF TABLES

Table 1: Population of Mathura city	8
Table 2 Details of Water Pumping Stations in Mathura	10
Table 3 Details of Sewage Pumping Stations in Mathura.....	14
Table 4: Historical water pumped and energy consumption data for last three years.....	15
Table 5: Rainfall and Climate data of Mathura City.....	15
Table 6: Water cost estimation.....	16
Table 7 Connected Load Details For Pumping Stations	17
Table 8: Tariff structure	25
Table 9 Energy Cost and Energy Consumption.....	25
Table 10 General details of Mathura Pumping stations	27
Table 11 Performance evaluation of Water Supply Pumps for Mathura City	29
Table 12 Performance evaluation of Sewage Pumps for Mathura City	43
Table 13 Estimated Energy Consumption	46
Table 14 Details of Auxiliary Load of pumping station	51
Table 15: Estimated Energy Consumption for Water Pumping Station	55
Table 16: Summary of energy efficiency measures for Mathura Water and Sewage pumping stations	61
Table 17: Cost Benefit Analysis	68
Table 18: R&M and O&M expenses for Mathura Pumping Stations.....	88
Table 19: Project Capital cost	90
Table 20: Project operating cost.....	90
Table 21: Financing terms and tax related assumptions	91
Table 22: Annuity payment to EESL	91
Table 23: Project Capital cost	92
Table 24: Adjustment factors to be used during M & V	97
Table 25: Financial Risk Analysis and Mitigation.....	99
Table 26: Project Implementation Schedule	105

LIST OF FIGURES

Figure 1 Mathura Water Distribution System Overview	9
Figure 2 Mathura Sewage Pumping System overview	9
Figure 3 Generic layout diagram of Water Supply Pumping Stations	23
Figure 4 Generic layout diagram of Sewage Pumping Stations	24
Figure 5 SLD of Pumping Station of Mathura City	24
Figure 6 P&ID diagram of all water supply pumping stations	26
Figure 7 P&ID diagram of all sewage Pumping station	27
Figure 8 Photographs of pumping station site	28
Figure 9 Schematic of business model of the project	89

ABBREVIATIONS

AMRUT	Atal Mission Rejuvenation and Urban Transformation
APFC	Automatic Power Factor Control
BEP	Best Efficiency Points
BPS	Booster Pumping Stations
CEA	Certified Energy Auditor
DUD	Department of Urban Development
EC	Energy Conservation
EE	Energy Efficiency
EEM	Energy Efficiency Measure
EESL	Energy Efficiency Services Limited
FY	Financial Year
GST	Goods and Services Tax
HT	High Tension
HSC	Horizontal Split Casing
IGEA	Investment Grade Energy Audit
kVA	Kilo Volt Ampere
kW	Kilowatt
kWh	kilowatt Hour
LED	Light Emitting Diode
LT	Low Tension
MEEP	Municipal Energy Efficiency Programme
MoUD	Ministry of Urban Development
MoU	Memorandum of Understanding
OHT	Over Head Tank
O&M	Operation and Maintenance
PF	Power Factor
PS	Pumping Station
PWW&SS	Public Water Works & Sewerage Systems
RPM	Rotations Per Minute
R&M	Repair & Maintenance
ROE	Return on Equity
SEC	Specific Energy Consumption
SHPSC	State level High Powered Steering Committee
SLTC	State Level Technical Committee
SPS	Sewerage Pumping Station
STP	Sewerage Treatment Plant
DUD	Department of Urban Development
TOE	Tonne of oil equivalent
ULB	Urban Local Body
UM	Under Maintenance
VFD	Variable Frequency Drive
WTP	Water Treatment Plant
WDS	Water Distribution Station

1 Introduction

1.1 Background of the Project

The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched by Prime Minister of India in June 2015 with the objective of providing basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities which will improve the quality of life for all.

To facilitate market transformation and replicate Municipal Energy Efficiency Programme on a large scale in India, MoUD, Government of India signed a MoU with Energy Efficiency Services Limited (EESL), a joint venture under Ministry of Power, Government of India on 28th September, 2016 under AMRUT. This will enable replacement of inefficient Pump sets in Public Water Works & Sewerage Water Systems with energy efficient Pump sets at no upfront cost to the Municipal Bodies. The investment will be recovered in form of fixed annuity.



Energy audit and optimizing energy consumption are mandatory reforms under AMRUT. EESL and Department of Urban Development (DUD), Government of Uttar Pradesh have jointly entered into an agreement on 9th February, 2017 in order to provide an overarching framework to facilitate engagement between the state government and various ULBs (covered under AMRUT) of Uttar Pradesh. Under this agreement, EESL is undertaking the project to replace old inefficient Pump sets by energy efficient Pump sets in Mathura City of Uttar Pradesh.



According to MoUD, energy audit for improving energy use is one of the mandated reforms under the AMRUT and this initiative would help the cities significantly. “This will substantially reduce costs of operation of water supply schemes and public lighting that will ultimately benefit the citizens. EESL will be promoting use of energy efficiency programmes across the country and will ensure supply of latest technologies under these municipal programmes”.

Energy cost accounts for 40 to 60 % of cost only for water supply in urban areas and energy efficiency interventions can reduce this cost by 20 to 40 %, depending on the type and age of pump sets being used for bulk water supply. By becoming energy efficient, ULB’s can reap annually up to 4,800 MU and Rs.3,200 Crores besides avoiding the need for 3,300 MW of power.

Necessary interventions would be undertaken by EESL without any financial burden on ULB as cost of the proposed Municipal Energy Efficiency Programmes would be borne out of annuity. MoU states that performance contracting offers a mechanism for ULB to finance these projects without upfront investment.

As per the MoU, EESL will develop overall strategy for taking up energy efficiency projects in urban areas by implementation of energy efficient Pump sets in public water works and sewage systems.

EESL will provide or arrange project funding for implementation as required and will procure energy efficient equipment and materials in a transparent manner besides ensuring repair and maintenance services for the goods replaced and installed by it. EESL is in the process of implementing energy efficient pumps for 500 cities under AMRUT scheme of Government of India. After the agreement between DUD and EESL was signed successfully on 09th February 2017, EESL initiated an open tendering process for hiring Energy Auditing Agency through competitive bidding. Based on the bidding evaluation, URS Verification was selected for doing the energy audit for Mathura Town. EESL has engaged URS for preparation of (IGEA) reports for Public Water Works and Sewerage Systems (PWW&SS) with an objective to replace inefficient pump sets with efficient ones vide its work order Ref LoA No: EESL/06/2016-17/Energy Audit/Uttar Pradesh /41-61/LOA-1617393 Dated: 28th March 2017

1.2 Stakeholders Involved

There are many stakeholders involved in AMRUT. Their roles and responsibilities are already defined by the MoUD and other technical committee. Generally, the MoUD, EESL, ULB and Department of Urban Development (DUD) have major role to execute under AMRUT.

MoUD: The MoUD committee may co-opt any representative from any Government Department or organization as Member or invite any expert to participate in its deliberations. Key roles of MoUD include:

- i. Allocation and release of funds to the States/UTs/Mission Directorate.
- ii. Overall monitoring and supervision of the Mission.
- iii. Advise to the State/UT/implementing agencies on innovative ways for resource mobilization, private financing and land leveraging.
- iv. Confirm appointment of organizations, institutions or agencies for third party monitoring.



DUD: Department of Urban Development (DUD) was setup to ensure the proper implementation and monitoring of the centrally assisted programme. DUD provides technical support to districts/towns to achieve their targets and also help in monitoring the state training plan. They also provide guidance and supervise the programme implementation through visits to the project sites.

ULB: At the City level, the ULB will be responsible for implementation of the Mission. The Municipal Commissioner will ensure timely preparation of all the required documents. The ULBs will ensure city level approvals of IGEA and bid documents and forward these to the State level Technical Committee (SLTC)/ State level High Powered Steering committee (SHPS) for approvals. The ULB will also be responsible for building coordination and collaboration among stakeholders for timely completion of projects without escalation of project cost.

SLTC: SLTC may co-opt member(s) from other State Government Departments/Government organizations and may also invite experts in the field to participate in its deliberations.

EESL: Ministry of Power has set up Energy Efficiency Services Limited (EESL), a Joint Venture of NTPC Limited, PFC, REC and POWERGRID to facilitate implementation of energy efficiency projects. It will promote energy efficiency programmes across the country and will ensure supply of energy efficient equipment under this municipal programme. Necessary interventions would be undertaken by EESL without any financial burden on ULBs as cost of the proposed Municipal Energy Efficiency Programmes would be borne out of annuity payments. EESL has been doing various Energy Efficient Programmes, list of same is provided below:

1. Domestic Appliances Programme (LED Bulbs, LED Tube lights, Fans, etc.)
2. Street Lighting National Programme
3. Agricultural Demand Side Management
4. Municipal Energy Efficiency Programme
5. Atal Jyoti Yojana (Solar LED Street Lights)

Energy Auditing Agency - URS: EESL has engaged URS Verification Pvt Ltd. for preparation of IGEA reports for public water works in Mathura, UP with an objective to replace inefficient pump sets with energy efficient ones. URS Verification had conducted energy audit activity at Mathura and had made IGEA with financial projections for Mathura ULB.

Pump Suppliers and Manufacturers: EESL has selectively taken on-board range of pump manufacturers and enquired with them regarding the necessary specifications of the products which can be used in line with the defined criteria according to EESL. All these manufacturers are rated manufacturers and comply with the quality and standards of their products.

1.3 Objective of the IGEA

Energy costs account for 40 to 60% of cost for water supply in urban areas and energy efficiency interventions can reduce this cost by 20 to 40%, depending on the type and age of pump sets being used for Public Water Works and Sewerage Systems (PWW&SS). The MoUD with support from EESL has designed framework project for Energy Efficiency in cities of India while giving priority to AMRUT and smart cities.



The objective of this project and IGEA report is to provide maximum information for creating baseline and analysis of current energy and utilization of Public water works systems.

This project is to be co-implemented by EESL and the objectives of this project are as under:

- To create increased demand for EE investments by adopting a ULB approach to facilitate the development of customized EE products and financing solutions in ULB.
- To raise the quality of EE investment proposals from a technical and commercial perspective.
- To expand the use of existing guarantees mechanisms for better risk management by EESL to catalyze additional commercial finance for energy efficiency.
- To establish a monitoring and evaluation system for the targeted ULB.

Scope of Work of Detailed Energy Audit

The general scope of work for detailed energy audits under IGEA as per Schedule 'A' is as follows:

- Discussion with Key personnel and Site visits of the facility
 - Initial discussions with Key personnel such as Commissioner, Chief Officer, Electrical/Mechanical engineer and pump operators to explain the objectives of the project, benefits of energy efficiency, and the approach that will be followed in Energy Audit.
 - Purpose of this discussion will be to ensure that key personnel of ULB have adequate understanding of the project.
 - Visiting all the facilities within the scope of project by identified agency to ascertain the availability of data and system complexity.
 - Identified agency will formulate a data collection strategy.
- Data Collection
 - Current energy usage (month wise) for all forms of energy for the last three years (quantity and cost)
 - Mapping of process
 - ULB and pumping station profile including name of station, years in operation, total water quantity pumped in last three years
 - List of major pumping equipment and specifications
- Analysis
 - Energy cost and trend analysis
 - Energy quantities and trend analysis
 - Specific consumption and trend analysis
 - Pumping costs trend analysis
 - Scope and potential for improvement in energy efficiency
- Detailed process mapping to identify major areas of energy use
- To identify all areas for energy saving (with or without investment) in the following areas:
 - Electrical: Power factor management, transformer loading, power quality tests, motor load studies, lighting load, electrical metering, monitoring and control system

- Water usage and pumping efficiencies (including water receipt, storage, distribution, utilization, etc.), pump specifications, break down maintenance
- Classify parameters related to EE Enhancements such as estimated quantum of energy saving, investment required, time frame for implementation, payback period and to classify the same in order of priority
- Undertake detailed financial analysis of the investments required for EE enhancements
- Design “Energy Monitoring System” for effective monitoring and analysis of energy consumption, energy efficiency.
- Correlate monthly pumping quantity data with electricity consumption for a period of last three years of normal operation for individual sections of the overall pumping station
- Recommend a time bound action plan for implementation
- The broad content of the IGEA report should be as follows:
 - **Executive summary:** Provides brief description of the facilities covered, measures evaluated, analysis methodology, results and a summary table presenting the cost and savings estimates for each recommended measure. It also includes a summary of the recommended measures and costs as well as the financial indicators of the Project.
 - **Background:** Background about the ULB and the project.
 - **Facility Description:** Details of the existing facilities targeted, such as water treatment & supply systems, sewage treatment and handling systems.
 - **Energy Scenario:** Energy consumption details of all facilities included in the audit and their energy sources.
 - **Baseline parameters and Adjustments:** Methodology followed in establishing the baseline parameters and criteria.
 - **Data Collection:** List the various types of data collected and their sources.
 - **System mapping:** Describe the methodology followed for system mapping and include the maps and process flow diagrams in the report.
 - **List of Potential EEMs:** A list of all identified measures with estimates of the savings and payback periods on investments, and a summary of the selected EEMs chosen for further development.

1.4 Methodology adopted for Energy Audit

A detailed energy audit was conducted at all the pumping stations falling under Nagar Nigam Mathura-vrindavan from 24th April, 2017 to 11th August, 2017. The energy audit team of URS comprised of BEE certified energy auditors/managers and pump experts. During the field visit, adequate numbers of portable energy audit instruments were used to carry out measurements of pump sets efficiency parameters. In addition to this, design and operational data was collected from logbooks, equipment manuals and pump manufacturers. Discussions were held with various technical and operating staffs of the ULB to understand the system and pump sets operations and requirements completely. The energy audit study mainly focused on the evaluation of operational efficiency/performance of the pump sets already installed in the premise from the energy conservation point of view.

The methodology planned for accomplishing the above scope of work was divided into three phases as detailed below:



Phase 1: Inception

- Conduct kick-off meeting
- Pilot visit to a few sites to ascertain the availability of data, measurements points and system complexity
- Discussed and finalized the methodology for data collection as per job card.

Phase 2: Detailed energy audit

- Initial meeting with concerned staff of ULB at each site to brief them regarding the project
- Walk-through of the site along with pumping station/site personnel to understand the site conditions and equipment involved
- Assessment of data availability (historical data/technical data sheets of major equipment/maintenance practices/cost details/electricity bills, etc.) and placing request for required data
- Finalization of measurement points and support required from ULB staff
- Conducting measurements and data collection with support from ULB staff
 - Energy auditing instruments used during project are listed below:
 - Power analyser: For electrical parameters(V, A, kW, kVA, kWh, kVAh, PF, Hz and THD)
 - Ultrasonic flow meter: For water flow measurement
 - Ultrasonic thickness gauge: For pipeline thickness measurement
 - Digital pressure gauges: For suction and discharge pressure measurement
 - Lux meter: For lighting intensity measurement
 - Filling& signing of job cards
 - Parallel activities of noting observations on the following:
 - SLD (Site Layout Diagram) & PID
 - Operation & Maintenance practices
 - Instrumentation in place and
 - Existing practices to monitor energy consumption.

Phase 3: Analysis and IGEA report preparation

- Compilation and analysis of data collected from site
- Performance assessment of the equipment
- Conceptualization and development of energy cost reduction projects
- Cost benefit analysis
- Review of adequacy of instrumentation for energy efficiency monitoring and
- Submission of IGEA report to ULB/ SLTC for approval.

2 Interaction with Facilities/ Key Personnel

The energy auditing team interacted for work proceeding and reporting with stakeholders for efficient information exchange. The kick-off meeting was held under the Junior Engineer, Water Works Department on 10th April, 2017 for discussing the data/information required, methodology to be followed and support required from the ULB. The ULB appointed its staff to provide support and information during energy audit. URS has provided day wise reporting to appointed staff of ULB regarding work status. Based on the work experience with ULB, inception report was submitted to EESL.

During the kick-off meeting at Mathura on 10th April 2017 following points were discussed:

- Support from the ULB will be given to the URS team for conducting energy audit
- Energy audit will be conducted by URS team in presence of EESL personnel and nodal official of ULB.
- Observations will be discussed with the appointed official of ULB and EESL
- URS can communicate with ULB official regarding scheduling of sites for audit
- Support will be provided by ULB to obtain various data to create baseline of energy consumption, quantity of water pumped etc.
- The letter of site activity conducted should be collected by URS after finishing the site work
- URS will regularly report the ULB official by informing the status of work and work schedule
- The site work completion letter should contain the information of pumps measured and those under maintenance
- URS will report the status of work on a daily basis to project-coordinator of EESL
- URS will submit the job card to EESL after completion of site work
- Signature of authorized personnel should be obtained on the job card in case of non-availability of data

EESL also appointed their staff to monitor audit works and to provide support and guidance for better quality of work flow. The appointed Staff from EESL have been trained for the information exchange and to provide maximum support for the site to be ready for energy audit. The appointed staff of EESL held periodic discussion with URS team members regarding the observation of energy audit and feasibility of EE projects at ULB.

2.1 Interaction with Pump Manufacturers

Some of the reputed pump manufacturers were selectively contacted regarding the costing and feasibility of different pump sets. The discussion with pump set manufacturers included the following points:

- Technical Feasibility of the suggested energy efficiency measures were discussed with the vendors.
- Commercial terms of EEM such as cost of equipment, auxiliary systems, and installation cost etc. were discussed with the vendors for assessing financial viability of EEM.

3 Project area and Facility description

3.1 General information about the city

Mathura is a city in the North Indian state of Uttar Pradesh. It is located approximately 50 kilometres north of Agra, and 145 kilometres south-east of Delhi; about 11 kilometres from the town of Vrindavan, and 22 kilometres from Govardhan. It is the administrative centre of Mathura District of Uttar Pradesh. Mathura is the birthplace of Krishna at the centre of Braj or Brij-bhoomi, called Shri Krishna Janma-Bhoomi. It is one of the seven cities (Sapta Puri) considered holy by Hindus.

Mathura has been chosen as one of the heritage cities for HRIDAY - Heritage City Development and Augmentation Yojana scheme of Government of India. Details about city population is provided in table 1.

Table 1: Population of Mathura city³

Census Year	Population (Nos.)
2001	2,074,516
2011	2,547,184

3.2 Accessibility to city from Metro cities & State capital

Air

The nearest international airport to Mathura is located in Delhi, at a distance of 147 km while the closest domestic airport is Kheria airport, Agra, located at a distance of 49 km.

Train

Mathura has its own Railway Station which lies in Jhansi railway division of the North Central Railway Zone. Mathura is a major railway junction, which is connected by many trains operating on routes between Delhi and Agra on regular basis.

Road

Mathura has good road network and is connected to all the areas of the Mathura city. Mathura is also well-linked with New Delhi through Noida-Agra express way.

³ Source: <http://www.census2011.co.in/census/district/516-mathura.html>

3.3 Pumping Stations in the Mathura

Main source of water for the city of Mathura is ground water. There are 141⁴ Nos. of pumps installed to cater the water needs of Mathura City. These 141 nos. of submersible pumps are used to supply water directly to the users. Out of 141 Nos. of water supply pumps, 121 Nos. were in operation during energy audit and 20 Nos. of pumps were under maintenance. The pictorial representation of the entire pumping station supply water to the user is shown in Figure 1.

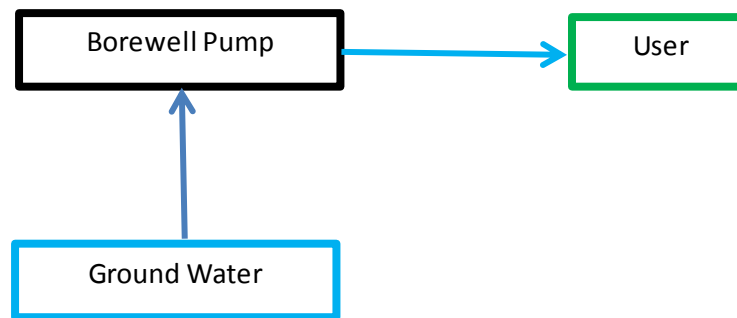


Figure 1 Mathura Water Distribution System Overview

Waste water from the household etc. is collected directly at sewage pumping stations. Further the waste water supplied to the sewage treatment plant through the 3 Nos. of MPS pumping stations. 35 Nos. of pumps are installed in sewage pumping system of Mathura to transfer the sewage water to the sewage treatment plant. Out of 35 Nos. of pump, 21 Nos. of pumps were in operation during energy audit and 14 Nos. of Pump sets were under maintenance. The pictorial representation of the entire sewage pumping station is shown in Figure 2.

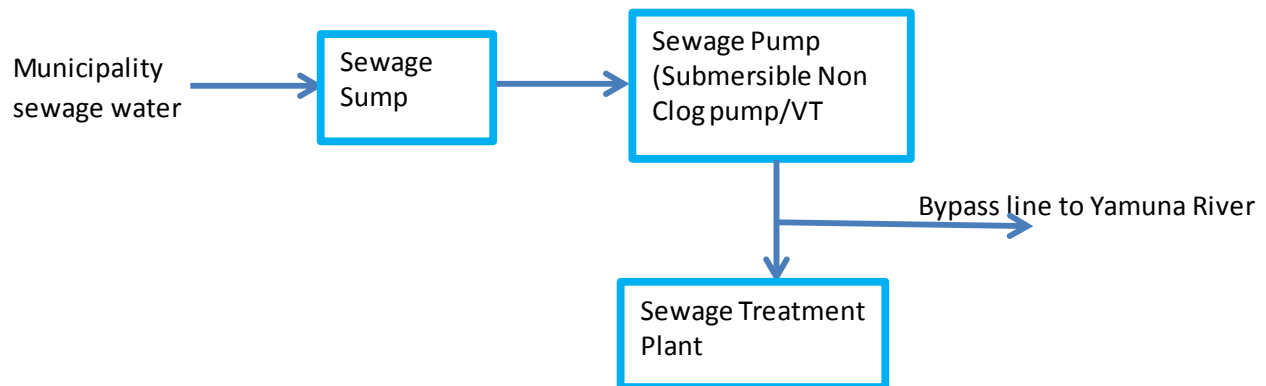


Figure 2 Mathura Sewage Pumping System overview

⁴ As per LOA, there were 143 pumps (water), however in LOA list, there was repetition of two pump sets. Therefore, total pump at Mathura, in IGEA, is considered as 141.

The details of the water pumping stations are provided in the table 2.

Table 2 Details of Water Pumping Stations in Mathura

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/D elivery Area
1	Bhuteshwar Campus TW No.2	0.20	Raw Water	Ground Water	User
2	Bhuteshwar Campus TW No.5	0.06	Raw Water	Ground Water	User
3	Bhuteshwar Campus TW No.7	0.24	Raw Water	Ground Water	User
4	Nagar Palika TW No.15	0.34	Raw Water	Ground Water	User
5	Bangali Ghat TW No.16	0.32	Raw Water	Ground Water	User
6	Police Line TW No.25	0.71	Raw Water	Ground Water	User
7	Bhuteshwar Campus TW No.27	0.08	Raw Water	Ground Water	User
8	District Jail TW No.29	0.46	Raw Water	Ground Water	User
9	Govind Nagar Sec. A	0.36	Raw Water	Ground Water	User
10	Kushak Gali-1	0.32	Raw Water	Ground Water	User
11	Shyam Ghat	0.14	Raw Water	Ground Water	User
12	Vishram Ghat	0.41	Raw Water	Ground Water	User
13	Chatta Bazar	0.58	Raw Water	Ground Water	User
14	Rampal Gali	0.28	Raw Water	Ground Water	User
15	Vrindavan Gate	0.42	Raw Water	Ground Water	User
16	Theknarnol	0.30	Raw Water	Ground Water	User
17	Dwarkeshpuri	0.06	Raw Water	Ground Water	User
18	Unth Gali	0.17	Raw Water	Ground Water	User
19	Naya Nagla Gali No.8	0.08	Raw Water	Ground Water	User
20	Chah Kathoti	0.17	Raw Water	Ground Water	User
21	Agra Hotel	0.56	Raw Water	Ground Water	User
22	Dhruv Ghat	0.56	Raw Water	Ground Water	User
23	Maholi Ki Paur	0.31	Raw Water	Ground Water	User
24	Gaja Paysa	0.25	Raw Water	Ground Water	User
25	Radhika Vihar	0.20	Raw Water	Ground Water	User
26	Dholi Pyau	0.30	Raw Water	Ground Water	User
27	Thateran Gali	0.21	Raw Water	Ground Water	User
28	Tulsi Chabutra	0.23	Raw Water	Ground Water	User
29	Bairag puri	0.11	Raw Water	Ground Water	User
30	Bhargva Gali	0.71	Raw Water	Ground Water	User
31	Gandhi Park Pump-1	0.20	Raw Water	Ground Water	User
32	Megha Gali	0.03	Raw Water	Ground Water	User
33	Bhadurpura	0.12	Raw Water	Ground Water	User

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/Delivery Area
34	Chaganpura	0.10	Raw Water	Ground Water	User
35	Krishna Vihar NH-2	0.09	Raw Water	Ground Water	User
36	Askunda	0.49	Raw Water	Ground Water	User
37	Mahavidya Face-2	0.28	Raw Water	Ground Water	User
38	Dalpat Khidki	0.16	Raw Water	Ground Water	User
39	Gopalpura	0.13	Raw Water	Ground Water	User
40	Shanti Nagar	0.36	Raw Water	Ground Water	User
41	Laxmi Nagar-1	0.53	Raw Water	Ground Water	User
42	Laxmi Nagar-2	0.32	Raw Water	Ground Water	User
43	Laxmi Nagar-4	0.31	Raw Water	Ground Water	User
44	Naya Nagla, Koyla Gali	0.21	Raw Water	Ground Water	User
45	Maholi Yojna-1	0.22	Raw Water	Ground Water	User
46	Maholi Yojna-3	0.30	Raw Water	Ground Water	User
47	Sheetla Ghati	0.20	Raw Water	Ground Water	User
48	Manas Nagar	0.26	Raw Water	Ground Water	User
49	Ratan Kund	0.17	Raw Water	Ground Water	User
50	Gau Ghat	0.26	Raw Water	Ground Water	User
51	Arjunpura	0.06	Raw Water	Ground Water	User
52	Officer Colony	0.23	Raw Water	Ground Water	User
53	Badpura Colony	0.50	Raw Water	Ground Water	User
54	Narayan Puri	0.58	Raw Water	Ground Water	User
55	Jhigurpura	0.19	Raw Water	Ground Water	User
56	Raigarpura	0.40	Raw Water	Ground Water	User
57	Gupta Kunj	0.14	Raw Water	Ground Water	User
58	Radha Nagar	0.26	Raw Water	Ground Water	User
59	Manoharpura	0.07	Raw Water	Ground Water	User
60	Krishna Nagar	0.14	Raw Water	Ground Water	User
61	Heja Hospital	0.10	Raw Water	Ground Water	User
62	Laxmi Nagar	0.24	Raw Water	Ground Water	User
63	Maholi Yojna-2	0.23	Raw Water	Ground Water	User
64	Antapada	0.32	Raw Water	Ground Water	User
65	Rani Mandi	0.14	Raw Water	Ground Water	User
66	Kutta Paysa	0.20	Raw Water	Ground Water	User
67	Gali Ravaliya	0.20	Raw Water	Ground Water	User
68	Gali Rajkumar	0.35	Raw Water	Ground Water	User
69	Gandhi Park-2	0.21	Raw Water	Ground Water	User

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/D elivery Area
70	Arjunpura-2	0.09	Raw Water	Ground Water	User
71	Theknarnol-2	0.31	Raw Water	Ground Water	User
72	Madhav Puri	0.24	Raw Water	Ground Water	User
73	Dholi Pyau Tiraha-New Construction	0.40	Raw Water	Ground Water	User
74	Ahilyabai Park Dampier Nagar MVDA	0.30	Raw Water	Ground Water	User
75	Ramlila Ground Krishna Nagar MVDA	0.11	Raw Water	Ground Water	User
76	Kankali Temple Dwarikapuri MVDA	0.21	Raw Water	Ground Water	User
77	Machli Mandi Bharatpur Gate	0.37	Raw Water	Ground Water	User
78	Nai Basti W.No.	0.22	Raw Water	Ground Water	User
79	Andi Kuiya	0.47	Raw Water	Ground Water	User
80	Kathoti Kua Chaupal	0.18	Raw Water	Ground Water	User
81	Kathoti Kua Masjid	0.09	Raw Water	Ground Water	User
82	Gupta Kunk WNo.7	0.20	Raw Water	Ground Water	User
83	Sadar Dhobi Pada W.No8	0.55	Raw Water	Ground Water	User
84	Gandhi Nagar W.No. 9	0.10	Raw Water	Ground Water	User
85	Laxmi Nagar W.No. 9	0.24	Raw Water	Ground Water	User
86	Bains Bhora Kotwali W.No.14	0.22	Raw Water	Ground Water	User
87	Radhey Shyam Ashram W.No.16	0.28	Raw Water	Ground Water	User
88	Om Nagar W.No.17	0.26	Raw Water	Ground Water	User
89	Om Nagar-2 W.No.17	0.31	Raw Water	Ground Water	User
90	Antapara behind Gurudwara W.No.18	0.21	Raw Water	Ground Water	User
91	Jogi Gali Antapada W.No.18	0.14	Raw Water	Ground Water	User
92	Khateek Mohalla Balmiki Basti W.No.19	0.28	Raw Water	Ground Water	User
93	Guru Nanak Nagar W.No.19	0.05	Raw Water	Ground Water	User
94	Krishnapuram-1 Ward-24	0.11	Raw Water	Ground Water	User
95	Krishnapuram-2 Ward-24	0.12	Raw Water	Ground Water	User
96	Balmiki Basti Dholi Pyau Ward-27	0.17	Raw Water	Ground Water	User
97	Mahavidya Park Ward-28	0.26	Raw Water	Ground Water	User
98	Hanuman Teela Ward-33	0.07	Raw Water	Ground Water	User
99	Kashmiri Gali Ward-34	0.18	Raw Water	Ground Water	User
100	Mission Teela Sadar Bazar Ward-35	0.41	Raw Water	Ground Water	User
101	Matia Gate Ward-37	0.32	Raw Water	Ground Water	User
102	Subhash Nagar Nala Ward-38	0.15	Raw Water	Ground Water	User

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/D elivery Area
103	Manshapuri Ward-39	0.12	Raw Water	Ground Water	User
104	Rampal Gali Ward-40	0.22	Raw Water	Ground Water	User
105	Theknarnol Ward-40	0.31	Raw Water	Ground Water	User
106	Lala Ganj Ward-42	0.14	Raw Water	Ground Water	User
107	Kashiram Yojna-3	0.15	Raw Water	Ground Water	User
108	Kashiram Yojna-4	0.21	Raw Water	Ground Water	User
109	Satrangi Garden Ward-8	0.48	Raw Water	Ground Water	User
110	Ambedkar Pratima Ward-10	0.21	Raw Water	Ground Water	User
111	Naya Nagla Ward-11	0.27	Raw Water	Ground Water	User
112	Ambedkar Nagar Ward-12	0.16	Raw Water	Ground Water	User
113	Mali Mohalla Sadar Ward-13	0.24	Raw Water	Ground Water	User
114	Naya Bans Ward-15	0.08	Raw Water	Ground Water	User
115	Machli Gate Ward-19	0.05	Raw Water	Ground Water	User
116	Bhim Nagar S.B.I. Ward-27	0.29	Raw Water	Ground Water	User
117	Motikunj Extension	0.33	Raw Water	Ground Water	User
118	Rani Mandi Balmiki Basti Ward-6	0.24	Raw Water	Ground Water	User
119	Matia Gate Joshiyan Garden	0.30	Raw Water	Ground Water	User
120	Sanjay Nagar Nala	0.30	Raw Water	Ground Water	User
121	Balmiki Basti Ward-1	0.22	Raw Water	Ground Water	User
122	Bhuteshwar Campus TW No.20	Under Maintenance	Raw Water	Ground Water	User
123	Bhuteshwar Campus	Under Maintenance	Raw Water	Ground Water	User
124	Bhuteshwar Campus TW No.24	Under Maintenance	Raw Water	Ground Water	User
125	Bhuteshwar Campus TW No.26	Under Maintenance	Raw Water	Ground Water	User
126	Goalpada	Under Maintenance	Raw Water	Ground Water	User
127	Gujrana Gali	Under Maintenance	Raw Water	Ground Water	User
128	Halan Ganj	Under Maintenance	Raw Water	Ground Water	User
129	Chaubachcha	Under Maintenance	Raw Water	Ground Water	User
130	Radhey Shyam Ashram	Under Maintenance	Raw Water	Ground Water	User
131	State Bank TW No.19	Under Maintenance	Raw Water	Ground Water	User
132	Gopalpura-2	Under Maintenance	Raw Water	Ground Water	User
133	Kucha Sunaran Ward-38	Under Maintenance	Raw Water	Ground Water	User

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/Delivery Area
134	Radha Nagar-2	Under Maintenance	Raw Water	Ground Water	User
135	Shamshan Ghat MVDA	Under Maintenance	Raw Water	Ground Water	User
136	Bhuteshwar Garden W.No.20	Under Maintenance	Raw Water	Ground Water	User
137	Patiram Gali Ward-40	Under Maintenance	Raw Water	Ground Water	User
138	Satgada Ward-45	Under Maintenance	Raw Water	Ground Water	User
139	General Ganj Ward-16	Under Maintenance	Raw Water	Ground Water	User
140	Ambakhar	Under Maintenance	Raw Water	Ground Water	User
141	Pani Ki Tanki Ward-17	Under Maintenance	Raw Water	Ground Water	User

Table 3 Details of Sewage Pumping Stations in Mathura

S. No	Facility Name & Location	MLD Capacity	Type of the facility	Source of water	Distribution/Delivery Area
1	Diary Farm SPS	16.00	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
2	Masani Nala SPS	13.59	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
3	Bangali Ghat SPS	14.50	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
4	Cantt. Nala SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
5	Vrindavan Gate SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
6	Krishna Ganga SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
7	Swami Ghat SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
8	Chinta Haran SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant
9	Dhruv Ghat SPS	NA	Sewage Pumping Station	Municipal Water	Sewage Treatment Plant

3.4 Historical Water Pumped and Energy Consumption Analysis

Historical data about water pumped and energy consumption of Nagar Nigam Mathura- Vrindavan is provided in the table below.

Table 4: Historical water pumped and energy consumption data for last three years⁵

Description	Water flow (kL /Annum)	Energy consumption (kWh/Annum)	Specific energy consumption (kWh/kL)
Jan-14 to Dec-14	Not available	2,430,016	Not available
Jan-15 to Dec-15	Not available	2,406,705	Not available
Jan-16 to Dec-16	Not available	2,923,171	Not available

3.5 Power Failure Data

Power failure data is not available with Nagar Nigam Mathura- Vrindavan.

3.6 Rainfall and Climate data

Rainfall and climate data of Mathura is provided in table 5.

Table 5: Rainfall and Climate data of Mathura City⁶

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Min. Temp (°C)	7.4	10.1	15.5	21.5	26.7	29.1	27	25.8	24.5	19	12	8.1
Max. Temp (°C)	22.1	25.3	31.5	37.7	41.5	40.4	35.1	33.1	33.6	33.6	29.3	23.9
Avg. Temp (°C)	14.7	17.7	23.5	29.6	34.1	34.7	31	29.4	29	26.3	20.6	16
Precipitation / Rainfall (mm)	14	6	12	2	6	28	202	271	125	31	5	5

3.7 Ground Water Profile

Water source in the city is primarily ground water that is pumped out with the help of bore wells. The water level below ground remains in range from 9 m to 55 m, as informed by the ULB personals. The pumping stations installed in Mathura city are having a bore length in the range of 55 m – 107 m.

3.8 Reservoir Levels at Different Seasons

Mathura depends totally on ground water from bore wells and there are no reservoirs. Yamuna River flows by the city but the water from this river is not used as water source in existing water distribution system.

⁵ Electricity bills were not provided for all pumping stations. In some pumping stations, electricity bills were available only for few months. Values provided in above table were based on available electricity bills

⁶ Source: <https://en.climate-data.org/location/4880/>

3.9 Water Cost Estimation

During energy audit, data regarding various operation and maintenance expenses borne by ULB was collected for estimating water cost. Details of expenditure by ULB during last year and estimated water cost are provided in the table 6.

Table 6: Water cost estimation

Particular	Units	Values
Energy cost (Electricity)	Rs. Lakhs	281.7
Repair & Maintenance	Rs. Lakhs	209.2
Operation (man power & raw material)	Rs. Lakhs	789.68
Miscellaneous cost (Cost of major replacement)	Rs. Lakhs	273.42
Total cost	Rs. Lakhs	1554
Annual water pumped to City (estimated)	kL	11,086,806
Water cost	Rs./kL	14.0

4 Pumping Stations Performance Evaluation

Mathura City is getting the drinking water supply from ground water through bore wells. Waster/sewage water from the households is collected at the sump. Further these sewage water transfers to the sewage treatment plant through the pumps installed at the MPS/IPS. Details of connected load at the pumping stations, layout and results of performance assessment are provided in subsequent sections of this chapter.

4.1 Connected load at pumping stations

Based on the data collected for the pumping station from Nagar Nigam Mathura- Vrindavan, details of connected load of Water Supply pumping stations is provided in the table 7.

Table 7 Connected Load Details For Pumping Stations

S. No	Pump Reference	Pump type	Rated Power (kW)
Water Supply Pump Sets			
1	Bhuteshwar Campus TW No.2	Submersible	9.3
2	Bhuteshwar Campus TW No.5	Submersible	9.3
3	Bhuteshwar Campus TW No.7	Submersible	9.3
4	Nagar Palika TW No.15	Submersible	9.3
5	Bangali Ghat TW No.16	Submersible	9.3
6	Police Line TW No.25	Submersible	9.3
7	Bhuteshwar Campus TW No.27	Submersible	9.3
8	District Jail TW No.29	Submersible	9.3
9	Govind Nagar Sec. A	Submersible	9.3
10	Kushak Gali-1	Submersible	9.3
11	Shyam Ghat	Submersible	7.5
12	Vishram Ghat	Submersible	9.3
13	Chatta Bazar	Submersible	9.3
14	Rampal Gali	Submersible	9.3
15	Vrindavan Gate	Submersible	9.3
16	Theknarnol	Submersible	9.3
17	Dwarkeshpuri	Submersible	9.3
18	Unth Gali	Submersible	9.3
19	Naya Nagla Gali No.8	Submersible	7.5
20	Chah Kathoti	Submersible	7.5
21	Agra Hotel	Submersible	9.3
22	Dhruv Ghat	Submersible	9.3
23	Maholi Ki Paur	Submersible	9.3
24	Gaja Paysa	Submersible	7.5

S. No	Pump Reference	Pump type	Rated Power (kW)
25	Radhika Vihar	Submersible	9.3
26	Dholi Pyau	Submersible	9.3
27	Thateran Gali	Submersible	9.3
28	Tulsi Chabutra	Submersible	7.5
29	Bairag puri	Submersible	9.3
30	Bhargva Gali	Submersible	9.3
31	Gandhi Park Pump-1	Submersible	7.5
32	Megha Gali	Submersible	4.5
33	Bhadurpura	Submersible	9.3
34	Chaganpura	Submersible	7.5
35	Krishna Vihar NH-2	Submersible	9.3
36	Askunda	Submersible	7.5
37	Mahavidya Face-2	Submersible	9.3
38	Dalpat Khidki	Submersible	7.5
39	Gopalpura	Submersible	9.3
40	Shanti Nagar	Submersible	9.3
41	Laxmi Nagar-1	Submersible	9.3
42	Laxmi Nagar-2	Submersible	9.3
43	Laxmi Nagar-4	Submersible	7.5
44	Naya Nagla, Koyla Gali	Submersible	7.5
45	Maholi Yojna-1	Submersible	9.3
46	Maholi Yojna-3	Submersible	9.3
47	Sheetla Ghati	Submersible	7.5
48	Manas Nagar	Submersible	7.5
49	Ratan Kund	Submersible	7.5
50	Gau Ghat	Submersible	7.5
51	Arjunpura	Submersible	9.3
52	Officer Colony	Submersible	9.3
53	Badpura Colony	Submersible	9.3
54	Narayan Puri	Submersible	9.3
55	Jhigurpura	Submersible	7.5
56	Raigarpura	Submersible	9.3
57	Gupta Kunj	Submersible	7.5
58	Radha Nagar	Submersible	9.3
59	Manoharpura	Submersible	9.3
60	Krishna Nagar	Submersible	9.3

S. No	Pump Reference	Pump type	Rated Power (kW)
61	Heja Hospital	Submersible	9.3
62	Laxmi Nagar	Submersible	9.3
63	Maholi Yojna-2	Submersible	9.3
64	Antapada	Submersible	9.3
65	Rani Mandi	Submersible	9.3
66	Kutta Paysa	Submersible	9.3
67	Gali Ravaliya	Submersible	9.3
68	Gali Rajkumar	Submersible	9.3
69	Gandhi Park-2	Submersible	9.3
70	Arjunpura-2	Submersible	9.3
71	Theknarnol-2	Submersible	9.3
72	Madhav Puri	Submersible	9.3
73	Dholi Pyau Tiraha-New Construction	Submersible	9.3
74	Ahilyabai Park Dampier Nagar MVDA	Submersible	9.3
75	Ramlila Ground Krishna Nagar MVDA	Submersible	9.3
76	Kankali Temple Dwarikapuri MVDA	Submersible	7.5
77	Machli Mandi Bharatpur Gate	Submersible	9.3
78	Nai Basti W.No.	Submersible	9.3
79	Andi Kuiya	Submersible	9.3
80	Kathoti Kua Chaupal	Submersible	9.3
81	Kathoti Kua Masjid	Submersible	9.3
82	Gupta Kunk WNo.7	Submersible	9.3
83	Sadar Dhobi Pada W.No8	Submersible	9.3
84	Gandhi Nagar W.No. 9	Submersible	9.3
85	Laxmi Nagar W.No. 9	Submersible	9.3
86	Bains Bhora Kotwali W.No.14	Submersible	9.3
87	Radhey Shyam Ashram W.No.16	Submersible	9.3
88	Om Nagar W.No.17	Submersible	9.3
89	Om Nagar-2 W.No.17	Submersible	9.3
90	Antapara behind Gurudwara W.No.18	Submersible	9.3
91	Jogi Gali Antapada W.No.18	Submersible	9.3
92	Khateek Mohalla Balmiki Basti W.No.19	Submersible	9.3
93	Guru Nanak Nagar W.No.19	Submersible	9.3
94	Krishnapuram-1 Ward-24	Submersible	9.3
95	Krishnapuram-2 Ward-24	Submersible	9.3
96	Balmiki Basti Dholi Pyau Ward-27	Submersible	9.3

S. No	Pump Reference	Pump type	Rated Power (kW)
97	Mahavidya Park Ward-28	Submersible	9.3
98	Hanuman Teela Ward-33	Submersible	9.3
99	Kashmiri Gali Ward-34	Submersible	9.3
100	Mission Teela Sadar Bazar Ward-35	Submersible	9.3
101	Matia Gate Ward-37	Submersible	9.3
102	Subhash Nagar Nala Ward-38	Submersible	9.3
103	Manshapuri Ward-39	Submersible	9.3
104	Rampal Gali Ward-40	Submersible	9.3
105	Theknarnol Ward-40	Submersible	9.3
106	Lala Ganj Ward-42	Submersible	9.3
107	Kashiram Yojna-3	Submersible	9.3
108	Kashiram Yojna-4	Submersible	9.3
109	Satrangi Garden Ward-8	Submersible	9.3
110	Ambedkar Pratima Ward-10	Submersible	9.3
111	Naya Nagla Ward-11	Submersible	9.3
112	Ambedkar Nagar Ward-12	Submersible	9.3
113	Mali Mohalla Sadar Ward-13	Submersible	9.3
114	Naya Bans Ward-15	Submersible	9.3
115	Machli Gate Ward-19	Submersible	9.3
116	Bhim Nagar S.B.I. Ward-27	Submersible	9.3
117	Motikunj Extension	Submersible	9.3
118	Rani Mandi Balmiki Basti Ward-6	Submersible	9.3
119	Matia Gate Joshiyan Garden	Submersible	9.3
120	Sanjay Nagar Nala	Submersible	9.3
121	Balmiki Basti Ward-1	Submersible	9.3
122	Bhuteshwar Campus TW No.20	Submersible	9.3
123	Bhuteshwar Campus	Submersible	9.3
124	Bhuteshwar Campus TW No.24	Submersible	9.3
125	Bhuteshwar Campus TW No.26	Submersible	9.3
126	Goalpada	Submersible	9.3
127	Gujrana Gali	Submersible	5.6
128	Halan Ganj	Submersible	7.5
129	Chaubachcha	Submersible	7.5
130	Radhey Shyam Ashram	Submersible	7.5
131	State Bank TW No.19	Submersible	9.3
132	Gopalpura-2	Submersible	9.3

S. No	Pump Reference	Pump type	Rated Power (kW)
133	Kucha Sunaran Ward-38	Submersible	9.3
134	Radha Nagar-2	Submersible	9.3
135	Shamshan Ghat MVDA	Submersible	9.3
136	Bhuteshwar Garden W.No.20	Submersible	9.3
137	Patiram Gali Ward-40	Submersible	9.3
138	Satgada Ward-45	Submersible	9.3
139	General Ganj Ward-16	Submersible	9.3
140	Ambakhar	Submersible	9.3
141	Pani Ki Tanki Ward-17	Submersible	9.3
Sub Total (A)			1267
1	Dairy Farm	Submersible Non Clog	75
2	Dairy Farm	Submersible Non Clog	30
3	Dairy Farm	Submersible Non Clog	75
4	Dairy Farm	Submersible Non Clog	30
5	Dairy Farm	Submersible Non Clog	75
6	Dairy Farm	Submersible Non Clog	30
7	Masani Nala	Submersible Non Clog	90
8	Masani Nala	Submersible Non Clog	30
9	Masani Nala	Submersible Non Clog	90
10	Masani Nala	Submersible Non Clog	30
11	Masani Nala	Submersible Non Clog	90
12	Bangali Ghat	VT	45
13	Bangali Ghat	VT	45
14	Bangali Ghat	VT	45
15	Bangali Ghat	VT	22
16	Bangali Ghat	VT	45
17	Cantt Sewage	Submersible Non Clog	19
18	Cantt Sewage	Submersible Non Clog	5
19	Cantt Sewage	Submersible Non Clog	19
20	Cantt Sewage	Submersible Non Clog	5
21	Cantt Sewage	Submersible Non Clog	19
22	Vrindavan Gate	VT	8
23	Vrindavan Gate	VT	8
24	Vrindavan Gate	VT	8
25	Vrindavan Gate	VT	4
26	Kishan Ganga	Submersible Non Clog	11

S. No	Pump Reference	Pump type	Rated Power (kW)
27	Kishan Ganga	Submersible Non Clog	11
28	Kishan Ganga	Submersible Non Clog	11
29	Swami Ghat	Submersible Non Clog	8
30	Swami Ghat	Submersible Non Clog	8
31	Swami Ghat	Submersible Non Clog	8
32	Chintaharan	Submersible Non Clog	19
33	Chintaharan	Submersible Non Clog	19
34	Chintaharan	Submersible Non Clog	19
35	Dhruv Ghat	Submersible Non Clog	4
Sub Total (B)			1051
C= A+B			2318

Pumps Name	Bulb (100W)	Bulb (60W)	LED (9W)	LED (50W)	LED (40W)	FTL (40W)	Fan (70W)	Cooler fan (120W)	Exhaust Fan (150W)	Exhaust Fan (250W)	Table Fan (35W)	HPS V (250)	HPS V (150)
Cantt. Nala SPS	1		1	1		1				1			
Dairy Farm SPS			1		1	2			2		1	3	2
Vrindavan Gate SPS	1	1	1	1							1		
Bengali Ghat SPS	3	2											
Masani Nala SPS	1		1	2			1		1				
Swami Ghat SPS			1	1			1		1	1		1	
Krishna Ganga SPS		1	2					1					
Chinta Haran SPS	1	1									1		
Total Nos.	7	5	7	5	1	3	2	1	4	2	3	4	2
Total Connected Load (D)	0.7	0.3	0.06	0.25	0.04	0.12	0.14	0.12	0.6	0.5	0.105	1	0.3
Auxiliary Load for Water Supply Pumps (kW) (E)							4						
Total Auxiliary Connected Load (kW) (F)							8						
Net Total Connected Load (kW), G= C+F							2327						

4.2 Mathura Pumping Station

4.2.1 Overview of Existing System

Main source of water for the city of Mathura is ground water. There are 141⁷ Nos. of pumps installed to cater the water needs of Mathura City. These 141 nos. of submersible pumps are used to supply water directly to the users. Out of 141 Nos. of water supply pumps, 121 Nos. were in operation during energy audit and 20 Nos. of pumps were under maintenance. The Bore depth of pump at Mathura Ranges from 55 - 107 m while the water level found to be present in the range of 9 m -55 m. The generic layout diagram of water supply pumping station is shown in Figure 3.

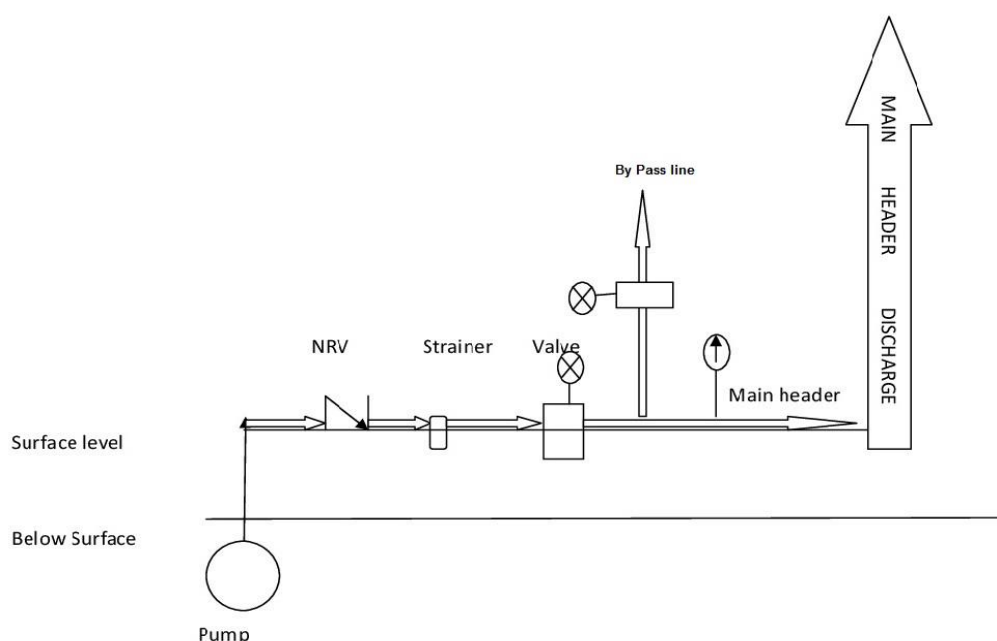


Figure 3 Generic layout diagram of Water Supply Pumping Stations

Waste water from the household etc. is collected directly at sewage pumping stations. Further the waste water supplied to the sewage treatment plant through the 3 Nos. of MPS pumping stations. 35 Nos. of pumps are installed in sewage pumping system of Mathura to transfer the sewage water to the sewage treatment plant. Out of 35 Nos. of pump, 21 Nos. of pumps were in operation during energy audit and 14 Nos. of Pump sets were under maintenance. The pictorial representation of the sewage pumping station is shown in Figure 4.

⁷ As per LOA, there were 143 pumps (water), however in LOA list, there was repetition of two pump sets. Therefore, total pump at Mathura, in IGEA, is considered as 141.

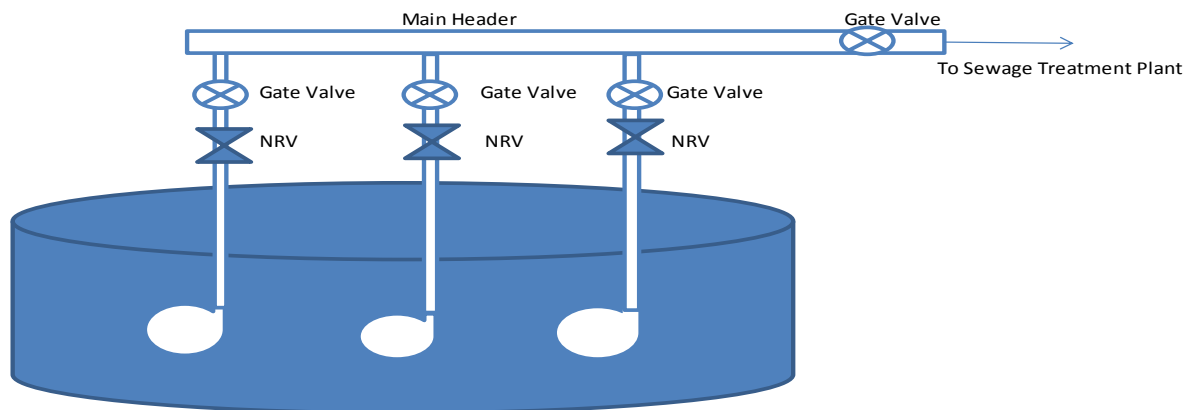


Figure 4 Generic layout diagram of Sewage Pumping Stations

4.2.2 Electricity Supply

Nagar Nigam Mathura- Vrindavan is getting the electricity from Dakshinanchal Vidyut Vitaran Nigam Ltd (DVVNL). All Water Pumping installations have low tension (LT) supply at 415V, 50Hz from DVVNL under LMV-7 is applicable to the Public water works, sewage treatment plants and sewage pumping stations functioning under Jal Sansthan, Jal Nigam or other local bodies.

MPS pumping station of sewage is having the dedicated transformer is getting the supply from DVVNL at 11 kV and stepped down to 415 V. No Energy Meter has been installed in the pumping stations. The SLD of the pumping system is shown in figure 5.

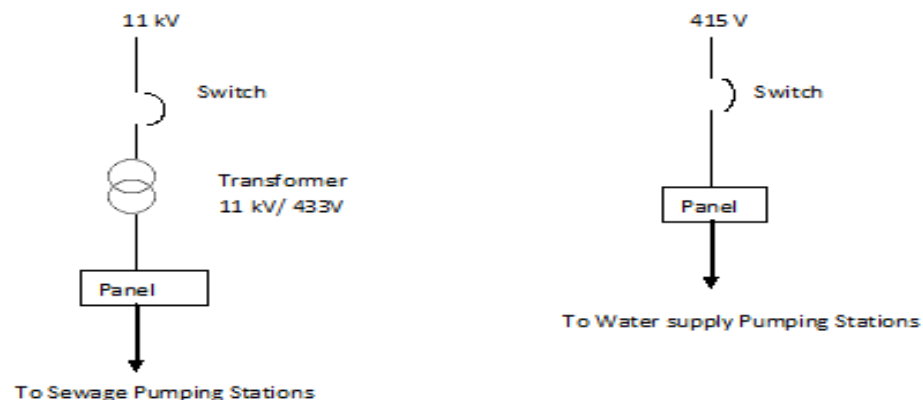


Figure 5 SLD of Pumping Station of Mathura City

4.2.3 Tariff Structure

The tariff for LMV-7, as per UPERC Tariff orders is provided in table 8.

Table 8: Tariff structure

Item	2016-17	2015-16	2014-15
Rate of energy charge per KWh	7.95	7.10	6.80
Rate of fixed charge per KW	290	230	230

4.2.4 Electricity Bill Analysis

The bills for the last three year have been taken from the Nagar Nigam Mathura- Vrindavan. Summary of same has been tabulated in the table 9.

Table 9 Energy Cost and Energy Consumption⁸

Period of energy bill	Energy consumption kwh/Annum	Percentage Increase of energy consumption over previous year (%)	Energy cost Rs/Annum
Jan-14 to Dec-14	2430016	NA	11642152
Jan-15 to Dec-15	2406705	NA	17087604
Jan-16 to Dec-17	2923171	NA	27323719

Note: The details of electricity bill analysis is provided in Annexure IV

4.2.5 Energy Consumption Pattern at Pumping Station

During energy audit, three phase power analyzer was installed at main incomer of Main pumping station (MPS) for recording variations of electrical parameters, key findings of analysis or recorded data is as follows is tabulate in below table:

Particulars	Unit	Sewage Pumping station	Water Supply Pumps
Voltage _{max}	V	441.46	449.44
Voltage _{min}	V	365.21	334.22
Voltage _{avg}	V	414.58	397.73
Current _{max}	A	122.7	23.0
Current _{min}	A	17.1	7.6
Current _{avg}	A	59.7	16.3
PF _{max}		0.931	0.974
PF _{min}		0.770	0.466
PF _{avg}		0.840	0.801
Power _{rmax}	kW	80.39	13.07

⁸ Electricity bills were not provided for all pumping stations. In some pumping stations, electricity bills were available only for few months. Values provided in above table were based on available electricity bills

Particulars	Unit	Sewage Pumping station	Water Supply Pumps
Power _{min}	kW	8.97	3.34
Power _{avg}	kW	36.85	9.10
Voltage THD	%	1.19	1.25
Current THD	%	2.28	3.5

* During log period frequency was found to be varying from 49.9 Hz to 50.1 Hz, whereas average frequency was recorded as 50 Hz.

4.2.6 Pumping Station System Mapping

P & ID station for all Water supply pumping stations are similar. Generic P & ID is shown in the figure 6.

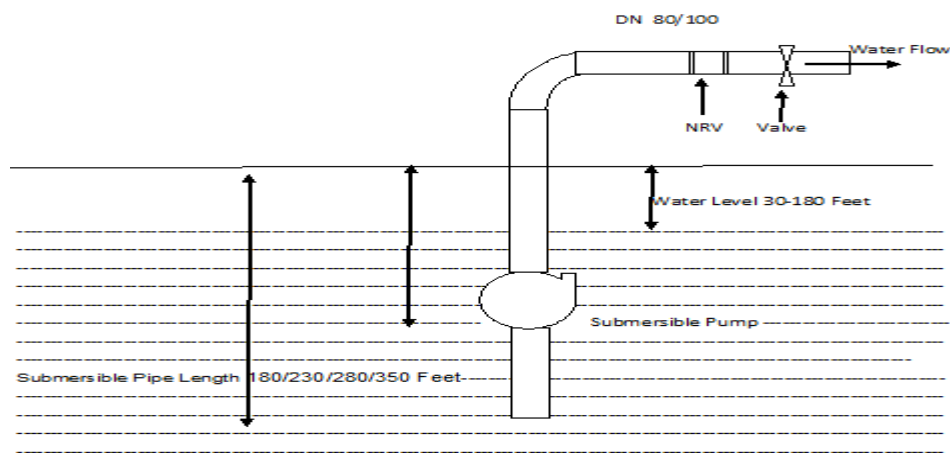


Figure 6 P&ID diagram of all water supply pumping stations

P & ID station for all Sewage Pumping stations are similar. Generic P & ID is shown in the figure 7.

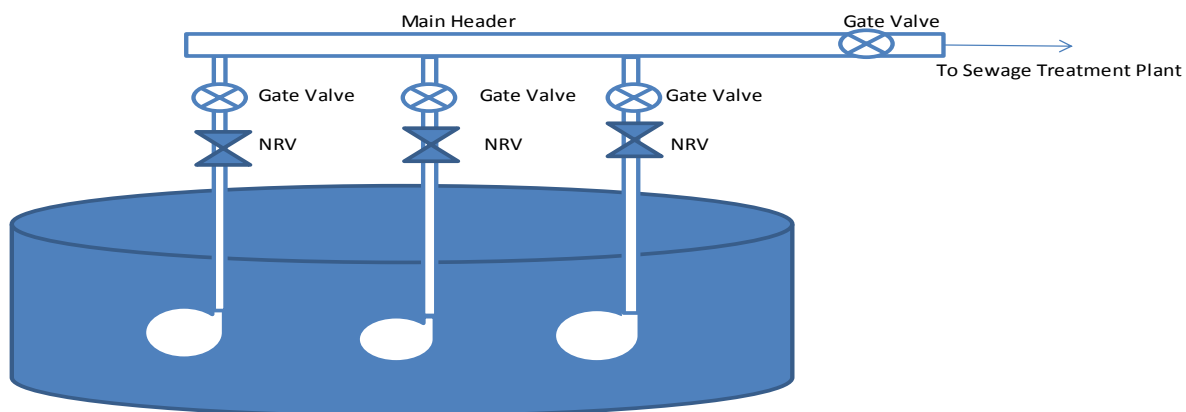


Figure 7 P&ID diagram of all sewage Pumping station

4.2.7 Pump Performance Evaluation

As per the methodology described in section-1.4, the energy audit team has collected detailed information from the pumping stations. Site data collection activities included the following:

- Data collection
- System mapping including collection of inventories, name plate details
- Measurements of flow, head and power input to motor
- Interaction with the site personnel on the operating practices
- Verification of Job card by the authorized representative of ULB

Detailed energy audit at Nagar Nigam Mathura- Vrindavan, U.P was conducted from 24/04/2017 to 11/08/2017. The general details of the sites audited are given table 10:

Table 10 General details of Mathura Pumping stations

Date	Value/Details
Name of Site	Nagar Nigam Mathura- Vrindavan
Area covered for water distribution	Mathura City
Classification (WTP, PS, SPS, STP)	Pumping Station, Sewage Pumping Station
Pump installed	176
No. of pumps where measurement could be taken	4
No. of pumps under maintenance	30

Photographs captured at the Nagar Nigam Mathura- Vrindavan to showcase the actual situation are provided in figure 8.



Figure 8 Photographs of pumping station site

The performance evaluation of the pumps was done based on the measurement done during energy audit. Results of performance evaluation of pumps are provided in table11:

Table 11 Performance evaluation of Water Supply Pumps for Mathura City

Parameters	Unit	Bhuteshwar Campus TW No.2	Bhuteshwar Campus TW No.5	Bhuteshwar Campus TW No.7	Nagar Palika TW No.15	Bangali Ghat TW No.16	Police Line TW No.25	Bhuteshwar Campus TW No.27	District Jail TW No.29	Govind Nagar Sec. A	Kushak Gali-1
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	M3/hr	36	-	30	-	24	36	36	24	36	30
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Measured Flow	m3/hr	24.7	28.21	27.05	17.24	16.13	35.42	10.22	32.98	33.05	22.52
Measured Discharge Pressure (A)	kg/cm2	1.1	1.8	1.2	1.3	1.8	1.7	2.2	0.8	1.1	0.8
Total Bore length	Ft.	230	350	230	230	230	230	230	230	230	230
Water Level Below Ground (B)	m	38	37	37	30	18	24	38	21	40	18
Height above Surface to Measured Gauge Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	39	38	38	31	19	25	39	22	41	19
Performance Evaluation											
Total Head (= (AX10)+(D))	m	50	56	50	44	37	42	61	30	52	27
Average kW	kW	8.63	11.51	8.86	9.61	7.51	13.07	9.57	12.81	10.11	11.71
Hydraulic Power	kW	3.36	4.30	3.68	2.07	1.63	4.05	1.70	2.69	4.68	1.66
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.34	9.79	7.53	8.17	6.38	11.11	8.13	10.89	8.60	9.95

Parameters	Unit	Bhuteshwar Campus TW No.2	Bhuteshwar Campus TW No.5	Bhuteshwar Campus TW No.7	Nagar Palika TW No.15	Bangali Ghat TW No.16	Police Line TW No.25	Bhuteshwar Campus TW No.27	District Jail TW No.29	Govind Nagar Sec. A	Kushak Gali-1
Pump Efficiency	%	45.8%	44.0%	48.9%	25.3%	25.5%	36.5%	20.9%	24.7%	54.5%	16.6%
Overall (Pump set) Efficiency	%	39.0%	37.4%	41.6%	21.5%	21.7%	31.0%	17.7%	21.0%	46.3%	14.1%
Specific Energy Consumption	kW/m ³	0.349	0.408	0.327	0.558	0.465	0.369	0.936	0.388	0.306	0.520

Parameters	Unit	Shyam Ghat	Vishram Ghat	Chatta Bazar	Rampal Gali	Vrindavan Gate	Theknarnol	Dwarkeshpuri	Unth Gali	Naya Nagla Gali No.8	Chah Kathoti
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18	18	15
Rated Power	HP	10	12.5	12.5	12.5	12.5	12.5	12.5	12.5	10	10
Rated Power	kW	7.46	9.325	9.325	9.325	9.325	9.325	9.325	9.325	7.46	7.46
Parameters Measured											
Measured Flow	m ³ /hr	8.87	34.3	36.41	22.97	25.96	21.41	15.33	10.38	11.45	19.4
Measured Discharge Pressure (A)	kg/cm ²	3.8	2.9	1.5	1.2	3	2.3	2.4	1.8	0.4	1.1
Total Bore length	Ft.	180	-	230	-	230	250	180	230	230	230
Water Level Below Ground (B)	m	9	9	30	40	15	46	34	43	34	34
Height above Surface to Measured Gauge Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	10	10	31	41	16	47	35	44	35	35
Performance Evaluation											
Total Head (=AX10)+(D)	m	48	39	46	53	46	70	59	62	39	46
Average kW	kW	6.133	12.11	12.46	8.85	11.11	12.41	12.19	9.51	8.65	8.09

Parameters	Unit	Shyam Ghat	Vishram Ghat	Chatta Bazar	Rampal Gali	Vrindavan Gate	Theknarnol	Dwarkeshpuri	Unth Gali	Naya Nagla Gali No.8	Chah Kathoti
Hydraulic Power	kW	1.16	3.64	4.56	3.32	3.25	4.08	2.46	1.75	1.22	2.43
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	5.21	10.29	10.59	7.52	9.44	10.55	10.36	8.08	7.35	6.87
Pump Efficiency	%	22.2%	35.4%	43.1%	44.1%	34.4%	38.7%	23.8%	21.7%	16.5%	35.4%
Overall (Pump set) Efficiency	%	18.9%	30.1%	36.6%	37.5%	29.3%	32.9%	20.2%	18.4%	14.1%	30.1%
Specific Energy Consumption	kW/m ³	0.691	0.353	0.342	0.385	0.428	0.580	0.795	0.916	0.755	0.417

Parameters	Unit	Agra Hotel	Dhruv Ghat	Maholi Ki Paur	Radhika Vihar	Dholi Pyau	Thateran Gali	Bairag puri	Bhargva Gali	Gandhi Park Pump-1	Megha Gali
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	24	24	24	24	21	24	18	18	15
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	10	6
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	7.46	4.476
Parameters Measured											
Measured Flow	m ³ /hr	28.07	27.8	25.74	24.68	24.87	17.58	14.18	39.20	24.98	6.93
Measured Discharge Pressure (A)	kg/cm ²	3.6	2.3	0.8	1.1	1.2	0.8	1	1.1	1.9	1.7
Total Bore length	Ft.	230	230	230	230	230	230	230	230	180	180
Water Level Below Ground (B)	m	9	12	49	40	37	40	24	43	27	30
Height above Surface to Measured Guage Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	10	13	50	41	38	41	25	44	28	31
Performance Evaluation											

Parameters	Unit	Agra Hotel	Dhruv Ghat	Maholi Ki Paur	Radhika Vihar	Dholi Pyau	Thateran Gali	Bairag puri	Bhargva Gali	Gandhi Park Pump-1	Megha Gali
Total Head (=(AX10)+(D))	M	46	36	58	52	50	49	35	55	47	48
Average kW	kW	11.87	7.56	8.90	9.54	8.41	10.29	6.13	11.12	8.03	3.34
Hydraulic Power	kW	3.52	2.73	4.07	3.49	3.39	2.35	1.35	5.87	3.20	0.91
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	10.09	6.43	7.56	8.11	7.15	8.75	5.21	9.45	6.83	2.84
Pump Efficiency	%	34.8%	42.4%	53.8%	43.1%	47.4%	26.8%	26.0%	62.1%	46.8%	31.9%
Overall (Pump set) Efficiency	%	29.6%	36.0%	45.7%	36.6%	40.3%	22.8%	22.1%	52.8%	39.8%	27.1%
Specific Energy Consumption	kW/m ³	0.423	0.272	0.346	0.387	0.338	0.585	0.432	0.284	0.322	0.483

Parameters	Unit	Bhadurpura	Chaganpura	Krishna Vihar NH-2	Askunda	Mahavidya Face-2	Dalpat Khidki	Gopalpura	Laxmi Nagar-1	Laxmi Nagar-2	Laxmi Nagar-4
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	24	18	18	18	15	18	18	18
Rated Power	HP	12.5	10	12.5	10	12.5	10	12.5	12.5	12.5	10
Rated Power	kW	9.325	7.46	9.325	7.46	9.325	7.46	9.325	9.325	9.325	7.46
Parameters Measured											
Measured Flow	m ³ /hr	15.55	24.09	11.02	32.44	17.57	19.77	18.19	29.42	31.84	39.23
Measured Discharge Pressure (A)	kg/cm ²	1	0.9	1	3.5	2.4	1.2	2.8	1.3	2.9	1.35
Total Bore length	Ft.	230	180	180	180	180	180	180	180	180	180
Water Level Below Ground (B)	m	34	37	40	9	34	40	30	9	12	12
Height above Surface to Measured Gauge Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	35	38	41	10	35	41	31	10	13	13

Parameters	Unit	Bhadurpura	Chaganpura	Krishna Vihar NH-2	Askunda	Mahavidya Face-2	Dalpat Khidki	Gopalpura	Laxmi Nagar-1	Laxmi Nagar-2	Laxmi Nagar-4
Performance Evaluation											
Total Head (=AX10)+(D)	m	45	47	51	45	59	53	59	23	42	26.5
Average kW	kW	11.22	7.73	8.53	9.99	12.13	7.13	12.76	6.89	8.89	6.97
Hydraulic Power	kW	1.91	3.08	1.53	3.98	2.82	2.85	2.92	1.84	3.64	2.83
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	9.54	6.57	7.25	8.49	10.31	6.06	10.84	5.86	7.56	5.92
Pump Efficiency	%	20.0%	46.9%	21.1%	46.8%	27.4%	47.1%	27.0%	31.4%	48.2%	47.8%
Overall (Pump set) Efficiency	%	17.0%	39.9%	17.9%	39.8%	23.3%	40.0%	22.9%	26.7%	41.0%	40.6%
Specific Energy Consumption	kW/m ³	0.722	0.321	0.774	0.308	0.691	0.361	0.701	0.234	0.279	0.178

Parameters	Unit	Naya Nagla, Koyla Gali	Maholi Yojna-1	Maholi Yojna-3	Sheetla Ghati	Manas Nagar	Ratan Kund	Gau Ghat	Arjunpura	Officer Colony
Rated Parameters										
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	M	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	24	24	18	18	18	18	18	18
Rated Power	HP	10	12.5	12.5	10	10	10	10	12.5	12.5
Rated Power	kW	7.46	9.325	9.325	7.46	7.46	7.46	7.46	9.325	9.325
Parameters Measured										
Measured Flow	m ³ /hr	20.93	27.03	36.9	14.06	23.51	11.9	23.26	12.32	19.13
Measured Discharge Pressure (A)	kg/cm ²	1.2	1	1.1	1.4	0.9	0.9	1.1	2	0.7
Total Bore length	Ft.	180	180	180	230	180	230	180	180	180
Water Level Below Ground (B)	M	34	35	37	55	37	49	27	40	15
Height above Surface to Measured Guage Pressure, if any (C)	M	1	1	1	1	1	1	1	1	1

Parameters	Unit	Naya Nagla, Koyla Gali	Maholi Yojna-1	Maholi Yojna-3	Sheetla Ghati	Manas Nagar	Ratan Kund	Gau Ghat	Arjunpura	Officer Colony
Static Discharge Head (D= B+C)	M	35	36	38	56	38	50	28	41	16
Performance Evaluation										
Total Head (=AX10)+(D)	M	47	46	49	70	47	59	39	61	23
Average kW	kW	7.03	8.75	9.97	6.03	6.21	5.51	7.66	9.51	9.15
Hydraulic Power	kW	2.68	3.39	4.92	2.68	3.01	1.91	2.47	2.05	1.20
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	5.98	7.44	8.47	5.13	5.28	4.68	6.51	8.08	7.78
Pump Efficiency	%	44.8%	45.5%	58.1%	52.3%	57.0%	40.8%	37.9%	25.3%	15.4%
Overall (Pump set) Efficiency	%	38.1%	38.7%	49.4%	44.4%	48.4%	34.7%	32.2%	21.5%	13.1%
Specific Energy Consumption	kW/m ³	0.336	0.324	0.270	0.429	0.264	0.463	0.329	0.772	0.478

Parameters	Unit	Badpura Colony	Narayan Puri	Jhigurpura	Raigarpura	Gupta Kunj	Radha Nagar	Manoharpura	Krishna Nagar
Rated Parameters									
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	M	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	15	30	18	15	18	24	24	24
Rated Power	HP	12.5	12.5	10	12.5	10	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	7.46	9.325	7.46	9.325	9.325	9.325
Parameters Measured									
Measured Flow	m3/hr	33.3	29.03	15.77	32.98	17.87	20.1	14.19	17.97
Measured Discharge Pressure (A)	kg/cm2	0.8	0.8	1.1	1.5	0.8	0.5	2.2	1.4
Total Bore length	Ft.	180	180	230	180	180	180	280	180
Water Level Below Ground (B)	M	30	37	37	27	40	40	55	37

Parameters	Unit	Badpura Colony	Narayan Puri	Jhigurpura	Raigarpura	Gupta Kunj	Radha Nagar	Manoharpura	Krishna Nagar
Height above Surface to Measured Gauge Pressure, if any (C)	M	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	M	31	38	38	28	41	41	56	38
Performance Evaluation									
Total Head (=AX10)+(D)	M	39	46	49	43	49	46	78	52
Average kW	kW	8.98	12.03	7.94	9.13	7.64	9.03	8.08	8.61
Hydraulic Power	kW	3.54	3.64	2.10	3.86	2.38	2.52	3.01	2.54
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.63	10.23	6.75	7.76	6.50	7.68	6.87	7.32
Pump Efficiency	%	46.4%	35.6%	31.2%	49.7%	36.7%	32.8%	43.9%	34.8%
Overall (Pump set) Efficiency	%	39.4%	30.2%	26.5%	42.3%	31.2%	27.9%	37.3%	29.6%
Specific Energy Consumption	kW/m ³	0.270	0.415	0.503	0.277	0.428	0.449	0.570	0.479

Parameters	Unit	Heja Hospital	Laxmi Nagar	Maholi Yojna-2	Antapada	Rani Mandi	Kutta Paysa	Gali Ravaliya	Gali Rajkumar	Gandhi Park-2	Arjunpura-2
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	M	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	24	18	18	24	24	24	24	24	24	24
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											

Parameters	Unit	Heja Hospital	Laxmi Nagar	Maholi Yojna-2	Antapada	Rani Mandi	Kutta Paysa	Gali Ravaliya	Gali Rajkumar	Gandhi Park-2	Arjunpura-2
Measured Flow	m3/hr	16.76	19.87	28.6	26.43	17.68	19.93	20.08	29.41	17.85	15.42
Measured Discharge Pressure (A)	kg/cm2	1.4	1.2	1.2	1.2	1.3	1	1.2	1.6	1.4	1.1
Total Bore length	Ft.	230	180	180	180	180	230	180	230	180	230
Water Level Below Ground (B)	M	46	12	37	24	30	43	38	46	27	43
Height above Surface to Measured Gauge Pressure, if any (C)	M	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	M	47	13	38	25	31	44	39	47	28	44
Performance Evaluation											
Total Head (=(AX10)+(D)	M	61	25	50	37	44	54	51	63	42	55
Average kW	kW	8.26	9.50	9.66	9.52	11.73	9.72	6.33	12.59	8.86	8.62
Hydraulic Power	kW	2.78	1.35	3.89	2.66	2.12	2.93	2.79	5.05	2.04	2.31
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.02	8.08	8.21	8.09	9.97	8.26	5.38	10.70	7.53	7.33
Pump Efficiency	%	39.7%	16.8%	47.4%	32.9%	21.2%	35.5%	51.9%	47.2%	27.1%	31.5%
Overall (Pump set) Efficiency	%	33.7%	14.2%	40.3%	28.0%	18.1%	30.2%	44.1%	40.1%	23.0%	26.8%
Specific Energy Consumption	kW/m ³	0.493	0.478	0.338	0.360	0.664	0.488	0.315	0.428	0.497	0.559

Parameters	Unit	Theknarnol-2	Madhav Puri	Dholi Pyau Tiraha-New Construction	Ahilyabai Park Dampier Nagar MVDA	Ramlila Ground Krishna Nagar MVDA	Kankali Temple Dwarikapuri MVDA	Nai Basti W.No.	Andi Kuiya	Kathoti Kua Chaupal	Kathoti Kua Masjid
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	24	21	24	27	18	18	18	18	18	18
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	10	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	7.46	9.325	9.325	9.325	9.325
Parameters Measured											
Measured Flow	m3/hr	25.51	21.57	20.14	24.7	18.58	18.67	27.86	31.24	18.47	18.57
Measured Discharge Pressure (A)	kg/cm2	1.3	1.3	1.6	1.2	1.6	1.2	0.9	0.7	1.2	2.1
Total Bore length	Ft.	230	180	180	230	180	180	230	230	180	180
Water Level Below Ground (B)	m	46	37	37	30	24	37	40	46	37	34
Height above Surface to Measured Gauge Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	47	38	38	31	25	38	41	47	38	35
Performance Evaluation											
Total Head (=(AX10)+(D)	m	60	51	54	43	41	50	50	54	50	56
Average Voltage	V	406.92	411.64	404.29	408.79	365.12	397.78	399.33	412.19	399.01	385.18
Average Current	A	14.21	14.63	20.63	16.78	19.19	14.93	16.97	18.99	16.48	22.01
Average PF	pf	0.87	0.77	0.84	0.87	0.81	0.74	0.91	0.78	0.82	0.88
Average kW	kW	8.77	8.06	11.93	9.95	9.87	7.57	10.56	10.63	9.37	12.86
Hydraulic Power	kW	4.17	3.00	2.96	2.89	2.07	2.54	3.79	4.59	2.51	2.83
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.46	6.85	10.14	8.46	8.39	6.44	8.98	9.03	7.96	10.93

Parameters	Unit	Theknarnol-2	Madhav Puri	Dholi Pyau Tiraha-New Construction	Ahilyabai Park Dampier Nagar MVDA	Ramlila Ground Krishna Nagar MVDA	Kankali Temple Dwarikapuri MVDA	Nai Basti W.No.	Andi Kuiya	Kathoti Kua Chaupal	Kathoti Kua Masjid
Pump Efficiency	%	55.9%	43.7%	29.2%	34.2%	24.7%	39.5%	42.3%	50.9%	31.6%	25.9%
Overall (Pump set) Efficiency	%	47.5%	37.2%	24.8%	29.1%	21.0%	33.6%	35.9%	43.2%	26.9%	22.0%
Specific Energy Consumption	kW/m ³	0.344	0.374	0.593	0.403	0.531	0.406	0.379	0.340	0.507	0.693

Parameters	Unit	Gupta Kunk WNo.7	Sadar Dhobi Pada W.No.8	Gandhi Nagar W.No. 9	Laxmi Nagar W.No. 9	Bains Bhora Kotwali W.No.14	Radhey Shyam Ashram W.No.16	Om Nagar W.No.17	Om Nagar-2 W.No.17	Jogi Gali Antapada W.No.18	Khateek Mohalla Balmiki Basti W.No.19
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18	18	18
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Measured Flow	m ³ /hr	22.6	39.15	16.69	17.23	27.62	17.49	21.59	17.09	23.08	20.13
Measured Discharge Pressure (A)	kg/cm ²	1.1	0.6	1	1.2	1.2	2.6	1	1.2	0.9	1.2
Total Bore length	Ft.	180	180	180	180	180	180	180	230	180	230
Water Level Below Ground (B)	m	37	18	34	37	40	15	34	37	34	40
Height above Surface to Measured Guage Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1

Parameters	Unit	Gupta Kunk W.No.7	Sadar Dhobi Pada W.No.8	Gandhi Nagar W.No. 9	Laxmi Nagar W.No. 9	Bains Bhora Kotwali W.No.14	Radhey Shyam Ashram W.No.16	Om Nagar W.No.17	Om Nagar-2 W.No.17	Jogi Gali Antapada W.No.18	Khateek Mohalla Balmiki Basti W.No.19
Static Discharge Head (D= B+C)	m	38	19	35	38	41	16	35	38	35	41
Performance Evaluation											
Total Head =(AX10)+(D)	m	49	25	45	50	53	42	45	50	44	53
Average kW	kW	7.30	10.26	8.23	9.56	9.05	11.94	9.23	8.48	8.54	9.07
Hydraulic Power	kW	3.02	2.67	2.05	2.35	3.99	2.00	2.65	2.33	2.77	2.91
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	6.20	8.72	7.00	8.13	7.70	10.15	7.85	7.21	7.26	7.71
Pump Efficiency	%	48.6%	30.6%	29.2%	28.9%	51.8%	19.7%	33.7%	32.3%	38.1%	37.7%
Overall (Pump set) Efficiency	%	41.3%	26.0%	24.8%	24.5%	44.0%	16.8%	28.7%	27.4%	32.4%	32.0%
Specific Energy Consumption	kW/m ³	0.323	0.262	0.493	0.555	0.328	0.682	0.427	0.496	0.370	0.451

Parameters	Unit	Guru Nanak Nagar W.No.19	Krishnapuram-1 Ward-24	Krishnapuram-2 Ward-24	Balmiki Basti Dholi Pyau Ward-27	Mahavidya Park Ward-28	Hanuman Teela Ward-33	Kashmiri Gali Ward-34	Mission Teela Sadar Bazar Ward-35	Matia Gate Ward-37	Subhash Nagar Nala Ward-38
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18	18	18
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Measured Flow	m ³ /hr	9.48	28.43	29.25	13.35	21.77	17.87	18.33	29.31	22.83	18.21

Parameters	Unit	Guru Nanak Nagar W.No.19	Krishnapuram-1 Ward-24	Krishnapuram-2 Ward-24	Balmiki Basti Dholi Pyau Ward-27	Mahavidya Park Ward-28	Hanuman Teela Ward-33	Kashmiri Gali Ward-34	Mission Teela Sadar Bazar Ward-35	Matia Gate Ward-37	Subhash Nagar Nala Ward-38
Measured Discharge Pressure (A)	kg/cm2	0.8	0.8	1.2	1.2	1.6	1.9	2.1	0.7	1.7	1.4
Total Bore length	Fl.	180	230	230	180	180	180	180	180	230	180
Water Level Below Ground (B)	m	37	30	30	37	37	34	15	30	46	34
Height above Surface to Measured Guage Pressure, if any (C)	m	1	1	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	38	31	31	38	38	35	16	31	47	35
Performance Evaluation											
Total Head (=AX10)+(D)	m	46	39	43	50	54	54	37	38	64	49
Average kW	kW	8.00	10.72	10.19	9.03	6.55	7.47	6.97	10.86	8.99	11.43
Hydraulic Power	kW	1.19	3.02	3.43	1.82	3.20	2.63	1.85	3.03	3.98	2.43
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	6.80	9.11	8.66	7.68	5.57	6.35	5.92	9.23	7.64	9.72
Pump Efficiency	%	17.5%	33.1%	39.5%	23.7%	57.5%	41.4%	31.2%	32.9%	52.1%	25.0%
Overall (Pump set) Efficiency	%	14.8%	28.2%	33.6%	20.1%	48.9%	35.2%	26.5%	27.9%	44.3%	21.3%
Specific Energy Consumption	kW/m ³	0.844	0.377	0.348	0.677	0.301	0.418	0.380	0.371	0.394	0.628

Parameters	Unit	Manshapuri Ward-39	Rampal Gali Ward-40	Theknarnol Ward-40	Lala Ganj Ward-42	Kashiram Yojna-3	Kashiram Yojna-4	Satrangi Garden Ward-8	Naya Nagla Ward-11
Rated Parameters									
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible

Parameters	Unit	Manshapuri Ward-39	Rampal Gali Ward-40	Theknarnol Ward-40	Lala Ganj Ward-42	Kashiram Yojna-3	Kashiram Yojna-4	Satrangi Garden Ward-8	Naya Nagla Ward-11
Rated Head	m	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	18	18	18	18	18	18	18	18
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured									
Measured Flow	m3/hr	15.27	24.37	21.83	17.02	14.65	20.61	31.84	22.47
Measured Discharge Pressure (A)	kg/cm2	1.2	1.1	1.2	1.5	3.5	4	0.8	0.9
Total Bore length	Ft.	180	180	180	230	180	180	180	180
Water Level Below Ground (B)	m	34	37	40	46	12	12	12	34
Height above Surface to Measured Gauge Pressure, if any (C)	m	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	35	38	41	47	13	13	13	35
Performance Evaluation									
Total Head (=(AX10)+(D)	m	47	49	53	62	48	53	21	44
Average kW	kW	9.45	6.87	7.46	7.80	7.00	11.30	6.94	7.86
Hydraulic Power	kW	1.95	3.25	3.15	2.87	1.92	2.97	1.82	2.69
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	8.03	5.84	6.35	6.63	5.95	9.61	5.90	6.68
Pump Efficiency	%	24.3%	55.7%	49.7%	43.4%	32.2%	31.0%	30.9%	40.3%
Overall (Pump set) Efficiency	%	20.7%	47.4%	42.2%	36.9%	27.4%	26.3%	26.3%	34.2%
Specific Energy Consumption	kW/m ³	0.619	0.282	0.342	0.458	0.478	0.548	0.218	0.350

Parameters	Unit	Mali Mohalla Sadar Ward-13	Naya Bans Ward-15	Machli Gate Ward-19	Motikunj Extension	Rani Mandi Balmiki Basti Ward-6	Matia Gate Joshiyan Garden	Sanjay Nagar Nala	Balmiki Basti Ward-1
Rated Parameters									
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured									
Measured Flow	m ³ /hr	24.16	16.49	10.74	27.43	24.47	25.34	25.17	18.17
Measured Discharge Pressure (A)	kg/cm ²	1.2	1.5	0.9	1.2	1.1	1.2	1.3	1.1
Total Bore length	Ft.	230	230	230	180	180	230	180	180
Water Level Below Ground (B)	m	37	46	40	34	37	46	34	40
Height above Surface to Measured Guage Pressure, if any (C)	m	1	1	1	1	1	1	1	1
Static Discharge Head (D= B+C)	m	38	47	41	35	38	47	35	41
Performance Evaluation									
Total Head (=AX10)+(D)	m	50	62	50	47	49	59	48	52
Average kW	kW	10.82	7.93	7.57	8.61	9.59	9.12	8.10	9.38
Hydraulic Power	kW	3.29	2.78	1.46	3.51	3.27	4.07	3.29	2.57
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	9.19	6.74	6.43	7.32	8.15	7.75	6.88	7.97
Pump Efficiency	%	35.8%	41.3%	22.7%	48.0%	40.1%	52.5%	47.8%	32.3%
Overall (Pump set) Efficiency	%	30.4%	35.1%	19.3%	40.8%	34.1%	44.6%	40.6%	27.4%
Specific Energy Consumption	kW/m ³	0.448	0.481	0.705	0.314	0.392	0.360	0.322	0.516

Table 12 Performance evaluation of Sewage Pumps for Mathura City

Parameters	Unit	Masani Nala SPS Pump 1	Masani Nala SPS Pump 2	Masani Nala SPS Pump 3	Masani Nala SPS Pump 4	Masani Nala SPS Pump 5	Krishna Ganga SPS Pump 2	Chinta Haran SPS Pump 1	Chinta Haran SPS Pump 3
Rated Parameters									
Pump Type		Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible
Rated Head	m	36	36	36	36	36	20	20.5	20.5
Rated Flow	M3/hr	270	270	540	270	540	108	270	270
Rated Power	HP	40	40	120	40	120	15	25	25
Rated Power	kW	30	30	90	30	90	11	19	19
Parameters Measured									
Measured Flow	m3/hr	236.7	262.1	398.7	215.2	389.0	52.3	66.4	66.1
Measured Discharge Pressure (A)	kg/c m2	2.0	2.6	2.2	2.8	2.1	1.9	2.2	2.1
Total Bore length	Ft.	34	34	34	34	34	20	21	21
Sewage Level Below Measured Gauge Pressure (B)	m	5	5	5	5	5	3	3	3
Performance Evaluation									
Total Head (=AX10)+(D)	m	25	31	27	33	26	22	25	24
Average kW	kW	39.25	45.90	67.53	45.32	68.57	10.43	13.05	13.77
Hydraulic Power	kW	16.38	22.79	30.19	19.92	28.37	3.23	4.66	4.45
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	33.37	39.02	57.40	38.52	58.28	8.87	11.09	11.71
Pump Efficiency	%	49.1%	58.4%	52.6%	51.7%	48.7%	36.4%	42.0%	38.0%
Overall (Pump set) Efficiency	%	41.7%	49.7%	44.7%	44.0%	41.4%	31.0%	35.7%	32.3%
Specific Energy Consumption	kW/m ³	0.166	0.175	0.169	0.211	0.176	0.199	0.196	0.209

Parameters	Unit	Swami Ghat SPS Pump 1	Swami Ghat SPS Pump 2	Parallel Operation Swami Ghat SPS Pump 1 & 2	Cantt. Nala SPS Pump 1	Dairy Farm SPS Pump 1	Dairy Farm SPS Pump 2	Dairy Farm SPS Pump 3	Dairy Farm SPS Pump 4	Dairy Farm SPS Pump 5
Rated Parameters										
Pump Type		Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible
Rated Head	m				25	35	28	35	28	35
Rated Flow	M3/hr				72	338.4	165.6	338.4	165.6	338.4
Rated Power	HP	10	10	20	25	100	40	100	40	100
Rated Power	kW	7.5	7.5	14.9	19	75	30	75	30	75
Parameters Measured										
Measured Flow	m3/hr	122.8	119.5	215.0	39.9	293.7	110.3	302.9	111.2	312.3
Measured Discharge Pressure (A)	kg/c m2	0.8	0.7	0.8	1.9	2.0	1.2	2.0	1.3	1.9
Total Bore length	Ft.	20	20	20	40	34	34	34	34	34
Sewage Level Below Measured Gauge Pressure (B)	m	3.5	3.5	3.5	6	6	6	6	6	6
Performance Evaluation										
Total Head (=AX10)+(D)	m	12	11	12	25	26	18	26	19	25
Average kW	kW	12.52	12.41	26.40	23.91	80.39	36.45	78.20	36.10	76.20
Hydraulic Power	kW	3.96	3.52	6.94	2.80	21.42	5.57	21.81	5.93	21.90
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft	kW	10.65	10.55	22.44	20.32	68.33	30.98	66.47	30.69	64.77
Pump Efficiency	%	37.2%	33.4%	30.9%	13.8%	31.3%	18.0%	32.8%	19.3%	33.8%
Overall (Pump set) Efficiency	%	31.6%	28.4%	26.3%	11.7%	26.6%	15.3%	27.9%	16.4%	28.7%
Specific Energy Consumption	kW/m ₃	0.102	0.104	0.123	0.599	0.274	0.331	0.258	0.325	0.244

Parameters	Unit	Vrindavan Gate SPS Pump 1	Vrindavan Gate SPS Pump 2	Bangali Ghat SPS Pump 1	Bangali Ghat SPS Pump 5	Parallel Operation of Bangali Ghat SPS Pump 1 & Pump 5
Rated Parametres						
Pump Type		VT	VT	VT	VT	VT
Rated Head	M	13.5	13.5	24	24	--
Rated Flow	M3/hr	90	90	349.2	349.2	-
Rated Power	kW	7.5	7.5	44.8	44.8	-
Parameters Measured						
Measured Flow	m3/hr	55.1	51.8	212.9	236.8	438.0
Measured Discharge Pressure (A)	kg/cm2	0.6	0.9	2.1	2.3	2.3
Total Bore length	Ft.	31	31	21	21	21
Suction Head (B)	M	1	1	1	1	1
Performance Evaluation						
Total Head (=AX10)-B	M	5	8	20	22	22
Average Voltage	V	365.21	369.23	418.43	424.89	417.53
Average Current	A	18.08	17.91	67.58	64.14	135.13
Average PF	Pf	0.796	0.782	0.821	0.931	0.800
Average kW	kW	9.11	8.97	41.26	43.97	75.13
Hydraulic Power	kW	0.77	1.16	11.94	14.61	27.03
Motor Efficiency	%	80%	80%	80%	80%	80%
Pump Shaft Power	kW	7.29	7.17	33.01	35.17	60.10
Pump Efficiency	%	10.6%	16.2%	36.2%	41.5%	45.0%
Overall (Pump set) Efficiency	%	8.5%	13.0%	28.9%	33.2%	36.0%
Specific Energy Consumption	kW/m ³	0.165	0.173	0.194	0.186	0.172

4.2.8 Total Energy Consumption Estimation For Pump sets & Pumping Stations

The pumps are the major energy consuming equipment at the pumping stations. During energy audit activity, the measurements on individual pumps were taken. The operating hours of the individual pumps were also collected at pumping stations to estimate annual energy consumption for the baseline estimation and future M&V usage. The details are given Table 13:

Table 13 Estimated Energy Consumption

S. No	Name of the Pump	Operating Pattern	Measured power consumption (kW)	Pumping quantity (m ³ /hour)	Estimated annual operating hours (hour/annum)	Estimated annual power consumption (kWh/annum)
Water Supply Pumps						
1	Bhuteshwar Campus TW No.2	Working	8.6	24.7	2920	25200
2	Bhuteshwar Campus TW No.5	Working	11.5	28.2	730	8406
3	Bhuteshwar Campus TW No.7	Working	8.9	27.1	3285	29094
4	Nagar Palika TW No.15	Working	9.6	17.2	7300	70177
5	Bangali Ghat TW No.16	Working	7.5	16.1	7300	54799
6	Police Line TW No.25	Working	13.1	35.4	7300	95387
7	Bhuteshwar Campus TW No.27	Working	9.6	10.2	2920	27935
8	District Jail TW No.29	Working	12.8	33.0	5110	65459
9	Govind Nagar Sec. A	Working	10.1	33.1	4015	40601
10	Kushak Gali-1	Working	11.7	22.5	5110	59821
11	Shyam Ghat	Working	6.1	8.9	5840	35819
12	Vishram Ghat	Working	12.1	34.3	4380	53042
13	Chatta Bazar	Working	12.5	36.4	5840	72766
14	Rampal Gali	Working	8.8	23.0	4380	38756
15	Vrindavan Gate	Working	11.1	26.0	5840	64882
16	Theknarnol	Working	12.4	21.4	5110	63415
17	Dwarkeshpuri	Working	12.2	15.3	1460	17793
18	Unth Gali	Working	9.5	10.4	5840	55538
19	Naya Nagla Gali No.8	Working	8.7	11.5	2555	22101
20	Chah Kathoti	Working	8.1	19.4	3285	26565
21	Agra Hotel	Working	11.9	28.1	7300	86675
22	Dhruv Ghat	Working	7.6	27.8	7300	55196
23	Maholi Ki Paur	Working	8.9	25.7	4380	38963
24	Gaja Paysa	Working	8.5	24.6	3650	31013
25	Radhika Vihar	Working	9.5	24.7	2920	27867
26	Dholi Pyau	Working	8.4	24.9	4380	36846

S. No	Name of the Pump	Operating Pattern	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated annual power consumption (kWh/annum)
27	Thateran Gali	Working	10.3	17.6	4380	45070
28	Tulsi Chabutra	Working	6.5	23.3	3650	23579
29	Bairag puri	Working	6.1	14.2	2920	17890
30	Bhargva Gali	Working	11.1	39.2	6570	73027
31	Gandhi Park Pump-1	Working	8.0	25.0	2920	23456
32	Megha Gali	Working	3.3	6.9	1460	4883
33	Bhadurpura	Working	11.2	15.6	2920	32762
34	Chaganpura	Working	7.7	24.1	1460	11291
35	Krishna Vihar NH-2	Working	8.5	11.0	2920	24917
36	Askunda	Working	10.0	32.4	5475	54695
37	Mahavidya Face-2	Working	12.1	17.6	5840	70859
38	Dalpat Khidki	Working	7.1	19.8	2920	20829
39	Gopalpura	Working	12.8	18.2	2555	32593
40	Shanti Nagar	Working	9.3	33.1	4015	37299
41	Laxmi Nagar-1	Working	6.9	29.4	6570	45289
42	Laxmi Nagar-2	Working	8.9	31.8	3650	32449
43	Laxmi Nagar-4	Working	7.0	39.2	2920	20352
44	Naya Nagla, Koyla Gali	Working	7.0	20.9	3650	25667
45	Maholi Yojna-1	Working	8.8	27.0	2920	25550
46	Maholi Yojna-3	Working	10.0	36.9	2920	29103
47	Sheetla Ghati	Working	6.0	14.1	5110	30830
48	Manas Nagar	Working	6.2	23.5	4015	24948
49	Ratan Kund	Working	5.5	11.9	5110	28139
50	Gau Ghat	Working	7.7	23.3	4015	30768
51	Arjunpura	Working	9.5	12.3	1825	17350
52	Officer Colony	Working	9.1	19.1	4380	40070
53	Badpura Colony	Working	9.0	33.3	5475	49147
54	Narayan Puri	Working	12.0	29.0	7300	87843
55	Jhigurpura	Working	7.9	15.8	4380	34777
56	Raigarpura	Working	9.1	33.0	4380	40004
57	Gupta Kunj	Working	7.6	17.9	2920	22314
58	Radha Nagar	Working	9.0	20.1	4745	42863
59	Manoharpura	Working	8.1	14.2	1825	14752
60	Krishna Nagar	Working	8.6	18.0	2920	25135
61	Heja Hospital	Working	8.3	16.8	2190	18082
62	Laxmi Nagar	Working	9.5	19.9	4380	41614
63	Maholi Yojna-2	Working	9.7	28.6	2920	28207

S. No	Name of the Pump	Operating Pattern	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated annual power consumption (kWh/annum)
64	Antapada	Working	9.5	26.4	4380	41698
65	Rani Mandi	Working	11.7	17.7	2920	34261
66	Kutta Paysa	Working	9.7	19.9	3650	35466
67	Gali Ravaliya	Working	6.3	20.1	3650	23092
68	Gali Rajkumar	Working	12.6	29.4	4380	55130
69	Gandhi Park-2	Working	8.9	17.9	4380	38821
70	Arjunpura-2	Working	8.6	15.4	2190	18878
71	Theknarnol-2	Working	8.8	25.5	4380	38427
72	Madhav Puri	Working	8.1	21.6	4015	32366
73	Dholi Pyau Tiraha-New Construction	Working	11.9	20.1	7300	87113
74	Ahilyabai Park Dampier Nagar MVDA	Working	9.9	24.7	4380	43570
75	Ramlila Ground Krishna Nagar MVDA	Working	9.9	18.6	2190	21608
76	Kankali Temple Dwarikapuri MVDA	Working	7.6	18.7	4015	30403
77	Machli Mandi Bharatpur Gate	Working	8.8	30.6	4380	38602
78	Nai Basti W.No.	Working	10.6	27.9	2920	30835
79	Andi Kuiya	Working	10.6	31.2	5475	58181
80	Kathoti Kua Chaupal	Working	9.4	18.5	3650	34188
81	Kathoti Kua Masjid	Working	12.9	18.6	1825	23470
82	Gupta Kunk WNo.7	Working	7.3	22.6	3285	23976
83	Sadar Dhobi Pada W.No8	Working	10.3	39.2	5110	52429
84	Gandhi Nagar W.No. 9	Working	8.2	16.7	2190	18031
85	Laxmi Nagar W.No. 9	Working	9.6	17.2	5110	48869
86	Bains Bhora Kotwali W.No.14	Working	9.1	27.6	2920	26437
87	Radhey Shyam Ashram W.No.16	Working	11.9	17.5	5840	69710
88	Om Nagar W.No.17	Working	9.2	21.6	4380	40426
89	Om Nagar-2 W.No.17	Working	8.5	17.1	6570	55714
90	Antapara behind Gurudwara W.No.18	Working	7.8	35.0	2190	17065
91	Jogi Gali Antapada W.No.18	Working	8.5	23.1	2190	18699
92	Khateek Mohalla Balmiki Basti W.No.19	Working	9.1	20.1	5110	46369
93	Guru Nanak Nagar W.No.19	Working	8.0	9.5	2007.5	16060
94	Krishnapuram-1 Ward-24	Working	10.7	28.4	1460	15648
95	Krishnapuram-2 Ward-24	Working	10.2	29.3	1460	14879
96	Balmiki Basti Dholi Ward-27	Working	9.0	13.4	4745	42863
97	Mahavidya Park Ward-28	Working	6.5	21.8	4380	28676
98	Hanuman Teela Ward-33	Working	7.5	17.9	1460	10909
99	Kashmiri Gali Ward-34	Working	7.0	18.3	3650	25428
100	Mission Teela Sadar Bazar Ward-35	Working	10.9	29.3	5110	55495

S. No	Name of the Pump	Operating Pattern	Measured power consumption (kW)	Pumping quantity (m ³ /hour)	Estimated annual operating hours (hour/annum)	Estimated annual power consumption (kWh/annum)
101	Matia Gate Ward-37	Working	9.0	22.8	5110	45915
102	Subhash Nagar Nala Ward-38	Working	11.4	18.2	2920	33385
103	Manshapuri Ward-39	Working	9.4	15.3	2920	27583
104	Rampal Gali Ward-40	Working	6.9	24.4	3285	22557
105	Theknarnol Ward-40	Working	7.5	21.8	5110	38146
106	Lala Ganj Ward-42	Working	7.8	17.0	2920	22763
107	Kashiram Yojna-3	Working	7.0	14.7	3650	25550
108	Kashiram Yojna-4	Working	11.3	20.6	3650	41245
109	Satrangi Garden Ward-8	Working	6.9	31.8	5475	37978
110	Ambedkar Pratima Ward-10	Working	9.1	35.7	2190	19912
111	Naya Nagla Ward-11	Working	7.9	22.5	4380	34435
112	Ambedkar Nagar Ward-12	Working	8.8	32.7	1825	15974
113	Mali Mohalla Sadar Ward-13	Working	10.8	24.2	3650	39483
114	Naya Bans Ward-15	Working	7.9	16.5	1825	14472
115	Machli Gate Ward-19	Working	7.6	10.7	1825	13809
116	Bhim Nagar S.B.I. Ward-27	Working	6.6	24.4	4380	28774
117	Motikunj Extension	Working	8.6	27.4	4380	37722
118	Rani Mandi Balmiki Basti Ward-6	Working	9.6	24.5	3650	34990
119	Matia Gate Joshayan Garden	Working	9.1	25.3	4380	39954
120	Sanjay Nagar Nala	Working	8.1	25.2	4380	35469
121	Balmiki Basti Ward-1	Working	9.4	18.2	4380	41085
Sub-Total (A)			1101	2746	476508	4397513
Sewage Water Pumping Stations						
122	Masani Nala SPS Pump 1	Five Pumps, one pump is operating at a time on rotational basis	39.3	236.7	1460	57310
123	Masani Nala SPS Pump 2		45.9	262.1	1460	67018
124	Masani Nala SPS Pump 3		67.5	398.7	1460	98588
125	Masani Nala SPS Pump 4		45.3	215.2	1460	66165
126	Masani Nala SPS Pump 5		68.6	389.0	1460	100111
127	Krishna Ganga SPS Pump 2	Three Pumps, 2W + 1 NW, pump operated on rotational basis	10.4	52.3	1460	19037
128	Krishna Ganga SPS Pump 3		10.4	54.3	1460	19037
129	Chinta Haran SPS Pump 1	Three Pumps, 2W + 1 NW, pump operated on rotational basis	13.0	66.4	1095	14288
130	Chinta Haran SPS Pump 3		13.8	66.1	1095	15082
131	Swami Ghat SPS Pump 1	Three Pumps, 2W + 1 NW, pump operated on rotational basis	12.5	122.8	3650	45713
132	Swami Ghat SPS Pump 2		12.4	119.5	3650	45285
133	Cantt. Nala SPS Pump 1	Five Pumps, 1W + 4NW	23.9	39.9	4380	104726

S. No	Name of the Pump	Operating Pattern	Measured power consumption (kW)	Pumping quantity (m3/ hour)	Estimated annual operating hours (hour/ annum)	Estimated annual power consumption (kWh/annum)
134	Dairy Farm SPS Pump 1	Six Pumps, 5W + 1 NW, one pump is operating at a tome on rotational basis	80.4	293.7	1460	117373
135	Dairy Farm SPS Pump 2		36.4	110.3	1460	53211
136	Dairy Farm SPS Pump 3		78.2	302.9	1460	114169
137	Dairy Farm SPS Pump 4		36.1	111.2	1460	52708
138	Dairy Farm SPS Pump 5		76.2	312.3	1460	111252
139	Vrindavan Gate SPS Pump 1	Three Pumps, 2W + 1 NW, pump operated on rotational basis	9.1	55.1	1825	16632
140	Vrindavan Gate SPS Pump 2		9.0	51.8	1825	16368
141	Bangali Ghat SPS Pump 1	Five Pumps, 2W + 3 NW, pump operated on rotational basis	41.3	212.9	1825	75304
142	Bangali Ghat SPS Pump 5		44.0	236.8	1825	80243
Sub-Total (B)			774	3710	38690	1289619
Net Total			1875	6456	515198	5687132

4.2.9 Auxiliaries in Pumping Stations

During the energy audit, auxiliary electrical load of pumping station were also studied and details of same is provided in table 14.

Table 14 Details of Auxiliary Load of pumping station

Pumps Name	Bulb (100 W)	Bulb (60 W)	LED (9 W)	LED (50 W)	LED (40 W)	FTL (40 W)	Fan (70 W)	Cooler fan (120 W)	Exhaust Fan (150W)	Exhaust Fan (250W)	Table Fan (35 W)	HPS V (250 W)	HPS V (150 W)
Cantt. Nala SPS	1		1	1		1				1			
Dairy Farm SPS			1		1	2			2		1	3	2
Vrindavan Gate SPS	1	1	1	1							1		
Bengali Ghat SPS	3	2											
Masani Nala SPS	1		1	2			1		1				
Swami Ghat SPS			1	1			1		1	1		1	
Krishna Ganga SPS		1	2					1					
Chinta Haran SPS	1	1									1		
Total Nos.	7	5	7	5	1	3	2	1	4	2	3	4	2
Total Connected Load (A)	0.7	0.3	0.06	0.25	0.04	0.12	0.14	0.12	0.6	0.5	0.105	1	0.3
Auxiliary Load for Water Supply Pumps (kW) (B)							4						
Total Connected Load (kW) (A+B)							8						

5 Baseline Assessment

Estimation of baseline is the key element in design and development of any energy efficiency project. It plays an important role in determining the savings associated with the implementation of energy efficiency measure (EEM) and determining the techno-financial feasibility of the EEM. In case of Municipal Energy Efficiency Programme (MEEP), the baseline is affected by many parameters including the changes in the system due to addition of command area, seasonal variations, increase in population which affect the required flow (Q) and the head (H).

Measurement and Verification (M&V) is the term given to the process for quantifying savings delivered by an Energy Efficiency Measure (EEM). It includes energy saving verification process involving measurements and reporting methodology. M & V methodology followed in this project includes following measurement schedule

- a. Measurement of parameters pre EEM implementation (just before installation of EEPs) for all operating combinations using portable instruments
- b. Measurement of parameters post EEM implementation for all operating combinations using portable instruments.

Energy savings are calculated as the difference in power drawn (in pre and post implementation scenario) multiplied by the operating hours mentioned in this report.

Baseline of this project will be estimated based on pre EEM implementation measurements, conducted just before installation of new EEPs at pumping station

5.1 Definition of possible and operating combinations

In ULBs, especially in case of pumping stations, where the pumps are connected in parallel, the pump operated in various combinations. For the purpose of this document, these combinations are defined as possible combinations. For example, for if 3 pumps are connected in parallel, there are 7 possible combinations considering three different pumps i.e.

Pump 1	Pump 1+ Pump 2	
Pump 2	Pump 2+ Pump 3	Pump 1+Pump 2+Pump 3
Pump 3	Pump 3 +Pump 1	

However, the ULB might be operating the pumps only in three combination, depending on the flow requirement, from the one discussed above. For the purpose of this document, these combinations are defined as operating combinations.

Operating Combination 1	Operating Combination 2	Operating Combination 3
Pump 1	Pump 1+ Pump 2	Pump 1+Pump 2+Pump 3

5.2 Key measurements for determining baseline or pre implementation level

To determine baseline, the following parameters would be measured during pre-implementation period (just before installation of new energy efficient pumps) for each operating combination.

- i. **Power Consumption, voltage, frequency (kW, Volt, Hz)**

Data Unit	kW, Volt, hz
Description	Voltage, frequency and power consumption of all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated portable instrument (power analyzer)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable power analyzer
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

ii. Flow rate (m³/hr)

Data Unit	m ³ /hr.
Description	Flow rate delivered for all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated portable instruments (flow meter)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable flow meter
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

iii. Head (m)

Data Unit	meters (m)
Description	Average head delivered for all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated instruments
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using pressure gauge installed at both the suction and discharge side of the pump
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

5.3 Baseline

The baseline energy consumption measurement for existing water pumping station will be established using pre implementation (just before installation of new pumps) measurements on existing pumps. Most of the electric parameters would be measured instantaneously using portable instruments, while operating hours would be provided by this report.

The baseline would be:

$$\begin{aligned} \text{Baseline Energy Consumption of a pump (kWh)} \\ = kW1 \times \text{hours of operation1} + kW2 \times \text{hours of operation2} + \dots \end{aligned}$$

Where, 1, 2.... represent operating combination of pump

$$\text{Baseline Energy Consumption of a ULB (kWh)} = \text{Baseline of pump1} + \text{Baseline of pump2} + \dots$$

Where 1, 2 ... represent baseline energy consumption of pumps of ULB

Baseline of this project will be estimated based on pre-implementation measurements, conducted just before installation of new EEPS at pumping station. Table 15 provides estimated present energy consumption of pumps operating at Mathura pumping station based on data provided in this report.

Table 15: Estimated Energy Consumption for Water Pumping Station

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
Water Supply Pumps								
1	Bhuteshwar Campus TW No.2	8.6	24.7	50	50	390.5	2920	25200
2	Bhuteshwar Campus TW No.5	11.5	28.2	50	56	357.9	730	8406
3	Bhuteshwar Campus TW No.7	8.9	27.1	50	50	381.8	3285	29094
4	Nagar Palika TW No.15	9.6	17.2	50	44	398.3	7300	70177
5	Bangali Ghat TW No.16	7.5	16.1	50	37	394.0	7300	54799
6	Police Line TW No.25	13.1	35.4	50	42	402.2	7300	95387
7	Bhuteshwar Campus TW No.27	9.6	10.2	50	61	380.0	2920	27935
8	District Jail TW No.29	12.8	33.0	50	30	413.0	5110	65459
9	Govind Nagar Sec. A	10.1	33.1	50	52	405.7	4015	40601
10	Kushak Gali-1	11.7	22.5	50	27	382.1	5110	59821
11	Shyam Ghat	6.1	8.9	50	48	390.4	5840	35819
12	Vishram Ghat	12.1	34.3	50	39	390.0	4380	53042
13	Chatta Bazar	12.5	36.4	50	46	449.4	5840	72766
14	Rampal Gali	8.8	23.0	50	53	399.2	4380	38756
15	Vrindavan Gate	11.1	26.0	50	46	380.3	5840	64882
16	Theknarnol	12.4	21.4	50	70	396.7	5110	63415
17	Dwarkeshpuri	12.2	15.3	50	59	398.1	1460	17793
18	Unth Gali	9.5	10.4	50	62	401.8	5840	55538
19	Naya Nagla Gali No.8	8.7	11.5	50	39	380.5	2555	22101
20	Chah Kathoti	8.1	19.4	50	46	421.6	3285	26565
21	Agra Hotel	11.9	28.1	50	46	391.8	7300	86675
22	Dhruv Ghat	7.6	27.8	50	36	389.2	7300	55196
23	Maholi Ki Paur	8.9	25.7	50	58	366.2	4380	38963

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
24	Radhika Vihar	9.5	24.7	50	52	375.0	2920	27867
25	Dholi Pyau	8.4	24.9	50	50	401.6	4380	36846
26	Thateran Gali	10.3	17.6	50	49	361.5	4380	45070
27	Bairag puri	6.1	14.2	50	35	391.0	2920	17890
28	Bhargva Gali	11.1	39.2	50	55	388.1	6570	73027
29	Gandhi Park Pump-1	8.0	25.0	50	47	390.0	2920	23456
30	Megha Gali	3.3	6.9	50	48	368.3	1460	4883
31	Bhadurpura	11.2	15.6	50	45	389.0	2920	32762
32	Chaganpura	7.7	24.1	50	47	389.0	1460	11291
33	Krishna Vihar NH-2	8.5	11.0	50	51	414.3	2920	24917
34	Askunda	10.0	32.4	50	45	401.4	5475	54695
35	Mahavidya Face-2	12.1	17.6	50	59	408.9	5840	70859
36	Dalpat Khidki	7.1	19.8	50	53	389.4	2920	20829
37	Gopalpura	12.8	18.2	50	59	418.7	2555	32593
38	Laxmi Nagar-1	6.9	29.4	50	23	415.6	6570	45289
39	Laxmi Nagar-2	8.9	31.8	50	42	412.6	3650	32449
40	Laxmi Nagar-4	7.0	39.2	50	26.5	412.9	2920	20352
41	Naya Nagla, Koyla Gali	7.0	20.9	50	47	411.4	3650	25667
42	Maholi Yojna-1	8.8	27.0	50	46	404.4	2920	25550
43	Maholi Yojna-3	10.0	36.9	50	49	428.6	2920	29103
44	Sheetla Ghati	6.0	14.1	50	70	395.0	5110	30830
45	Manas Nagar	6.2	23.5	50	47	334.9	4015	24948
46	Ratan Kund	5.5	11.9	50	59	371.5	5110	28139
47	Gau Ghat	7.7	23.3	50	39	395.3	4015	30768
48	Arjunpura	9.5	12.3	50	61	381.8	1825	17350
49	Officer Colony	9.1	19.1	50	23	395.2	4380	40070

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
50	Badpura Colony	9.0	33.3	50	39	398.9	5475	49147
51	Narayan Puri	12.0	29.0	50	46	396.9	7300	87843
52	Jhigurpura	7.9	15.8	50	49	400.4	4380	34777
53	Raigarpura	9.1	33.0	50	43	392.9	4380	40004
54	Gupta Kunj	7.6	17.9	50	49	384.8	2920	22314
55	Radha Nagar	9.0	20.1	50	46	380.5	4745	42863
56	Manoharpura	8.1	14.2	50	78	381.5	1825	14752
57	Krishna Nagar	8.6	18.0	50	52	392.3	2920	25135
58	Heja Hospital	8.3	16.8	50	61	407.6	2190	18082
59	Laxmi Nagar	9.5	19.9	50	25	434.8	4380	41614
60	Maholi Yojna-2	9.7	28.6	50	50	387.4	2920	28207
61	Antapada	9.5	26.4	50	37	408.2	4380	41698
62	Rani Mandi	11.7	17.7	50	44	433.4	2920	34261
63	Kutta Paysa	9.7	19.9	50	54	382.0	3650	35466
64	Gali Ravaliya	6.3	20.1	50	51	368.2	3650	23092
65	Gali Rajkumar	12.6	29.4	50	63	417.4	4380	55130
66	Gandhi Park-2	8.9	17.9	50	42	408.4	4380	38821
67	Arjunpura-2	8.6	15.4	50	55	339.0	2190	18878
68	Theknarnol-2	8.8	25.5	50	60	406.9	4380	38427
69	Madhav Puri	8.1	21.6	50	51	411.6	4015	32366
70	Dholi Pyau Tiraha-New Construction	11.9	20.1	50	54	404.3	7300	87113
71	Ahilyabai Park Dampier Nagar MVDA	9.9	24.7	50	43	408.8	4380	43570
72	Ramlila Ground Krishna Nagar MVDA	9.9	18.6	50	41	365.1	2190	21608
73	Kankali Temple Dwarikapuri MVDA	7.6	18.7	50	50	397.8	4015	30403
74	Nai Basti W.No.	10.6	27.9	50	50	399.3	2920	30835
75	Andi Kuiya	10.6	31.2	50	54	412.2	5475	58181

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
76	Kathoti Kua Chaupal	9.4	18.5	50	50	399.0	3650	34188
77	Kathoti Kua Masjid	12.9	18.6	50	56	385.2	1825	23470
78	Gupta Kunk W.No.7	7.3	22.6	50	49	428.5	3285	23976
79	Sadar Dhobi Pada W.No8	10.3	39.2	50	25	387.1	5110	52429
80	Gandhi Nagar W.No. 9	8.2	16.7	50	45	334.2	2190	18031
81	Laxmi Nagar W.No. 9	9.6	17.2	50	50	400.6	5110	48869
82	Bains Bhora Kotwali W.No.14	9.1	27.6	50	53	407.1	2920	26437
83	Radhey Shyam Ashram W.No.16	11.9	17.5	50	42	398.2	5840	69710
84	Om Nagar W.No.17	9.2	21.6	50	45	418.2	4380	40426
85	Om Nagar-2 W.No.17	8.5	17.1	50	50	418.1	6570	55714
86	Jogi Gali Antapada W.No.18	8.5	23.1	50	44	382.7	2190	18699
87	Khateek Mohalla Balmiki Basti W.No.19	9.1	20.1	50	53	381.8	5110	46369
88	Guru Nanak Nagar W.No.19	8.0	9.5	50	46	395.8	2007.5	16060
89	Krishnapuram-1 Ward-24	10.7	28.4	50	39	405.2	1460	15648
90	Krishnapuram-2 Ward-24	10.2	29.3	50	43	387.4	1460	14879
91	Balmiki Basti Dholi Pyau Ward-27	9.0	13.4	50	50	382.4	4745	42863
92	Mahavidya Park Ward-28	6.5	21.8	50	54	397.0	4380	28676
93	Hanuman Teela Ward-33	7.5	17.9	50	54	370.5	1460	10909
94	Kashmiri Gali Ward-34	7.0	18.3	50	37	373.9	3650	25428
95	Mission Teela Sadar Bazar Ward-35	10.9	29.3	50	38	440.9	5110	55495
96	Matia Gate Ward-37	9.0	22.8	50	64	423.1	5110	45915
97	Subhash Nagar Nala Ward-38	11.4	18.2	50	49	398.0	2920	33385
98	Manshapuri Ward-39	9.4	15.3	50	47	432.8	2920	27583
99	Rampal Gali Ward-40	6.9	24.4	50	49	413.2	3285	22557
100	Theknarnol Ward-40	7.5	21.8	50	53	406.8	5110	38146
101	Lala Ganj Ward-42	7.8	17.0	50	62	379.5	2920	22763

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
102	Kashiram Yojna-3	7.0	14.7	50	48	382.3	3650	25550
103	Kashiram Yojna-4	11.3	20.6	50	53	403.2	3650	41245
104	Satrangi Garden Ward-8	6.9	31.8	50	21	399.7	5475	37978
105	Naya Nagla Ward-11	7.9	22.5	50	44	419.4	4380	34435
106	Mali Mohalla Sadar Ward-13	10.8	24.2	50	50	426.1	3650	39483
107	Naya Bans Ward-15	7.9	16.5	50	62	438.6	1825	14472
108	Machli Gate Ward-19	7.6	10.7	50	50	380.2	1825	13809
109	Motikunj Extension	8.6	27.4	50	47	382.4	4380	37722
110	Rani Mandi Balmiki Basti Ward-6	9.6	24.5	50	49	409.3	3650	34990
111	Matia Gate Joshiyan Garden	9.1	25.3	50	59	442.9	4380	39954
112	Sanjay Nagar Nala	8.1	25.2	50	48	409.0	4380	35469
113	Balmiki Basti Ward-1	9.4	18.2	50	52	413.0	4380	41085
Sewage Water Pumping Stations								
114	Masani Nala SPS Pump 1	39.3	236.7	50	25	410.4	1460	57310
115	Masani Nala SPS Pump 2	45.9	262.1	50	31	407.8	1460	67018
116	Masani Nala SPS Pump 3	67.5	398.7	50	27	412.8	1460	98588
117	Masani Nala SPS Pump 4	45.3	215.2	50	33	414.3	1460	66165
118	Masani Nala SPS Pump 5	68.6	389.0	50	26	420.3	1460	100111
119	Krishna Ganga SPS Pump 2	10.4	52.3	50	22	431.5	1460	19037
120	Chinta Haran SPS Pump 1	13.0	66.4	50	25	423.1	1095	14288
121	Chinta Haran SPS Pump 3	13.8	66.1	50	24	413.1	1095	15082
122	Swami Ghat SPS Pump 1	12.5	122.8	50	12	433.9	3650	45713
123	Swami Ghat SPS Pump 2	12.4	119.5	50	11	436.3	3650	45285
124	Cantt. Nala SPS Pump 1	23.9	39.9	50	25	382.6	4380	104726
125	Dairy Farm SPS Pump 1	80.4	293.7	50	26	434.0	1460	117373
126	Dairy Farm SPS Pump 2	36.4	110.3	50	18	409.8	1460	53211

S. No	Pump Name	Measured Power Consumption	Flow Rate	Frequency	Head	Voltage	Hours Baseline	Baseline Energy Consumption
		kW	m3/hr.	Hz	m	V	Hours	kWh
127	Dairy Farm SPS Pump 3	78.2	302.9	50	26	411.1	1460	114169
128	Dairy Farm SPS Pump 4	36.1	111.2	50	19	414.7	1460	52708
129	Dairy Farm SPS Pump 5	76.2	312.3	50	25	441.5	1460	111252
130	Bangali Ghat SPS Pump 1	41.3	212.9	50	20	418.4	1825	75304
131	Bangali Ghat SPS Pump 5	44.0	236.8	50	22	424.9	1825	80243
Total		1780.7	6055.6					5422877

6 Energy Efficiency Measures

6.1 Summary of Energy Efficiency Measures

A summary of the proposed energy efficiency measures for water pumping stations and sewage pumping stations are provided in Table 16.

Table 16: Summary of energy efficiency measures for Mathura Water and Sewage pumping stations

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
Water Supply Pumps							
1	Bhuteshwar Campus TW No.2	25200	7344	1.3	0.6	27	29.14%
2	Bhuteshwar Campus TW No.5	8406	2896	1.5	0.2	77	34.45%
3	Bhuteshwar Campus TW No.7	29094	7095	1.3	0.6	28	24.39%
4	Nagar Palika TW No.15	70177	41177	1.2	3.3	4	58.68%
5	Bangali Ghat TW No.16	54799	31535	1.2	2.5	6	57.55%
6	Police Line TW No.25	95387	43502	1.5	3.5	5	45.61%
7	Bhuteshwar Campus TW No.27	27935	18214	1.2	1.4	10	65.20%
8	District Jail TW No.29	65459	40425	1.3	3.2	5	61.76%
9	Govind Nagar Sec. A	40601	7633	1.5	0.6	29	18.80%
10	Kushak Gali-1	59821	43230	1.2	3.4	4	72.27%
11	Shyam Ghat	35819	22276	1.1	1.8	8	62.19%
12	Vishram Ghat	53042	25048	1.5	2.0	9	47.22%
13	Chatta Bazar	72766	26034	1.5	2.1	9	35.78%
14	Rampal Gali	38756	12354	1.3	1.0	16	31.88%
15	Vrindavan Gate	64882	30351	1.3	2.4	7	46.78%
16	Theknarnol	63415	26825	1.5	2.1	8	42.30%

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
17	Dwarkeshpuri	17793	10877	1.2	0.9	17	61.13%
18	Unth Gali	55538	35469	1.2	2.8	5	63.86%
19	Naya Nagla Gali No.8	22101	15887	1.1	1.3	11	71.88%
20	Chah Kathoti	26565	11212	1.2	0.9	16	42.21%
21	Agra Hotel	86675	40003	1.4	3.2	5	46.15%
22	Dhruv Ghat	55196	19022	1.3	1.5	11	34.46%
23	Maholi Ki Paur	38963	7721	1.5	0.6	29	19.82%
24	Radhika Vihar	27867	9311	1.3	0.7	21	33.41%
25	Dholi Pyau	36846	9877	1.3	0.8	20	26.81%
26	Thateran Gali	45070	25310	1.2	2.0	7	56.16%
27	Bairag puri	17890	9997	1.1	0.8	17	55.88%
28	Bhargva Gali	73027	7645	1.6	0.6	31	10.47%
29	Gandhi Park Pump-1	23456	6481	1.3	0.5	31	27.63%
30	Megha Gali	4883	2238	1.1	0.2	75	45.83%
31	Bhadurpura	32762	21852	1.2	1.7	8	66.70%
32	Chaganpura	11291	3106	1.3	0.2	64	27.51%
33	Krishna Vihar NH-2	24917	15979	1.1	1.3	10	64.13%
34	Askunda	54695	16510	1.5	1.3	13	30.18%
35	Mahavidya Face-2	70859	40883	1.3	3.3	5	57.70%
36	Dalpat Khidki	20829	5680	1.3	0.5	35	27.27%
37	Gopalpura	32593	19016	1.3	1.5	11	58.34%
38	Laxmi Nagar-1	45289	21550	1.2	1.7	8	47.58%
39	Laxmi Nagar-2	32449	8280	1.3	0.7	24	25.52%
40	Laxmi Nagar-4	20352	5322	1.3	0.4	38	26.15%
41	Naya Nagla, Koyla Gali	25667	7888	1.3	0.6	25	30.73%
42	Maholi Yojna-1	25550	7573	1.3	0.6	26	29.64%

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
43	Maholi Yojna-3	29103	4313	1.6	0.3	55	14.82%
44	Sheetla Ghati	30830	5928	1.3	0.5	34	19.23%
45	Manas Nagar	24948	2981	1.3	0.2	67	11.95%
46	Ratan Kund	28139	8981	1.2	0.7	19	31.92%
47	Gau Ghat	30768	11694	1.2	0.9	16	38.01%
48	Arjunpura	17350	10167	1.2	0.8	18	58.60%
49	Officer Colony	40070	29978	1.2	2.4	6	74.81%
50	Badpura Colony	49147	13940	1.3	1.1	14	28.36%
51	Narayan Puri	87843	39575	1.4	3.1	5	45.05%
52	Jhigurpura	34777	17051	1.2	1.4	11	49.03%
53	Raigarpura	40004	10327	1.5	0.8	22	25.82%
54	Gupta Kunj	22314	8923	1.2	0.7	20	39.99%
55	Radha Nagar	42863	19887	1.2	1.6	9	46.40%
56	Manoharpura	14752	4750	1.3	0.4	42	32.20%
57	Krishna Nagar	25135	10845	1.2	0.9	17	43.15%
58	Heja Hospital	18082	6996	1.3	0.6	29	38.69%
59	Laxmi Nagar	41614	29763	1.1	2.4	6	71.52%
60	Maholi Yojna-2	28207	8257	1.5	0.7	27	29.27%
61	Antapada	41698	20489	1.3	1.6	10	49.14%
62	Rani Mandi	34261	22365	1.2	1.8	8	65.28%
63	Kutta Paysa	35466	16015	1.3	1.3	12	45.16%
64	Gali Ravaliya	23092	4584	1.3	0.4	44	19.85%
65	Gali Rajkumar	55130	17025	1.6	1.4	14	30.88%
66	Gandhi Park-2	38821	21624	1.2	1.7	8	55.70%
67	Arjunpura-2	18878	9151	1.2	0.7	20	48.47%
68	Theknarnol-2	38427	6397	1.5	0.5	35	16.65%

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
69	Madhav Puri	32366	10496	1.3	0.8	19	32.43%
70	Dholi Pyau Tiraha-New Construction	87113	47803	1.4	3.8	4	54.87%
71	Ahilyabai Park Dampier Nagar MVDA	43570	20536	1.3	1.6	10	47.13%
72	Ramlila Ground Krishna Nagar MVDA	21608	12871	1.2	1.0	14	59.57%
73	Kankali Temple Dwarikapuri MVDA	30403	10774	1.2	0.9	17	35.44%
74	Nai Basti W.No.	30835	11401	1.5	0.9	20	36.98%
75	Andi Kuiya	58181	14053	1.5	1.1	16	24.15%
76	Kathoti Kua Chaupal	34188	16535	1.2	1.3	11	48.36%
77	Kathoti Kua Masjid	23470	14072	1.3	1.1	14	59.96%
78	Gupta Kunk W.No.7	23976	5964	1.3	0.5	34	24.87%
79	Sadar Dhobi Pada W.No.8	52429	27664	1.3	2.2	7	52.77%
80	Gandhi Nagar W.No. 9	18031	9417	1.2	0.7	19	52.23%
81	Laxmi Nagar W.No. 9	48869	25813	1.2	2.1	7	52.82%
82	Bains Bhora Kotwali W.No.14	26437	6015	1.5	0.5	37	22.75%
83	Radhey Shyam Ashram W.No.16	69710	47243	1.2	3.8	4	67.77%
84	Om Nagar W.No.17	40426	19355	1.3	1.5	10	47.88%
85	Om Nagar-2 W.No.17	55714	26312	1.2	2.1	7	47.23%
86	Jogi Gali Antapada W.No.18	18699	7687	1.3	0.6	26	41.11%
87	Khateek Mohalla Balmiki Basti W.No.19	46369	19374	1.3	1.5	10	41.78%
88	Guru Nanak Nagar W.No.19	16060	11292	1.1	0.9	15	70.31%
89	Krishnapuram-1 Ward-24	15648	7633	1.3	0.6	26	48.78%
90	Krishnapuram-2 Ward-24	14879	5786	1.3	0.5	35	38.89%
91	Balmiki Basti Dholi Pyau Ward-27	42863	25950	1.2	2.1	7	60.54%
92	Mahavidya Park Ward-28	28676	3181	1.3	0.3	63	11.09%
93	Hanuman Teela Ward-33	10909	3933	1.3	0.3	51	36.05%
94	Kashmiri Gali Ward-34	25428	12210	1.2	1.0	14	48.02%

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
95	Mission Teela Sadar Bazar Ward-35	55495	27314	1.3	2.2	7	49.22%
96	Matia Gate Ward-37	45915	10243	1.5	0.8	22	22.31%
97	Subhash Nagar Nala Ward-38	33385	19740	1.2	1.6	9	59.13%
98	Manshapuri Ward-39	27583	16393	1.2	1.3	11	59.43%
99	Rampal Gali Ward-40	22557	3134	1.3	0.2	64	13.89%
100	Theknarnol Ward-40	38146	8872	1.3	0.7	23	23.26%
101	Lala Ganj Ward-42	22763	7506	1.3	0.6	27	32.97%
102	Kashiram Yojna-3	25550	11844	1.2	0.9	15	46.36%
103	Kashiram Yojna-4	41245	21503	1.3	1.7	9	52.14%
104	Satrangi Garden Ward-8	37978	18430	1.2	1.5	9	48.53%
105	Naya Nagla Ward-11	34435	12993	1.3	1.0	15	37.73%
106	Mali Mohalla Sadar Ward-13	39483	17651	1.3	1.4	11	44.70%
107	Naya Bans Ward-15	14472	5234	1.3	0.4	38	36.16%
108	Machli Gate Ward-19	13809	8471	1.1	0.7	20	61.35%
109	Motikunj Extension	37722	9762	1.3	0.8	21	25.88%
110	Rani Mandi Balmiki Basti Ward-6	34990	13320	1.3	1.1	15	38.07%
111	Matia Gate Joshiyan Garden	39954	8668	1.5	0.7	26	21.69%
112	Sanjay Nagar Nala	35469	9267	1.3	0.7	22	26.13%
113	Balmiki Basti Ward-1	41085	19412	1.2	1.5	9	47.25%
	Sub- Total (A)	4185294	1805761	147	144	12	43.15%
Sewage Pumping Station							
114	Masani Nala SPS Pump 1	57310	20759	5.3	1.7	39	36.22%
115	Masani Nala SPS Pump 2	67018	14790	5.4	1.2	55	22.07%
116	Masani Nala SPS Pump 3	98588	25499	7.1	2.0	42	25.86%
117	Masani Nala SPS Pump 4	66165	21116	5.4	1.7	38	31.91%
118	Masani Nala SPS Pump 5	100111	40653	7.0	3.2	26	40.61%

Sl. No	Energy Efficiency Measures (EEM) Replacement of Pump with Energy Efficient Pump	Present Annual Energy Consumption (kWh/year)	Annual Energy Savings (kWh/year)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)	Percentage of Energy Saving (%)
119	Krishna Ganga SPS Pump 2	19037	4582	2.2	0.4	73	24.07%
120	Chinta Haran SPS Pump 1	14288	4284	2.2	0.3	78	29.98%
121	Chinta Haran SPS Pump 3	15082	5200	2.2	0.4	64	34.47%
122	Swami Ghat SPS Pump 1	45713	21039	2.1	1.7	15	46.02%
123	Swami Ghat SPS Pump 2	45285	23374	2.1	1.9	14	51.62%
124	Cantt. Nala SPS Pump 1	104726	68629	2.7	5.5	6	65.53%
125	Dairy Farm SPS Pump 1	117373	67619	6.6	5.4	15	57.61%
126	Dairy Farm SPS Pump 2	53211	38931	3.6	3.1	14	73.16%
127	Dairy Farm SPS Pump 3	114169	64189	6.6	5.1	16	56.22%
128	Dairy Farm SPS Pump 4	52708	36281	3.4	2.9	14	68.83%
129	Dairy Farm SPS Pump 5	111252	61731	6.6	4.9	16	55.49%
130	Bangali Ghat SPS Pump 1	75304	41099	9.2	3.3	34	54.58%
131	Bangali Ghat SPS Pump 5	80243	38383	9.2	3.1	36	47.83%
	Sub- Total (B)	1237583	598158	89	48	22	48.33%
	Net Total (A+B)	5422877	2403919	236	191	15	44.33%

6.2 Detailed Energy Efficiency Measures

Opportunity of energy saving identified of Mathura Water and Sewage pumping stations are discussed below:

6.2.1 EEM 1: Replacement of existing pump inefficient pump with energy efficient pump

Existing operating conditions: Main source of water for the city of Mathura is ground water. There are 141⁹ Nos. of pumps installed to cater the water needs of Mathura City. These 141 nos. of submersible pumps are used to supply water directly to the users. Out of 141 Nos. of water supply pumps, 121 Nos. were in operation during energy audit and 20 Nos. of pumps were under maintenance. Apart from water distribution pump sets, 35 Nos. of pump sets are also installed in the sewage water pumping system to transfer the sewage water to the sewage treatment plant. Out of 35 Nos. of pump, 21 Nos. of pumps were in operation during energy audit and 14 Nos. of Pump sets were under maintenance.

Recommendations: The present operating pumps' efficiencies for water supply pumps are in range of 15.4% to 62.1% and for sewage pumps is 13.8% to 58.4%. The efficiency of the pump is low mainly due to pump operating far away from the Best Efficiency Point (BEP). Therefore, it is suggested to replace existing pump with energy efficient pump to reduce the energy consumption.

Cost benefit analysis: Expected savings from replacement of pump is about 2,403,919 kWh per year, which would result in a cost benefit of about Rs.191 Lakh per year. Estimated investment for implementation of this measure is about Rs.236 Lakh, which basically includes cost of pump set, installation cost and cost of Web based dashboard. Simple payback period is estimated to be about 15 months. Cost benefit analysis of recommendation is provided in table 17.

⁹ As per LOA, there were 143 pumps (water), however in LOA list, there was repetition of two pump sets. Therefore, total pump at Mathura, in IGEA, is considered as 141.

Table 17: Cost Benefit Analysis

Parameters	Unit	Bhuteshwar Campus TW No.2	Bhuteshwar Campus TW No.5	Bhuteshwar Campus TW No.7	Nagar Palika TW No.15	Bangali Ghat TW No.16	Police Line TW No.25	Bhuteshwar Campus TW No.27	District Jail TW No.29	Govind Nagar Sec. A	Kushak Gali-1
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	36	-	30	-	24	36	36	24	36	30
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Flow Delivered	m3/hr	24.7	28.21	27.05	17.24	16.13	35.42	10.22	32.98	33.05	22.52
Head of the Pump	m	50	56	50	44	37	42	61	30	52	27
Motor Power Consumption	kW	8.63	11.51	8.86	9.61	7.51	13.07	9.57	12.81	10.11	11.71
Calculated Efficiency of the Pump set	%	39.0%	37.4%	41.6%	21.5%	21.7%	31.0%	17.7%	21.0%	46.3%	14.1%
Proposed Pump											
Head of the Pump	M	50	56	50	44	37	42	61	30	52	27
Flow of the Pump	m3/hr	24.7	28.21	27.05	17.24	16.13	35.42	10.22	32.98	33.05	22.52
Power of the motor on existing duty point	kW	6.12	7.55	6.70	3.97	3.19	7.11	3.33	4.90	8.21	3.25
Proposed efficiency of pump set on existing duty point	%	55%	57%	55%	52.0%	51%	57%	51%	55%	57%	51%
Operating Hours	hours	2920	730	3285	7300	7300	7300	2920	5100	4015	5100
Annual energy saving	kWh/annum	7344	2896	7095	41177	31535	43502	18214	40425	7633	43230
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.6	0.2	0.6	3.3	2.5	3.5	1.4	3.2	0.6	3.4
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.816	0.679	0.566	0.522	0.816	0.522	0.679	0.816	0.522
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Parameters	Unit	Bhuteshwar Campus TW No.2	Bhuteshwar Campus TW No.5	Bhuteshwar Campus TW No.7	Nagar Palika TW No.15	Bangali Ghat TW No.16	Police Line TW No.25	Bhuteshwar Campus TW No.27	District Jail TW No.29	Govind Nagar Sec. A	Kushak Gali-1
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.069	0.057	0.048	0.044	0.069	0.044	0.057	0.069	0.044
Total Cost	Rs in Lakhs	1.326	1.476	1.326	1.204	1.156	1.476	1.156	1.326	1.476	1.156
Payback Period	months	27	77	28	4	6	5	10	5	29	4

Parameters	Unit	Shyam Ghat	Vishram Ghat	Chatta Bazar	Rampal Gali	Vrindavan Gate	Theknarnol	Dwarkeshpur i	Unth Gali	Naya Nagla Gali No.8	Chah Kathoti
Rated Parameters											
Pump Type		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18	18	15
Rated Power	kW	7.46	9.325	9.325	9.325	9.325	9.325	9.325	9.325	7.46	7.46
Parameters Measured											
Flow Delivered	m ³ /hr	8.87	34.3	36.41	22.97	25.96	21.41	15.33	10.38	11.45	19.4
Head of the Pump	m	48	39	46	53	46	70	59	62	39	46
Motor Power Consumption	kW	6.133	12.11	12.46	8.85	11.11	12.41	12.19	9.51	8.65	8.09
Calculated Efficiency of the Pump set	%	18.9%	30.1%	36.6%	37.5%	29.3%	32.9%	20.2%	18.4%	14.1%	30.1%
Proposed Pump											
Head of the Pump	m	48	39	46	53	46	70	59	62	39	46
Flow of the Pump	m ³ /hr	8.87	34.3	36.41	22.97	25.96	21.41	15.33	10.38	11.45	19.4
Power of the motor on existing duty point	kW	2.32	6.39	8.00	6.03	5.91	7.16	4.74	3.44	2.43	4.67
Overall Efficiency	%	50%	57%	57%	55%	55%	57%	52%	51%	50%	52%
Operating Hours	hours	5840	4380	5840	4380	5840	5110	1460	5840	2555	3285
Annual Present Energy Consumption	kWh/annum	35819	53042	72766	38756	64882	63415	17793	55538	22101	26565
Annual energy saving	kWh/annum	22276	25048	26034	12354	30351	26825	10877	35469	15887	11212
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	1.8	2.0	2.1	1.0	2.4	2.1	0.9	2.8	1.3	0.9

Parameters	Unit	Shyam Ghat	Vishram Ghat	Chatta Bazar	Rampal Gali	Vrindavan Gate	Theknarnol	Dwarkeshpur i	Unth Gali	Naya Nagla Gali No.8	Chah Kathoti
Investment towards new Pump set including GST	Rs in Lakhs	0.478	0.816	0.816	0.679	0.679	0.816	0.566	0.522	0.478	0.566
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.040	0.069	0.069	0.057	0.057	0.069	0.048	0.044	0.040	0.048
Total Cost	Rs in Lakhs	1.108	1.476	1.476	1.326	1.326	1.476	1.204	1.156	1.108	1.204
Payback Period	months	8	9	9	16	7	8	17	5	11	16

Parameters	Unit	Agra Hotel	Dhruv Ghat	Maholi Ki Paur	Radhika Vihar	Dholi Pyau	Thateran Gali	Bairag puri	Bhargva Gali	Gandhi Park Pump-1	Megha Gali
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	24	24	24	24	21	24	18	18	15
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	7.46	4.476
Parameters Measured											
Flow Delivered	m ³ /hr	28.07	27.8	25.74	24.68	24.87	17.58	14.18	39.20	24.98	6.93
Head of the Pump	m	46	36	58	52	50	49	35	55	47	48
Motor Power Consumption	kW	11.87	7.56	8.90	9.54	8.41	10.29	6.13	11.12	8.03	3.34
Calculated Efficiency of the Pump set	%	29.6%	36.0%	45.7%	36.6%	40.3%	22.8%	22.1%	52.8%	39.8%	27.1%
Proposed Pump											
Head of the Pump	m	46	36	58	52	50	49	35	55	47	48
Flow of the Pump	m ³ /hr	28.07	27.8	25.74	24.68	24.87	17.58	14.18	39.2	24.98	6.93

Parameters	Unit	Agra Hotel	Dhruv Ghat	Maholi Ki Paur	Radhika Vihar	Dholi Pyau	Thateran Gali	Bairag puri	Bhargva Gali	Gandhi Park Pump-1	Megha Gali
Power of the motor on existing duty point	kW	6.39	4.96	7.13	6.35	6.16	4.51	2.70	9.95	5.81	1.81
Overall Efficiency	%	55%	55%	57%	55%	55%	52%	50%	59%	55%	50%
Operating Hours	hours	7300	7300	4380	2920	4380	4380	2920	6570	2920	1460
Annual energy saving	kWh/annum	40003	19022	7721	9311	9877	25310	9997	7645	6481	2238
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	3.2	1.5	0.6	0.7	0.8	2.0	0.8	0.6	0.5	0.2
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.679	0.816	0.679	0.679	0.566	0.478	0.920	0.679	0.478
Investment towards NRV replacement including GST	Rs in Lakhs	0.229	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.312	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.057	0.069	0.057	0.057	0.048	0.040	0.078	0.057	0.040
Total Cost	Rs in Lakhs	1.354	1.326	1.476	1.326	1.326	1.204	1.108	1.588	1.326	1.108
Payback Period	months	5	11	29	21	20	7	17	31	31	75

Parameters	Unit	Bhadurpur a	Chaganpur a	Krishna Vihar NH-2	Askunda	Mahavidya Face-2	Dalpat Khidki	Gopalpura	Laxmi Nagar-1	Laxmi Nagar-2	Laxmi Nagar-4
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	24	18	18	18	15	18	18	18
Rated Power	kW	9.325	7.46	9.325	7.46	9.325	7.46	9.325	9.325	9.325	7.46
Parameters Measured											

Parameters	Unit	Bhadurpur a	Chaganpur a	Krishna Vihar NH-2	Askunda	Mahavidya Face-2	Dalpat Khidki	Gopalpura	Laxmi Nagar-1	Laxmi Nagar-2	Laxmi Nagar-4
Flow Delivered	m3/hr	15.55	24.09	11.02	32.44	17.57	19.77	18.19	29.42	31.84	39.23
Head of the Pump	m	45	47	51	45	59	53	59	23	42	26.5
Motor Power Consumption	kW	11.22	7.73	8.53	9.99	12.13	7.13	12.76	6.89	8.89	6.97
Calculated Efficiency of the Pump set	%	17.0%	39.9%	17.9%	39.8%	23.3%	40.0%	22.9%	26.7%	41.0%	40.6%
Proposed Parameters											
Head of the Pump	m	45	47	51	45	59	53	59	23	42	26.5
Flow of the Pump	m3/hr	15.55	24.09	11.02	32.44	17.57	19.77	18.19	29.42	31.84	39.23
Rated Motor Input Power	kW	4.5	7.5	3.7	9.3	7.5	7.5	7.5	4.5	7.5	7.5
Power of the motor on existing duty point	kW	3.74	5.61	3.06	6.97	5.13	5.19	5.31	3.61	6.62	5.15
Overall Efficiency	%	51%	55%	50%	57%	55%	55%	55%	51%	55%	55%
Operating Hours	hours	2920	1460	2920	5475	5840	2920	2555	6570	3650	2920
Annual Present Energy Consumption	kWh/annum	32762	11291	24917	54695	70859	20829	32593	45289	32449	20352
Annual energy saving	kWh/annum	21852	3106	15979	16510	40883	5680	19016	21550	8280	5322
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	1.7	0.2	1.3	1.3	3.3	0.5	1.5	1.7	0.7	0.4
Investment towards new Pump set including GST	Rs in Lakhs	0.522	0.679	0.478	0.816	0.679	0.679	0.679	0.522	0.679	0.679
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.044	0.057	0.040	0.069	0.057	0.057	0.057	0.044	0.057	0.057
Total Cost	Rs in Lakhs	1.156	1.326	1.108	1.476	1.326	1.326	1.326	1.156	1.326	1.326
Payback Period	months	8	64	10	13	5	35	11	8	24	38

Parameters	Unit	Naya Nagla, Koyla Gali	Maholi Yojna-1	Maholi Yojna-3	Sheetla Ghati	Manas Nagar	Ratan Kund	Gau Ghat	Arjunpura	Officer Colony
Rated Parameters										
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	24	24	18	18	18	18	18	18
Rated Power	kW	7.46	9.325	9.325	7.46	7.46	7.46	7.46	9.325	9.325
Parameters Measured										
Flow Delivered	m ³ /hr	20.93	27.03	36.9	14.06	23.51	11.9	23.26	12.32	19.13
Head of the Pump	m	47	46	49	70	47	59	39	61	23
Motor Power Consumption	kW	7.03	8.75	9.97	6.03	6.21	5.51	7.66	9.51	9.15
Calculated Efficiency of the Pump set	%	38.1%	38.7%	49.4%	44.4%	48.4%	34.7%	32.2%	21.5%	13.1%
Proposed Parameters										
Head of the Pump	m	47	46	49	70	47	59	39	61	23
Flow of the Pump	m ³ /hr	20.93	27.03	36.9	14.06	23.51	11.9	23.26	12.32	19.13
Rated Motor Input Power	kW	7.5	7.5	11.2	7.5	7.5	4.5	5.6	5.6	5.6
Power of the motor on existing duty point	kW	4.87	6.16	8.49	4.87	5.47	3.75	4.75	3.94	2.30
Overall Efficiency	%	55%	55%	58%	55%	55%	51%	52%	52%	52%
Operating Hours	hours	3650	2920	2920	5110	4015	5110	4015	1825	4380
Annual energy saving	kWh/annum	7888	7573	4313	5928	2981	8981	11694	10167	29978
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.6	0.6	0.3	0.5	0.2	0.7	0.9	0.8	2.4
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.679	0.917	0.679	0.679	0.522	0.566	0.566	0.566
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.057	0.077	0.057	0.057	0.044	0.048	0.048	0.048
Total Cost	Rs in Lakhs	1.326	1.326	1.584	1.326	1.326	1.156	1.204	1.204	1.204

Parameters	Unit	Naya Nagla, Koyla Gali	Maholi Yojna-1	Maholi Yojna-3	Sheetla Ghati	Manas Nagar	Ratan Kund	Gau Ghat	Arjunpura	Officer Colony
Payback Period	months	25	26	55	34	67	19	16	18	6

Parameters	Unit	Badpura Colony	Narayan Puri	Jhigurpura	Raigarpura	Gupta Kunj	Radha Nagar	Manoharpura	Krishna Nagar
Rated Parameters									
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	15	30	18	15	18	24	24	24
Rated Power	kW	9.325	9.325	7.46	9.325	7.46	9.325	9.325	9.325
Parameters Measured									
Flow Delivered	m ³ /hr	33.3	29.03	15.77	32.98	17.87	20.1	14.19	17.97
Head of the Pump	m	39	46	49	43	49	46	78	52
Motor Power Consumption	kW	8.98	12.03	7.94	9.13	7.64	9.03	8.08	8.61
Hydraulic Power	kW	3.54	3.64	2.10	3.86	2.38	2.52	3.01	2.54
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.63	10.23	6.75	7.76	6.50	7.68	6.87	7.32
Pump Efficiency	%	46.4%	35.6%	31.2%	49.7%	36.7%	32.8%	43.9%	34.8%
Calculated Efficiency of the Pump set	%	39.4%	30.2%	26.5%	42.3%	31.2%	27.9%	37.3%	29.6%
Proposed Parameters									
Head of the Pump	m	39	46	49	43	49	46	78	52
Flow of the Pump	m ³ /hr	33.3	29.03	15.77	32.98	17.87	20.1	14.19	17.97
Rated Motor Input Power	kW	7.5	7.5	5.6	9.3	5.6	5.6	7.5	5.6
Power of the motor on existing duty point	kW	6.43	6.61	4.05	6.78	4.59	4.84	5.48	4.89
Overall Efficiency	%	55%	55%	52%	57%	52%	52%	55%	52%
Operating Hours	hours	5475	7320	4380	4380	2920	4745	1825	2920
Annual energy saving	kWh/annum	13940	39575	17051	10327	8923	19887	4750	10845
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	1.1	3.1	1.4	0.8	0.7	1.6	0.4	0.9
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.679	0.566	0.816	0.566	0.566	0.679	0.566

Parameters	Unit	Badpura Colony	Narayan Puri	Jhigurpura	Raigarpura	Gupta Kunj	Radha Nagar	Manoharpura	Krishna Nagar
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.229	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.312	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.057	0.048	0.069	0.048	0.048	0.057	0.048
Total Cost	Rs in Lakhs	1.326	1.354	1.204	1.476	1.204	1.204	1.326	1.204
Payback Period	months	14	5	11	22	20	9	42	17

Parameters	Unit	Heja Hospital	Laxmi Nagar	Maholi Yojna-2	Antapada	Rani Mandi	Kutta Paysa	Gali Ravaliya	Gali Rajkumar	Gandhi Park-2	Arjunpura-2
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	M	65	65	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	24	18	18	24	24	24	24	24	24	24
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Flow Delivered	m3/hr	16.76	19.87	28.6	26.43	17.68	19.93	20.08	29.41	17.85	15.42
Head of the Pump	m	61	25	50	37	44	54	51	63	42	55
Motor Power Consumption	kW	8.26	9.50	9.66	9.52	11.73	9.72	6.33	12.59	8.86	8.62
Hydraulic Power	kW	2.78	1.35	3.89	2.66	2.12	2.93	2.79	5.05	2.04	2.31
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.02	8.08	8.21	8.09	9.97	8.26	5.38	10.70	7.53	7.33
Pump Efficiency	%	39.7%	16.8%	47.4%	32.9%	21.2%	35.5%	51.9%	47.2%	27.1%	31.5%
Calculated Efficiency of the Pump set	%	33.7%	14.2%	40.3%	28.0%	18.1%	30.2%	44.1%	40.1%	23.0%	26.8%
Proposed Parameters											
Head of the Pump	m	61	25	50	37	44	54	51	63	42	55
Flow of the Pump	m3/hr	16.76	19.87	28.6	26.43	17.68	19.93	20.08	29.41	17.85	15.42

Parameters	Unit	Heja Hospital	Laxmi Nagar	Maholi Yojna-2	Antapada	Rani Mandi	Kutta Paysa	Gali Ravaliya	Gali Rajkumar	Gandhi Park-2	Arjunpura-2
Rated Motor Input Power	kW	7.5	3.7	9.3	7.5	5.6	7.5	7.5	11.2	5.6	5.6
Power of the motor on existing duty point	kW	5.06	2.71	6.83	4.84	4.07	5.33	5.07	8.70	3.93	4.44
Overall Efficiency	%	55%	50%	57%	55%	52%	55%	55%	58%	52%	52%
Operating Hours	hours	2190	4380	2920	4380	2920	3650	3650	4380	4380	2190
Annual energy saving	kWh/annum	6996	29763	8257	20489	22365	16015	4584	17025	21624	9151
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.6	2.4	0.7	1.6	1.8	1.3	0.4	1.4	1.7	0.7
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.478	0.816	0.679	0.566	0.679	0.679	0.917	0.566	0.566
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.040	0.069	0.057	0.048	0.057	0.057	0.077	0.048	0.048
Total Cost	Rs in Lakhs	1.326	1.108	1.476	1.326	1.204	1.326	1.326	1.584	1.204	1.204
Payback Period	months	29	6	27	10	8	12	44	14	8	20

Parameters	Unit	Theknarnol-2	Madhav Puri	Dholi Pyau Tiraha-New Construction	Ahilyabai Park Dampier Nagar MVDA	Ramlila Ground Krishna Nagar MVDA	Kankali Temple Dwarikapuri MVDA	Nai Basti W.No.	Andi Kuiya	Kathoti Kua Chaupal	Kathoti Kua Masjid
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	24	21	24	27	18	18	18	18	18	18

Parameters	Unit	Theknarnol-2	Madhav Puri	Dholi Pyau Tiraha-New Construction	Ahilyabai Park Dampier Nagar MVDA	Ramlila Ground Krishna Nagar MVDA	Kankali Temple Dwarikapuri MVDA	Nai Basti W.No.	Andi Kuiya	Kathoti Kua Chaupal	Kathoti Kua Masjid
Rated Power	HP	12.5	12.5	12.5	12.5	12.5	10	12.5	12.5	12.5	12.5
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	7.46	9.325	9.325	9.325	9.325
Parameters Measured											
Flow Delivered	m ³ /hr	25.51	21.57	20.14	24.7	18.58	18.67	27.86	31.24	18.47	18.57
Head of the Pump	m	60	51	54	43	41	50	50	54	50	56
Motor Power Consumption	kW	8.77	8.06	11.93	9.95	9.87	7.57	10.56	10.63	9.37	12.86
Hydraulic Power	kW	4.17	3.00	2.96	2.89	2.07	2.54	3.79	4.59	2.51	2.83
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	7.46	6.85	10.14	8.46	8.39	6.44	8.98	9.03	7.96	10.93
Pump Efficiency	%	55.9%	43.7%	29.2%	34.2%	24.7%	39.5%	42.3%	50.9%	31.6%	25.9%
Calculated Efficiency of the Pump set	%	47.5%	37.2%	24.8%	29.1%	21.0%	33.6%	35.9%	43.2%	26.9%	22.0%
Proposed Parameters											
Head of the Pump	m	60	51	54	43	41	50	50	54	50	56
Flow of the Pump	m ³ /hr	25.51	21.57	20.14	24.7	18.58	18.67	27.86	31.24	18.47	18.57
Rated Motor Input Power	kW	9.3	7.5	7.5	7.5	5.6	5.6	9.3	9.3	5.6	7.5
Power of the motor on existing duty point	kW	7.31	5.45	5.39	5.26	3.99	4.89	6.66	8.06	4.84	5.15
Overall Efficiency	%	57%	55%	55%	55%	52%	52%	57%	57%	52%	55%
Operating Hours	hours	4380	4015	7300	4380	2190	4015	2920	5475	3650	1825
Annual energy saving	kWh/annum	6397	10496	47803	20536	12871	10774	11401	14053	16535	14072
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.5	0.8	3.8	1.6	1.0	0.9	0.9	1.1	1.3	1.1
Investment towards new Pump set including GST	Rs in Lakhs	0.816	0.679	0.679	0.679	0.566	0.566	0.816	0.816	0.566	0.679
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.229	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.312	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Parameters	Unit	Theknarnol-2	Madhav Puri	Dholi Pyau Tiraha-New Construction	Ahilyabai Park Dampier Nagar MVDA	Ramlila Ground Krishna Nagar MVDA	Kankali Temple Dwarikapuri MVDA	Nai Basti W.No.	Andi Kuiya	Kathoti Kua Chaupal	Kathoti Kua Masjid
GST											
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.069	0.057	0.057	0.057	0.048	0.048	0.069	0.069	0.048	0.057
Total Cost	Rs in Lakhs	1.476	1.326	1.354	1.326	1.204	1.204	1.476	1.476	1.204	1.326
Payback Period	months	35	19	4	10	14	17	20	16	11	14

Parameters	Unit	Gupta Kunk W.No.7	Sadar Dhobi Pada W.No.8	Gandhi Nagar W.No. 9	Laxmi Nagar W.No. 9	Bains Bhora Kotwali W.No.14	Radhey Shyam Ashram W.No.16	Om Nagar W.No.17	Om Nagar- 2 W.No.17	Jogi Gali Antapada W.No.18	Khateek Mohalla Balmiki Basti W.No.19
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18	18	18
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Flow Delivered	m ³ /hr	22.6	39.15	16.69	17.23	27.62	17.49	21.59	17.09	23.08	20.13
Head of the Pump	m	49	25	45	50	53	42	45	50	44	53
Motor Power Consumption	kW	7.30	10.26	8.23	9.56	9.05	11.94	9.23	8.48	8.54	9.07
Hydraulic Power	kW	3.02	2.67	2.05	2.35	3.99	2.00	2.65	2.33	2.77	2.91
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	6.20	8.72	7.00	8.13	7.70	10.15	7.85	7.21	7.26	7.71
Pump Efficiency	%	48.6%	30.6%	29.2%	28.9%	51.8%	19.7%	33.7%	32.3%	38.1%	37.7%
Calculated Efficiency of the Pump set	%	41.3%	26.0%	24.8%	24.5%	44.0%	16.8%	28.7%	27.4%	32.4%	32.0%
Proposed Parameters											
Head of the Pump	m	49	25	45	50	53	42	45	50	44	53
Flow of the Pump	m ³ /hr	22.6	39.15	16.69	17.23	27.62	17.49	21.59	17.09	23.08	20.13

Parameters	Unit	Gupta Kunk W.No.7	Sadar Dhobi Pada W.No.8	Gandhi Nagar W.No. 9	Laxmi Nagar W.No. 9	Bains Bhora Kotwali W.No.14	Radhey Shyam Ashram W.No.16	Om Nagar W.No.17	Om Nagar- 2 W.No.17	Jogi Gali Antapada W.No.18	Khateek Mohalla Balmiki Basti W.No.19
Rated Motor Input Power	kW	7.5	7.5	5.6	5.6	9.3	5.6	7.5	5.6	7.5	7.5
Power of the motor on existing duty point	kW	5.48	4.85	3.93	4.51	6.99	3.85	4.81	4.48	5.03	5.28
Overall Efficiency	%	55%	55%	52%	52%	57%	52%	55%	52%	55%	55%
Operating Hours	hours	3285	5110	2190	5110	2920	5840	4380	6570	2190	5110
Annual energy saving	kWh/annum	5964	27664	9417	25813	6015	47243	19355	26312	7687	19374
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.5	2.2	0.7	2.1	0.5	3.8	1.5	2.1	0.6	1.5
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.679	0.566	0.566	0.816	0.566	0.679	0.566	0.679	0.679
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.057	0.048	0.048	0.069	0.048	0.057	0.048	0.057	0.057
Total Cost	Rs in Lakhs	1.326	1.326	1.204	1.204	1.476	1.204	1.326	1.204	1.326	1.326
Payback Period	months	34	7	19	7	37	4	10	7	26	10

Parameters	Unit	Guru Nanak Nagar W.No.19	Krishnapuram -1 Ward-24	Krishnapuram -2 Ward-24	Balmiki Basti Dholi Pyau Ward-27	Mahavidya Park Ward- 28	Hanuman Teela Ward-33	Kashmiri Gali Ward- 34	Mission Teela Sadar Bazar Ward-35	Matia Gate Ward-37	Subhash Nagar Nala Ward-38
Rated Parameters											
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65	65	65
Rated Flow	m3/hr	18	18	18	18	18	18	18	18	18	18

Parameters	Unit	Guru Nanak Nagar W.No.19	Krishnapuram -1 Ward-24	Krishnapuram -2 Ward-24	Balmiki Basti Dholi Pyau Ward-27	Mahavidya Park Ward-28	Hanuman Teela Ward-33	Kashmiri Gali Ward-34	Mission Teela Sadar Bazar Ward-35	Matia Gate Ward-37	Subhash Nagar Nala Ward-38
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured											
Flow Delivered	m3/hr	9.48	28.43	29.25	13.35	21.77	17.87	18.33	29.31	22.83	18.21
Head of the Pump	m	46	39	43	50	54	54	37	38	64	49
Motor Power Consumption	kW	8.00	10.72	10.19	9.03	6.55	7.47	6.97	10.86	8.99	11.43
Hydraulic Power	kW	1.19	3.02	3.43	1.82	3.20	2.63	1.85	3.03	3.98	2.43
Motor Efficiency	%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
Pump Shaft Power	kW	6.80	9.11	8.66	7.68	5.57	6.35	5.92	9.23	7.64	9.72
Pump Efficiency	%	17.5%	33.1%	39.5%	23.7%	57.5%	41.4%	31.2%	32.9%	52.1%	25.0%
Calculated Efficiency of the Pump set	%	14.8%	28.2%	33.6%	20.1%	48.9%	35.2%	26.5%	27.9%	44.3%	21.3%
Proposed Parameters											
Head of the Pump	m	46	39	43	50	54	54	37	38	64	49
Flow of the Pump	m3/hr	9.48	28.43	29.25	13.35	21.77	17.87	18.33	29.31	22.83	18.21
Rated Motor Input Power	kW	3.7	7.5	7.5	4.5	7.5	7.5	4.5	7.5	9.3	5.6
Power of the motor on existing duty point	kW	2.38	5.49	6.23	3.56	5.82	4.78	3.62	5.51	6.98	4.67
Overall Efficiency	%	50%	55%	55%	51%	55%	55%	51%	55%	57%	52%
Operating Hrs	hours	2007	1460	1460	4745	4380	1460	3650	5110	5110	2920
Annual energy saving	kWh/annum	11292	7633	5786	25950	3181	3933	12210	27314	10243	19740
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	0.9	0.6	0.5	2.1	0.3	0.3	1.0	2.2	0.8	1.6
Investment towards new Pump set including GST	Rs in Lakhs	0.478	0.679	0.679	0.522	0.679	0.679	0.522	0.679	0.816	0.566
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077

Parameters	Unit	Guru Nanak Nagar W.No.19	Krishnapuram -1 Ward-24	Krishnapuram -2 Ward-24	Balmiki Basti Dholi Pyau Ward-27	Mahavidya Park Ward-28	Hanuman Teela Ward-33	Kashmiri Gali Ward-34	Mission Teela Sadar Bazar Ward-35	Matia Gate Ward-37	Subhash Nagar Nala Ward-38
including GST											
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.040	0.057	0.057	0.044	0.057	0.057	0.044	0.057	0.069	0.048
Total Cost	Rs in Lakhs	1.108	1.326	1.326	1.156	1.326	1.326	1.156	1.326	1.476	1.204
Payback Period	months	15	26	35	7	63	51	14	7	22	9

Parameters	Unit	Manshapuri Ward-39	Rampal Gali Ward-40	Theknarnol Ward-40	Lala Ganj Ward-42	Kashiram Yojna-3	Kashiram Yojna-4	Satrangi Garden Ward-8	Naya Nagla Ward-11
Rated Parameters									
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured									
Flow Delivered	m ³ /hr	15.27	24.37	21.83	17.02	14.65	20.61	31.84	22.47
Head of the Pump	m	47	49	53	62	48	53	21	44
Motor Power Consumption	kW	9.45	6.87	7.46	7.80	7.00	11.30	6.94	7.86
Calculated Efficiency of the Pump set	%	20.7%	47.4%	42.2%	36.9%	27.4%	26.3%	26.3%	34.2%
Proposed Parameters									
Head of the Pump	m	47	49	53	62	48	53	21	44
Flow of the Pump	m ³ /hr	15.27	24.37	21.83	17.02	14.65	20.61	31.84	22.47
Rated Motor Input Power	kW	4.5	7.5	7.5	7.5	4.5	7.5	4.5	7.5
Power of the motor on existing duty point	kW	3.83	5.91	5.73	5.22	3.75	5.41	3.57	4.90
Overall Efficiency	%	51%	55%	55%	55%	51%	55%	51%	55%
Operating Hrs	hours	2920	3285	5110	2920	3650	3650	5475	4380
Annual energy saving	kWh/annum	16393	3134	8872	7506	11844	21503	18430	12993

Parameters	Unit	Manshapuri Ward-39	Rampal Gali Ward-40	Theknarnol Ward-40	Lala Ganj Ward-42	Kashiram Yojna-3	Kashiram Yojna-4	Satragi Garden Ward-8	Naya Nagla Ward-11
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	1.3	0.2	0.7	0.6	0.9	1.7	1.5	1.0
Investment towards new Pump set including GST	Rs in Lakhs	0.522	0.679	0.679	0.679	0.522	0.679	0.522	0.679
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.044	0.057	0.057	0.057	0.044	0.057	0.044	0.057
Total Cost	Rs in Lakhs	1.156	1.326	1.326	1.326	1.156	1.326	1.156	1.326
Payback Period	months	11	64	23	27	15	9	9	15

Parameters	Unit	Mali Mohalla Sadar Ward-13	Naya Bans Ward-15	Machli Gate Ward-19	Motikunj Extension	Rani Mandi Balmiki Basti Ward-6	Matia Gate Joshiyan Garden	Sanjay Nagar Nala	Balmiki Basti Ward-1
Rated Parameters									
Pump Make		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	Submersible
Rated Head	m	65	65	65	65	65	65	65	65
Rated Flow	m ³ /hr	18	18	18	18	18	18	18	18
Rated Power	kW	9.325	9.325	9.325	9.325	9.325	9.325	9.325	9.325
Parameters Measured									
Flow Delivered	m ³ /hr	24.16	16.49	10.74	27.43	24.47	25.34	25.17	18.17
Head of the Pump	m	50	62	50	47	49	59	48	52
Motor Power Consumption	kW	10.82	7.93	7.57	8.61	9.59	9.12	8.10	9.38
Calculated Efficiency of the Pump set	%	30.4%	35.1%	19.3%	40.8%	34.1%	44.6%	40.6%	27.4%
Proposed Parameters									

Parameters	Unit	Mali Mohalla Sadar Ward-13	Naya Bans Ward-15	Machli Gate Ward-19	Motikunj Extension	Rani Mandi Balmiki Basti Ward-6	Matia Gate Joshiyan Garden	Sanjay Nagar Nala	Balmiki Basti Ward-1
Head of the Pump	m	50	62	50	47	49	59	48	52
Flow of the Pump	m ³ /hr	24.16	16.49	10.74	27.43	24.47	25.34	25.17	18.17
Rated Motor Input Power	kW	7.5	7.5	3.7	7.5	7.5	9.3	7.5	5.6
Power of the motor on existing duty point	kW	5.98	5.06	2.92	6.38	5.94	7.14	5.98	4.95
Overall Efficiency	%	55%	55%	50%	55%	55%	57%	55%	52%
Operating Hours	hours	3650	1825	1825	4380	3650	4380	4380	4380
Annual energy saving	kWh/annum	17651	5234	8471	9762	13320	8668	9267	19412
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/annum	1.4	0.4	0.7	0.8	1.1	0.7	0.7	1.5
Investment towards new Pump set including GST	Rs in Lakhs	0.679	0.679	0.478	0.679	0.679	0.816	0.679	0.566
Investment towards NRV replacement including GST	Rs in Lakhs	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
Investment towards gate valve replacement including GST	Rs in Lakhs	0.299	0.299	0.299	0.299	0.299	0.299	0.299	0.299
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.057	0.057	0.040	0.057	0.057	0.069	0.057	0.048
Total Cost	Rs in Lakhs	1.326	1.326	1.108	1.326	1.326	1.476	1.326	1.204
Payback Period	months	11	38	20	21	15	26	22	9

Parameters	Unit	Masani Nala SPS Pump 1	Masani Nala SPS Pump 2	Masani Nala SPS Pump 3	Masani Nala SPS Pump 4	Masani Nala SPS Pump 5	Krishna Ganga SPS Pump 2	Chinta Haran SPS Pump 1	Chinta Haran SPS Pump 3
Rated Parameters									
Pump Type		Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible
Rated Head	m	36	36	36	36	36	20	20.5	20.5
Rated Flow	M ³ /hr	270	270	540	270	540	108	270	270
Rated Power	kW	30	30	90	30	90	11	19	19
Parameters Measured									
Flow Delivered	m ³ /hr	236.7	262.1	398.7	215.2	389.0	52.3	66.4	66.1

Parameters	Unit	Masani Nala SPS Pump 1	Masani Nala SPS Pump 2	Masani Nala SPS Pump 3	Masani Nala SPS Pump 4	Masani Nala SPS Pump 5	Krishna Ganga SPS Pump 2	Chinta Haran SPS Pump 1	Chinta Haran SPS Pump 3
Head of the Pump	m	25	31	27	33	26	22	25	24
Motor Power Consumption	kW	39.25	45.90	67.53	45.32	68.57	10.43	13.05	13.77
Calculated Efficiency of the Pump set	%	41.7%	49.7%	44.7%	44.0%	41.4%	31.0%	35.7%	32.3%
Proposed Parameters									
Head of the Pump	m	25	31	27	33	26	22	25	24
Flow of the Pump	m ³ /hr	237	262	399	215	389	52	66	66
Rated Motor Input Power	kW	26.25	33.75	52.5	33.75	45	9	9	9
Power of the motor on existing duty point	kW	25.03	35.77	50.06	30.86	40.72	7.92	9.14	9.03
Pump Efficiency	%	77%	75%	71%	76.0%	82%	48%	60%	58%
Overall Efficiency	%	65%	64%	60%	65%	70%	41%	51%	49%
Operating Hrs	hours	1460	1460	1460	1460	1460	1825	1095	1095
Annual energy saving	kWh/ann um	20759	14790	25499	21116	40653	4582	4284	5200
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/ann um	1.7	1.2	2.0	1.7	3.2	0.4	0.3	0.4
Investment towards new Pump set including GST	Rs in Lakhs	2.768	3.733	4.414	3.733	4.343	1.427	1.427	1.427
Investment towards NRV replacement including GST	Rs in Lakhs	1.055	0.588	1.055	0.588	1.055	0.245	0.245	0.245
Investment towards gate valve replacement including GST	Rs in Lakhs	1.181	0.658	1.181	0.658	1.181	0.338	0.338	0.338
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.233	0.315	0.372	0.315	0.366	0.120	0.120	0.120
Total Cost	Rs in Lakhs	5.315	5.371	7.100	5.371	7.022	2.208	2.208	2.208

Parameters	Unit	Masani Nala SPS Pump 1	Masani Nala SPS Pump 2	Masani Nala SPS Pump 3	Masani Nala SPS Pump 4	Masani Nala SPS Pump 5	Krishna Ganga SPS Pump 2	Chinta Haran SPS Pump 1	Chinta Haran SPS Pump 3
Payback Period	months	39	55	42	38	26	73	78	64

Parameters	Unit	Swami Ghat SPS Pump 1	Swami Ghat SPS Pump 2	Cantt. Nala SPS Pump 1	Dairy Farm SPS Pump 1	Dairy Farm SPS Pump 2	Dairy Farm SPS Pump 3	Dairy Farm SPS Pump 4	Dairy Farm SPS Pump 5
Rated Parameters									
Pump Type		Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible	Non Clog Submersible
Rated Head	m	-	-	25	35	28	35	28	35
Rated Flow	M3/hr	-	-	72	338.4	165.6	338.4	165.6	338.4
Rated Power	kW	7.5	7.5	19	75	30	75	30	75
Parameters Measured									
Flow Delivered	m3/hr	122.8	119.5	39.9	293.7	110.3	302.9	111.2	312.3
Head of the Pump	m	12	11	25	26	18	26	19	25
Motor Power Consumption	kW	12.52	12.41	23.91	80.39	36.45	78.20	36.10	76.20
Calculated Efficiency of the Pump set	%	31.6%	28.4%	11.7%	26.6%	15.3%	27.9%	16.4%	28.7%
Proposed Parameters									
Head of the Pump	m	12	11	25	26	18	26	19	25
Flow of the Pump	m3/hr	123	119	40	294	110	303	111	312
Rated Motor Input Power	kW	7.5	7.5	11.25	37.5	11.25	37.5	15	37.5
Power of the motor on existing duty point	kW	6.76	6.00	8.24	34.08	9.78	34.23	11.25	33.92
Pump Efficiency	%	69%	69%	40%	74%	67%	75%	62%	76%
Overall Efficiency	%	59%	59%	34%	63%	57%	64%	53%	65%
Operating Hrs	hours	3650	3650	4380	1460	1460	1460	1460	1460
Annual energy saving	kWh/ann um	21039	23374	68629	67619	38931	64189	36281	61731
Electricity Rate	Rs/kWh	7.95	7.95	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost saving	Rs in lakhs/ann um	1.7	1.9	5.5	5.4	3.1	5.1	2.9	4.9

Parameters	Unit	Swami Ghat SPS Pump 1	Swami Ghat SPS Pump 2	Cantt. Nala SPS Pump 1	Dairy Farm SPS Pump 1	Dairy Farm SPS Pump 2	Dairy Farm SPS Pump 3	Dairy Farm SPS Pump 4	Dairy Farm SPS Pump 5
Investment towards new Pump set including GST	Rs in Lakhs	1.321	1.321	1.844	3.962	2.142	3.962	1.899	3.962
Investment towards NRV replacement including GST	Rs in Lakhs	0.245	0.245	0.270	1.055	0.588	1.055	0.588	1.055
Investment towards gate valve replacement including GST	Rs in Lakhs	0.338	0.338	0.354	1.181	0.658	1.181	0.658	1.181
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.111	0.111	0.155	0.334	0.181	0.334	0.160	0.334
Total Cost	Rs in Lakhs	2.093	2.093	2.700	6.610	3.645	6.610	3.382	6.610
Payback Period	months	15	14	6	15	14	16	14	16

Parameters	Unit	Bangali Ghat SPS Pump 1	Bangali Ghat SPS Pump 5
Rated Parameters			
Pump Type		VT	VT
Rated Head	m	24	24
Rated Flow	M3/hr	349.2	349.2
Rated Power	kW	44.8	44.8
Parameters Measured			
Measured Flow	m3/hr	212.9	236.8
Head of the Pump	m	20	22
Motor Power Consumption	kW	41.26	43.97
Calculated Efficiency of the Pump set	%	28.9%	33.2%
Proposed Parameters			
Head of the Pump	m	20	22
Flow of the Pump	m3/hr	213	237
Rated Motor Input Power	kW	37.3	37.3
Power of the motor on existing duty point	kW	18.74	22.94

Parameters	Unit	Bangali Ghat SPS Pump 1	Bangali Ghat SPS Pump 5
Pump Efficiency	%	75%	75%
Overall Efficiency	%	64%	64%
Operating Hours	hours	1825	1825
Annual energy saving	kWh/annum	41099	38383
Electricity Rate	Rs/kWh	7.95	7.95
Annual cost saving	Rs in lakhs/annum	3.3	3.1
Investment towards new Pump set including GST	Rs in Lakhs	3.979	3.979
Investment towards NRV replacement including GST	Rs in Lakhs	2.290	2.290
Investment towards gate valve replacement including GST	Rs in Lakhs	2.563	2.563
Investment towards Web based dashboard including GST	Rs in Lakhs	0.077	0.077
Investment towards Installation & Commissioning including GST	Rs in Lakhs	0.335	0.335
Total Cost	Rs in Lakhs	9.245	9.245
Payback Period	months	34	36

7 Repair & Maintenance Measures

7.1 Present R&M and O&M expenses

Pump sets requires periodic repair and maintenance to keep them in running condition and each R & M activity has a cost associated with it. During energy audit, it was observed that need of repair and maintenance arises generally for replacement of consumables and for addressing wear and tears of components of pump set. During energy audit, data regarding repair and maintenance cost was requested to municipality official but partial data of R& M is received from him. Details of R & M and other cost associated with pumping stations are provided in table 18:

Table 18: R&M and O&M expenses for Mathura Pumping Stations

Financial Data	Units	Values
Cost of Repair & Maintenance in FY2014 - 2015	Rs. Lakh	147.1
Cost of Repair & Maintenance in FY2015 - 2016	Rs. Lakh	129.2
Cost of Repair & Maintenance in FY2016- 2017	Rs. Lakh	209.2
Cost of Operation in FY2014 -2015	Rs. Lakh	641.73
Cost of Operation in FY2015-2016	Rs. Lakh	669.28
Cost of Operation in FY2016-2017	Rs. Lakh	789.68
Cost of Purchase of new pump/motors/accessories in FY2014-2015	Rs. Lakh	22.18
Cost of Purchase of new pump/motors/accessories in FY2015- 2016	Rs. Lakh	220.88
Cost of Purchase of new pump/motors/accessories in FY2016 -2017	Rs. Lakh	273.42

In above tables, cost of operations includes jal kal staff cost, jal kal sewage , Borewell, Sewage Contractor, labor cost on daily basis.

In proposed scenario, repair and maintenance cost for the pump sets reduces most of old and inefficient pumps will be replaced by new energy efficient pumps. Along with this, during project period, repair and maintenance of new pumps will be done by EESL selected manufacturer.

8 Project Financials and Business model

An IGEA Report is the process of conducting an energy audit to identify efficiency improvement opportunities, and translating the technical findings into financial terms to present it as a bankable project capable of securing a loan. Therefore it is important to conduct a detailed financial analysis for the project to ascertain the financial viability of the project.

This project would be implemented in Annuity Mode. In this mode, EESL will invest all the capital investment required for implementation of the Energy Efficiency Project. **EESL will assure a minimum energy savings of approx. 20% as compared to the existing energy consumption. Payments would not be affected if savings are higher than 20%.** Further EESL would provide Repair & Maintenance (R&M) for the replaced pump sets during the project period. The repayment to EESL (in the form of annuity) would be determined on cost plus ROE basis. Schematic of business model of this project is provided in figure 9.

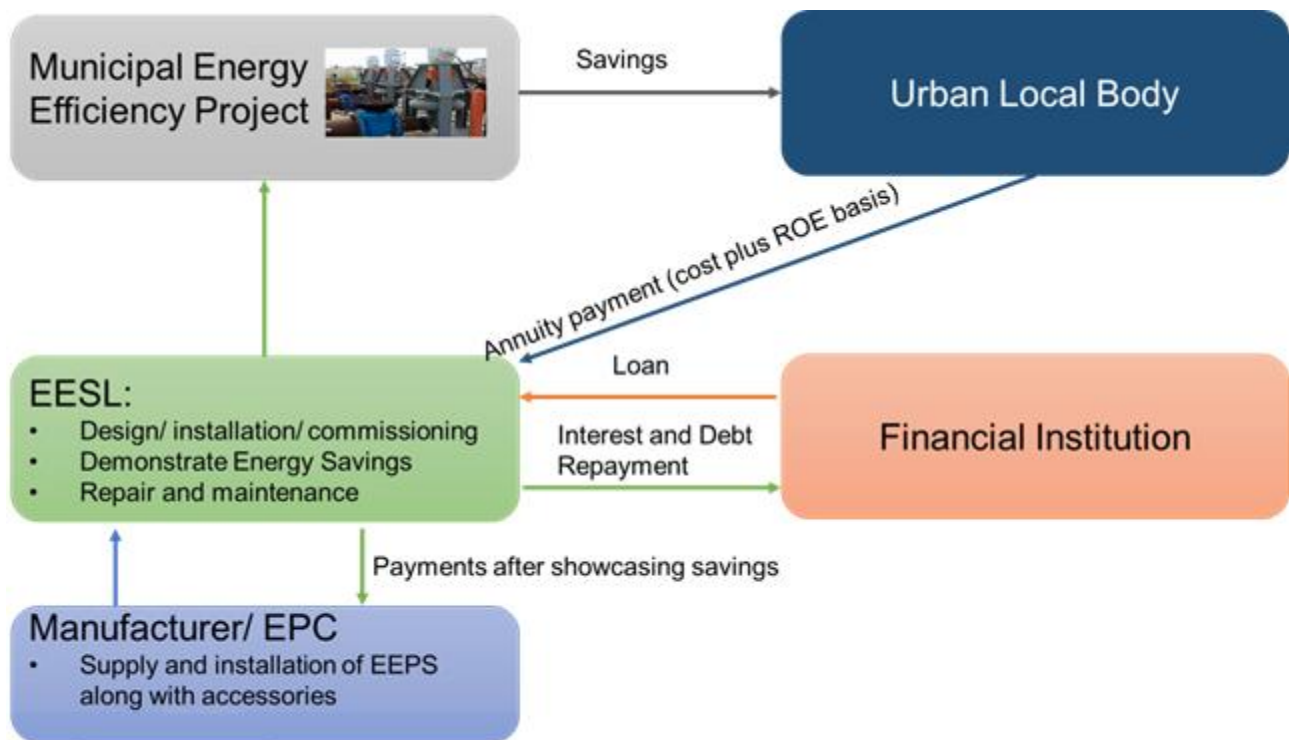


Figure 9 Schematic of business model of the project

8.1 Total Project cost (CAPEX)

The following are the key components considered while arriving at the total project cost:

- Cost of pump, motor and other accessories (like NRV and gate valve), discovered through a transparent bidding process;

- ii. Cost of dismantling, installation and commissioning including testing charges, discovered through a transparent bidding process;
- iii. Project Establishment and Supervision charges of EESL at 5 % of total cost of equipment including installation;
- iv. Cost of preparation of IGEA, as per actual tendered cost, plus EESL's service charge at 15%;
- v. All applicable goods and services taxes on actual basis; and
- vi. Capitalized interest during the Project Implementation Period.

Details of project capital cost is provided in table 19.

Table 19: Project Capital cost

Capital Cost Related assumption	Unit	Value
Number of Pumps	No.	131
Total Cost of Equipment including installation, commissioning and testing	INR lakhs	235.55
<i>Cost of pump including motor</i>	INR lakhs	125.17
<i>Cost of NRV</i>	INR lakhs	39.04
<i>Cost of Gate valve</i>	INR lakhs	50.72
<i>Cost of Web based dashboard</i>	INR lakhs	10.06
<i>Installation and Commissioning Cost including testing charges</i>	INR lakhs	10.55
EESL's administrative and establishment charge	%	5
Cost of preparation of IGEA report including EESL service charges and applicable GST	INR lakhs	10.49
Total Project Cost w/o Capitalized interest	INR lakhs	257.82
Commissioning Details		
Total Months for Commissioning	months	9
Capitalized interest	INR lakhs	14.45
Total Project Cost	INR lakhs	272.27

8.2 Operating Costs (OPEX)

The following are the key components considered while arriving at the operating cost for the project

- i. Project Establishment and Supervision charges of EESL at 4% of total project cost, with annual escalation of 5%; and
- ii. Actual incurred Repair & Maintenance charges, discovered through a transparent bidding process.

Details of operating cost is provided in table 20.

Table 20: Project operating cost

Operational Details	Unit	Value
EESL's administrative and establishment charges	%	4%

8.3 Financing Terms and other tax related assumptions

The following are the key financial assumptions used in developing the model. Details of financing terms and tax related assumptions are provided in table 21.

Table 21: Financing terms and tax related assumptions

Parameters	Unit	Value
Term of the project	years	7
Financing Details		
Debt Percentage	%	70
Cost of Debt	%	11
Equity Percentage	%	30
Cost of Equity (post- tax)	%	16
Tax Details		
Corporate Tax	%	34.61
Goods and Services Tax	%	18

8.4 Output - Annuity Payment to EESL

Based on the cost parameters and assumptions mentioned above, the annuity payment to EESL was computed. Details of annuity payment to EESL is provided in table 22.

Table 22: Annuity payment to EESL

Year		1	2	3	4	5	6	7	Total
Calculations of annuity payment									
Total Debt to be repaid	INR lakh	47.07	44.07	41.08	38.08	35.09	32.09	29.10	266.59
Principal Repayment	INR lakh	27.23	27.23	27.23	27.23	27.23	27.23	27.23	190.59
Interest	INR lakh	19.84	16.85	13.85	10.86	7.86	4.87	1.87	76.00
Total Equity Repayments	INR lakh	30.58	27.73	24.87	22.02	19.16	16.31	13.45	154.13
Recovery of equity investment	INR lakh	11.67	11.67	11.67	11.67	11.67	11.67	11.67	81.68
Return on equity	INR lakh	18.91	16.06	13.20	10.35	7.49	4.64	1.78	72.45
R&M Charges	INR lakh	0.00	5.89	17.67	22.38	27.09	35.33	42.40	150.75
EESL's administrative and establishment charge	INR lakh	10.89	11.44	12.01	12.61	13.24	13.90	14.59	88.67
Annuity Payment to EESL	INR lakh	88.54	89.13	95.62	95.09	94.58	97.63	99.54	660.13
Goods and Services Tax on annuity payment	INR lakh	15.94	16.04	17.21	17.12	17.02	17.57	17.92	118.82
Annuity Payment to EESL incl. all applicable taxes	INR lakh	104.48	105.17	112.84	112.20	111.60	115.21	117.5	778.96
ULB Savings									
Total Savings	INR lakh	191.11	195.52	199.79	203.88	207.74	211.35	214.7	1424.1
Profit to ULB	INR lakh	86.63	90.36	86.95	91.67	96.14	96.15	97.20	645.10
% of savings with ULBs	%								45.3%

8.5 Sensitivity analysis

The sensitivity analysis has been conducted to determine the impact of change in capital cost and change in savings on the percentage of monetary share of accrued savings retained by the ULB. Details of project sensitivity analysis is provided below

Table 23: Project Capital cost

Change in Capital Cost	% of savings retained by the utility
-10%	49.52%
-5%	47.41%
0%	45.30%
5%	43.19%
10%	41.08%
Change in Interest(ROE, Interest, D/E ratio)	% of savings retained by the utility
-10%	39.22%
-5%	42.42%
0%	45.30%
5%	47.90%
10%	50.27%

8.6 Payment Security Mechanism

Payment default by the borrower is perceived as one of the most important risks. For projects based on ESCO model, wherein ESCO or financial institution pays the upfront capital for project implementation, the regular payment to the ESCO/financial institution is crucial to maintain a positive cash flow. There are difficulties associated with measuring energy performance accurately and equitably, and therefore the actual energy savings may be disputable, especially in circumstances where the energy baseline and stipulated factors are not well established at the pre-project stage. Apart from possible dispute on actual savings, host's bankruptcy and dismissal of a management body could also be possible reasons for non-payment. Payment security mechanism is necessary to ensure confidence of investors in an ESCO projects. The mechanism should be structured in a way which would be acceptable to ESCO/financial institution. The payment security mechanism maybe in form of irrevocable bank guarantees or letter of credit (LOC) furnished by the ESCO/financial institution.

Letter of credit

Letter of credit (LC) is the obligation taken by the bank to make the payment once certain criteria are met. Whereas, bank guarantee (BG) is a promise made by a bank that the liabilities of the debtor will be met in event the energy user fails to make the payment. The major difference between bank guarantee (BG) and letter of credit (LC) is that BG reduces the loss in the transaction if transaction doesn't go as planned while letter of credit ensures that transaction proceeds as planned. As the ultimate objective of the program is to improve the energy efficiency in water supply and sewage system and ensuring the success of the project, letter of credit would be preferred payment security mechanism.

Letter of credits processes payment on receipt of required documents from the service provider. Major challenges associated with letter of credit are enlisted below:

- Letter of credits are usually irrevocable agreement and hence any changes in terms of contract will be difficult to address in letter of credit.
- Getting letter of credit is difficult considering the stringent qualification criteria. Letter of credit is usually issued to companies and organization that have cash flow, asset and good credit score.
- Usually line of credit are issued with terms for paying it back, herein energy user will be using the line of credit to pay the service provider for its services. In case of energy savings line of credit could be used as an guarantee in case of default by the government entity

In the case of the AMRUT program, the state government play a critical role in implementation of the project would sign the tri partite agreement for implementation of the project. The state government shall provide an unconditional, revolving and irrevocable Letter of Credit from a scheduled and nationalized bank (other than co-operative banks) at its own cost for the entire contract period. The amount of letter of credit shall be equivalent to 2 times the quarterly invoice. The LC may then be drawn upon by EESL for recovery of the eligible payments, in case of defaults.

9 Key Observations and Suggestions

To achieve optimum performance and reliability, a pump must be operated close to its best efficiency point (BEP). At the BEP, the hydrodynamic unbalanced load of the pump is at its minimum. Basically, when a pump operates at a point that is far away from the actual BEP, it results in an overall increase in hydrodynamic unbalanced load. This in turn affects the performance, reliability and efficiency of the pump.

Main source of water for the city of Mathura is ground water. There are 141¹⁰ Nos. of pumps installed to cater the water needs of Mathura City. These 141 nos. of submersible pumps are used to supply water directly to the users. Out of 141 Nos. of water supply pumps, 121 Nos. were in operation during energy audit and 20 Nos. of pumps were under maintenance. Apart from water distribution pump sets, 35 Nos. of pump sets are also installed in the sewage water pumping system to transfer the sewage water to the sewage treatment plant. Out of 35 Nos. of pump, 21 Nos. of pumps were in operation during energy audit and 14 Nos. of Pump sets were under maintenance.

The present operating pumps' efficiencies for water supply pumps are in range of 15.4% to 62.1% and for sewage pumps is 13.8% to 58.4%. The efficiency of the pump is low mainly due to pump operating far away from the Best Efficiency Point (BEP).

9.1 Observation

- Main header pipeline of the sewage MPS station is old and rusted. Therefore, only one Pump is operating at at time.
- Pressure gauge is installed at the Dairy farm sewage pumping station but none was operating during the audit.
- Screen installed to the sewage pumping station but not working properly.
- In some of the pumping stations the NRV and gate valve is not functioning properly.
- There is no monitoring of discharge pressure and flow throughout the system.

9.2 Recommendations

- Energy meters have to be installed to all pumping stations.
- Screen has to be checked and install new system to prevent heavy solid particles entering to the system.
- Monitoring of discharge pressure and flow.

¹⁰ As per LOA, there were 143 pumps (water), however in LOA list, there was repetition of two pump sets. Therefore, total pump at Mathura, in IGEA, is considered as 141.

10 Measurement and Verification (M&V)

Measurement and Verification (M&V) is the term given to the process for quantifying savings delivered by an Energy Efficiency Measure (EEM). It includes energy saving verification process involving measurements and reporting methodology. M & V methodology followed in this project includes following measurement schedule

- Measurement of parameters pre EEM implementation (just before installation of EEPS) for all operating combinations using portable instruments
- Measurement of parameters post EEM implementation for all operating combinations using portable instruments.

Energy savings are calculated as the difference in power drawn (in pre and post implementation scenario) multiplied by the operating hours mentioned in IGEA.

These energy savings shall be verified in accordance with M&V plan presented in the final report by EESL and as agreed upon by the ULB. The energy savings will be determined and signed by EESL, Pump Supplier and the ULB. EESL shall submit a report as per the reporting template attached to this agreement verifying the savings mentioned in the agreement.

The report shall be submitted by EESL to all the ULB within 15 days of the completion of the verification

10.1 Definition of possible and operating combinations

In ULBs, especially in case of pumping stations, where the pumps are connected in parallel, the pump operated in various combinations. For the purpose of this document, these combinations are defined as possible combinations. For example, for if 3 pumps are connected in parallel, there are 7 possible combinations considering three different pumps i.e.

Pump 1	Pump 1+ Pump 2	
Pump 2	Pump 2+ Pump 3	Pump 1+Pump 2+Pump 3
Pump 3	Pump 3 +Pump 1	

However, the ULB might be operating the pumps only in three combination, depending on the flow requirement, from the one discussed above. For the purpose of this document, these combinations are defined as operating combinations.

Operating Combination 1	Operating Combination 2	Operating Combination 3
Pump 1	Pump 1+ Pump 2	Pump 1+Pump 2+Pump 3

10.2 Flow of activities under M & V process

- First, measurements of old pump would be carried out by the supplier when new pump is ready to be installed at ULB.
- Instantaneous measurement of parameters like flow, head (both at suction and discharge) and power of old pump would be carried out for all operating combinations after stabilisation using portable meters. These parameters will be called pre implementation parameters
- Pre implementation parameters will be verified by EESL, ULB and Supplier.

- Then, old pump will be replaced by new pump and instantaneous measurements of parameters mentioned above will be carried out on new pump after stabilisation for same operating combinations. These parameters will be called post implementation parameters.
- Energy savings of a pump for each combination would be determined by multiplying the difference in instantaneous power consumption in pre and post EEM implementation scenario with corresponding operating hours mentioned in IGEA. Total savings of a pump will be the summation of energy savings in each operating combination (i.e. weighted average savings of a pump would be estimated)
- The flow and head of new pump i.e. post implementation parameters should match pre implementation parameters.
- Post implementation parameters will be verified by EESL, ULB and supplier.
- Penalty would be imposed on pump supplier if energy savings, at ULB level, are less than 20% of existing energy consumption

10.3 Pre and post implementation assessment

To determine savings, the following parameters would be measured during pre and post implementation for each operating combination,

i. Power Consumption, voltage, frequency (kW, Volt, hz)

Data Unit	kW, Volt, hz
Description	Voltage, frequency and power consumption of all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated portable instrument (power analyzer)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable power analyzer
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

ii. Flow rate (m³/hr)

Data Unit	m ³ /hr
Description	Flow rate delivered for all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated portable instruments (flow meter)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable flow meter
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

iii. Head (m)

Data Unit	meters (m)
Description	Average head delivered for all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated instruments
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using pressure gauge installed at both the suction and discharge side of the pump
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

10.4 Correction Factors and adjustments

In case of deviation in frequency and voltage at the time of post implementation parameter measurements, following correction factors would be applied on parameters of new pump to determine actual. Adjustments factors to be used during M&V are provided in table 24.

Table 24: Adjustment factors to be used during M & V

Factor Affecting	Rationale for adjustment	Adjustment to be made
Variation in supply frequency	As per pump affinity law	$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$ $\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$ Where, Q is the flow of the meter N is the speed of the shaft P is the power drawn
Voltage Variation	As per BEE guidelines	If the post implementation voltage is 10% higher than pre implementation voltage, power consumption will increase by 0.75% If the post implementation voltage is 10% lower than pre implementation voltage, power consumption will increase by 2%

10.5 Determination of Savings

- Based on this data, the energy savings would be calculated as given below:

$$\% \text{ savings } (s_1) = \frac{((kW_{pre1} - kW_{post1}) \times h_1) + ((kW_{pre2} - kW_{post2}) \times h_2) + \dots}{(kW_{pre1} \times h_1) + (kW_{pre2} \times h_2) + \dots}$$

- Where, 1, 2.... represents parameter for different operating combinations of a pump
 - h1, h2 represents annual operating hours of a pump in different combinations
 - kW_{pre} – Instantaneous power consumption of old pump in a particular combination
 - kW_{post} – Instantaneous power consumption of new pump in a particular combination
 - s1 represents percentage savings of a pump
- Further, aggregate savings at a ULB level would be determined based on weighted average savings of all pumps:

The aggregate percentage savings at ULB would be

$$\text{aggregate \% savings at ULB} = \frac{s_1 \times e_1 + s_2 \times e_2 + s_3 \times e_3 \dots}{e_1 + e_2 + e_3 \dots}$$

- Where, e represents energy consumption of one pump in all combination

$$e_1 = kW_{pre1} \times \text{hour1} + kW_{pre2} \times \text{hour2} + \dots$$

- s1, s2, s3, s4, s5..... are percentage savings for individual pumps replaced at ULB
- e1, e2, e3, e4, e5..... are annual energy consumption of each pump

11 Risk Responsibility Matrix & Risk Mitigation

To develop an effective business model, it is necessary to identify clear roles and responsibilities and the risks associated with the project development. This is useful to develop appropriate structure and plan for project financing and risk mitigation mechanism for ring fencing the risks of project investors. Some of the major risks and their mitigation mechanisms are discussed below. As established in the previous sections, the preferred mode for implementation of this project is annuity mode. Therefore the responsibility matrix has been prepared considering the preferred implementing mode. Details of financial risk and associated mitigation measures table 25.

Table 25: Financial Risk Analysis and Mitigation

Risk	Key Incidence of risk	Description	Mitigation Measure
Operational Risk: Usage risks are usually a direct consequence of use of equipment by the end users. These risks are usually beyond the control of the ESCO			
Inaccurate Baseline	ULB	Baseline for any ESCO based project is usually defined in terms of energy consumption and the performance level of the equipment. In case of pumping stations, when pumps are connected in parallel, few pumps might not be operational during baseline determination. Also, an increase or decrease in operating hours can show up as corresponding increase or decrease in “savings” unless adequate adjustments are applied	The design of the M&V protocol would include sufficient measures in form of engineering formula for baseline correction to sufficiently mitigate this risk
Operational change in the facility	ULB	Operational changes can be in terms of change in usage hours. Further in case of pumping system, the operational changes can be a result of use of higher size of pumps, increase in number of pumps connected in a parallel system, increase in required flow among others.	
Market Risk: Market risks arise due to uncertainty of market conditions. These risks can be attributed to various stakeholders and factors including suppliers of technology, maturity of technology and consumers among others.			
Availability of suppliers	EESL	Availability of suppliers and the technology are keys to development of any ESCO project. Competition in market leads to market forces optimizing the cost. This also leads to new technology innovations and product differentiation. Dependence on a single supplier also increase the project risk, where the project is dependent on capability of single vendor to supply quality products in required quantity in a pre-determined	EESL is mitigating the risk by ensuring the involvement of manufacturers and suppliers throughout the project lifecycle including taking inputs during IGEA preparation. Further pumping is a matured industry with many suppliers

Risk	Key Incidence of risk	Description	Mitigation Measure
		time frame. Ineffective competition may lead to installation of inferior quality product and also cause delay in implementation.	
Age of the technology	EESL	Mature technology are by nature stable and more dependable than new technology. The performance standards for mature technologies are also well defined. There are many inherent risks associated with new technology, these include price fluctuations, rapid technology improvements (which could lead to project being more effective later i.e. early adopters curse ¹¹), lesser awareness about technology shortcomings and effects.	Pumping is a matured technology with key technical parameters and fundamentals remaining relatively constant during the past century.
Financial Risk: The financial risk mainly deals with the cost escalations associated with the project. These risks if not mitigated properly affect the profitability and feasibility of the project			
Equipment Cost Escalation	ULB	The increase in equipment cost could be due to various factors including increase in cost of raw materials, changed policies and regulations. The escalated cost could result in reducing the project profitability and in worst scenarios making the project unviable.	In the annuity mode, the equipment cost considered is the cost discovered in competitive bidding. This will ensure the best possible cost for the ULB. Further, manufacturer's budgetary quotations are taken while developing the IGEA.
Installation and annual maintenance cost Escalation	ULB (before bidding) Technology supplier (post bidding)	Installation cost is the function of manpower cost, cost of carrying inventory and material required for installation. For a project with longer execution cycle, managing installation and annual maintenance cost can be key to success of the project. In addition to factor affecting increase in manpower cost (change in labor laws etc.), the reasons for installation and annual maintenance cost are similar to equipment cost escalation. As the selected technology supplier is contractually responsible for installation	For the ULB the mitigation measures are same above

¹¹ The new technology turns old very quickly. Also rapid improvements lead to reduction in cost in near future. For example early adopters of solar technology had to pay a higher feed in tariff as compared to later adopters

Risk	Key Incidence of risk	Description	Mitigation Measure
		and annual maintenance at the rate mentioned in its bids. The risk is transferred to the technology provider post bidder selection.	
M&V Costs	EESL	M&V costs tend to vary significantly depending on the extent of measurements, involvement of technical manpower, and automation required in the M&V methods and protocols adopted	M&V mechanism will be clearly defined, agreed and incorporated into project financials prior to project implementation
Time and Budget Overruns	EESL	Failure to implement a viable project in a timely manner can add costs	To be addressed by closely monitoring progress with unit
Design and construction risk: Improper design and delays in constructions are a significant risk to ESCO project.			
Delays in procurement, installation and commissioning	All stakeholders	Delay in procurement, installation and commissioning could drive up project cost. Longer project durations could also increase the probability of other regulatory and policy related risks. It is important to plan the project efficiently to minimize these risks. Projects undertaken by EESL usually require procurement of large quantity of a single product	Standardization of bidding and other contractual documents is key to minimize this risk. Additionally all the stakeholders including ULBs, state government, manufacturers and energy auditors need to be engaged since project inception
Improper selection of energy efficiency solution and integration of energy efficient solution	All stakeholders	The aim of an ESCO project is reduce energy consumption while maintaining or improving performance of the equipment. Proper selection of solution is important to achieve these objectives. Improper selection of solution could lead to non-achievement of savings as estimated. It could also lead to not meeting the performance parameters from the baseline scenario	The manufacturers and technology suppliers are engaged since the project inception including overseeing energy audit activities and selection of technology. Further the manufacturers should be encouraged to visit the facility before bidding for the project.
Performance risks: related to performance of energy efficient equipment post implementation. Poor performance could lead to reduced savings from the ESCO project. This may result in poor financial returns for the project			
Equipment performance depreciation	EESL /Technology Supplier	In many conditions the equipment performance deteriorates over the life of the project. The derating of the equipment needs to be properly modelled in the business model for the project. Incorrect assumptions could lead to severe financial implication of the project. There are two key reasons for the equipment performance	Derating of equipment has been appropriately modelled in the financial model. The values of derating have been finalized after consultation with manufacturers. Proper quality control

Risk	Key Incidence of risk	Description	Mitigation Measure
		depreciation. Quality of equipment: Equipment installed as a part of the project does not conform to quality standards set. It is also possible that the vendor supplies equipment which do not meet the technical specification set out in the bidding document. External conditions: These conditions include various external parameters including power quality and operating condition (flow output and pump submergence) deviating from the design parameters	action plan needs to be developed as part of the bidding documents and contract. Capacity building of pump operators in proper operations of the new pumps installed
Repair/maintenance and warranty risks	EESL /Technology Supplier	Repair/maintenance and warranty risks relate to faulty equipment risks. The risk also arises due to different agencies being responsible for operations and repair/maintenance. In case of this project, operation would be managed by urban utility, whereas EESL and in turn technology supplier would be responsible for the repair and maintenance. A dispute also might arise related to deviation from warranty conditions which are also not under EESL/technology supplier control. EESL offers extended warranty up to the life of the project under most of its projects. The payment to EESL is also linked to satisfactory replacement of faulty equipment and timely repairs.	Capacity building of pump operators will be taken up to facilitate proper operations and routine preventive maintenance of the new pumps installed EESL will define Comprehensive repair and maintenance requirements including spares and components inventory, as well as appropriate systems (e.g. for registering complaints and turn-around times) and will make the equipment suppliers contractually responsible for preventive maintenance requirements.
Environmental and Legal Risk			
Reduction of water level	ULB, state government and general population	In areas where ground water is supplied through submersible pumps, another important risk is reduction of water level due to over drawl of water by the farmers because of more efficient high discharge new pumps. This could result in many short and long term environmental effects. If the water table is not recharged consistently if might	Change in operation guidelines, i.e. reduction if water supply hours if the flow is increased

Risk	Key Incidence of risk	Description	Mitigation Measure
		result in other long term effects including desertification.	
Utilization of old inventory in other areas	ULB and EESL	If the collected inefficient pumps are not destroyed they could be used again. This would defeat the purpose of the project and lead to over-estimation of environmental benefits associated with the project.	Proper destruction of old inventory
Health, Safety and Social risk			
Health Safety and Social risk	ULB and EESL	As principal employer EESL is responsible for these risks including: • Nonpayment of minimum wages • Child labor • Insurance for workers • Emergency preparedness, fire & electrical safety • Safety of tools and equipment used	EESL should contractually make the technology supplier and contractor adequately responsible for this risk. As principal employer of all the people working under this project, EESL should collect proper documentation.

12 Project Implementation Schedule

12.1 Execution Strategy

EESL and other stakeholders need to pay attention to project execution in order to deliver impactful projects. The efforts and money on a project that is poorly executed do not produce results on the expected lines.

Following are the project execution strategies to keep projects running efficiently and on schedule:

Define specific and measurable objectives: The well-executed project is seen as one that achieves its desired results. Those specifics should include:

- The timeline for the project- Identify milestones and deadlines that are needed to accomplish incremental progress.
- The staff and infrastructure resources necessary to complete the project. This would include full-time employees, outside contractors, part-time staff or specialized freelance support to properly execute the project.
- The cost of the project- Be sure to take into account human resources and material costs, including hardware and software or consulting fees, travel or other incremental expenses.

Plan for the unexpected: The project managers should take into account that not everything will go as planned. Being prepared for changes also means standing behind a project's goals on a broad level. As the project is being executed, project leaders should be able to explain and support what has happened in the project to date, along with: current status, what the results thus far mean to the project and its objectives, and what specific impact these results will have on the project in terms of cost reduction, broader opportunities, etc.

Measure progress through project waypoints: The process to improvement must invariably include measurement; and not just on a one-and-done basis. The different stakeholders need to measure progress along the way to see an updated view of the project so that they can respond immediately if (and when) project parameters need to be re-calibrated or changed. Measurement should be happening organically so that project leaders have visibility into the time commitment of project participants and the cost of materials and infrastructure.

12.2 Proposed schedule

The total implementation period of the EEM's as per the schedule provided by the pumping station is given in table 26.

Table 26: Project Implementation Schedule

T0: Date of signing of MoU between State Government and EESL

Sr. No	Activity	T0	T0 + 30 days	T0 + 90 days	T0 + 105 days	T0 + 135 days
1	Signing of MoU between State Government and EESL					
2	Inviting tenders for hiring of agency to prepare IGEA Report					
3	Preparation of IGEA and submission to ULB					
4	Submission of IGEA to SLTC by ULB					
5	SLTC approval on IGEA					

T1: Date of signing tripartite agreement between State Government, ULB and EESL, known as effective date

Sr. No	Activity	T1	T1 + 30 days	T1 + 90 days	T1 + 255 days	T1 + 270 days
1	Signing of tripartite agreement between State Government, ULB and EESL					
2	Inviting tenders for selection of pump supplier					
3	Selection of pump supplier					
4	Installation of energy efficient pump sets at ULB					
5	Submission of M & V report to ULB by EESL					

Since the ULB has water supplying priorities; the implementation is proposed to be carried out in such a way that the operation of pumping station is not impacted.

Annexures

The Annexures have been compiled as a separate document.

List of Annexures:

1. Energy Auditor/Manager Certificate
2. Verified Job Cards
3. Calibration Certificates of Instruments
4. Electricity Bills
5. Budgetary Quotations from Pump Manufacturers