









# INVESTMENT GRADE ENERGY AUDIT REPORT

## Nagar Nigam Bareilly, Uttar Pradesh

Submitted by

**Energy Efficiency Services Limited** 

Submitted To

**Nagar Nigam Bareilly** 

August, 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, Uttar Pradesh" for taking up the reform on priority basis with Energy Efficiency Services Limited (EESL) and signing the agreement on 09<sup>th</sup> 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, Directorate of Urban Local Bodies, State Mission Director, AMRUT, Govt. of UP
- Shri Vishal Bhardwaj, Additional Director, Directorate of Urban Local Bodies, Govt. of UP

We would also like to thank the officials of the "Nagar Nigam Bareilly" 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 Bareilly during the survey and detailed energy audit.

- Shri Balram Singh (GM, Nagar Nigam, Bareilly)
- Shri Premchand (Junior Engineer, Nagar Nigam, Bareilly)

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 "MITCON Consultancy & Engineering Services Ltd (MITCON)" for carrying out the energy audit and preparation of the IGEA report. We acknowledge the efforts put in by the following officials of MITCON during the energy audit.

- Shri Loveneesh Khurana, Senior Consultant (EA 20888)
- Shri Dheeraj Kumar, Engineer

On Behalf of Energy Efficiency Services Limited

Mr. Tarun Tayal, Regional Manager, EESL - UP











## **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 28<sup>th</sup> 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, Government of Uttar Pradesh have jointly entered into an agreement on 9<sup>th</sup> 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 Bareilly, City of Uttar Pradesh.

## **Description of Facilities**

The city spreads over an area of 3841.9 km2 and is governed by Municipal Corporation which comes under Bareilly Metropolitan Region. As per the Census (2011), the population of Bareilly city was 44,48,359.

There are 64 pumping stations in the Bareilly (as listed in the below table) having single submersible or vertical turbine types pumps which are used to supply underground (bore well) water to overhead tanks or directly to the consumers. Three phase LT motor having star-delta starter are used for the pumps in all the pumping stations. Most of the pumping stations are provided with the dosing pump for chlorination of the underground water supplied for the domestic requirement of Bareilly.

The capacity of the pumping stations of Bareilly varies from 2.88 to 5.76 MLD and these pumping stations supply underground water to overhead tank of 150 to 2100 kL capacity or directly to the consumer. The running hour of the pumping stations varies as per the water requirement and during energy audit operating hours found in the range of 4 to 20 hours per day with the average of 16 Hours. Description of facility and list of pumping stations of Bareilly are provided in table below.











#### Description of facility and water storage capacity

St.     Pump No.     Name of bore well station     covered for distribution     Source of water     Mo. D     Dimp at storage     Type of storage       1     Pump No. 1     Civil Lines - 6     Barelily     Ground Water     1     1886     OHT       2     Pump No. 3     Civil Lines - 6     Barelily     Ground Water     1     2000     OHT       4     Pump No. 4     Jublee Park - 2     Barelily     Ground Water     1     2000     OHT       6     Pump No. 6     Jublee Park - 9     Barelily     Ground Water     1     2000     OHT       7     Pump No. 6     Ground Stater     1     1985     OHT       7     Pump No. 6     Ground Stater     1     1985     OHT       8     Pump No. 10     Gott. Inter College     Barelily     Ground Water     1     1985     OHT       10     Pump No. 10     Gott. Inter College     Barelily     Ground Water     1     NA     OHT       11     Pump No. 12     Matin Park     Barelily     Ground Water	Tear     Type of storage     Pump flow (MLD)       1885     OHT     4.32       NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     3.16       1985     OHT     3.16       1985     OHT     4.32       1995     OHT     3.16       1985     OHT     4.32       1990     OHT     4.32       1990     OHT     3.31       NA     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       1999     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       1995     OHT     3.16       1995     OHT     3.20
No.     Pump No. 1     Civil Lines - 5     Barelly     Ground Water     1     Name     Storage       1     Pump No. 2     Civil Lines - 6     Barelly     Ground Water     1     NA     OHT       3     Pump No. 2     Civil Lines - 7     Barelly     Ground Water     1     2000     OHT       4     Pump No. 5     Jublee Park - 2     Barelly     Ground Water     1     2000     OHT       6     Pump No. 6     Jublee Park - 8     Barelly     Ground Water     1     2001     OHT       7     Pump No. 7     Rampur Bagh     Barelly     Ground Water     1     995     OHT       9     Pump No. 6     Gort. Inter College     Barelly     Ground Water     1     Nam No     Nam Dev     OHT     1     Nam No     Nam Dev     Nam Dev     Nam Dev     Nam No     Nam Dev     Nam No     <	OT     storage     (MLD)       1885     OHT     4.32       NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     3.16       1985     OHT     3.16       1985     OHT     3.16       1985     OHT     4.32       1995     OHT     3.16       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       2014     OHT     3.16       1995     OHT     3.16       1995     OHT     3.16       1995     OHT     3.16       1995     OHT     3.31       N
distribution     and     Call       1     Pump No. 1     Civil Lines - 6     Barelily     Ground Water     1     NA     OHT       2     Pump No. 3     Civil Lines - 7     Barelily     Ground Water     1     2000     OHT       4     Pump No. 4     Jublee Park - 2     Barelily     Ground Water     1     2000     OHT       7     Pump No. 5     Jublee Park - 4     Barelily     Ground Water     1     2001     OHT       7     Pump No. 6     Gher Jafar Khan     Barelily     Ground Water     1     1995     OHT       9     Pump No. 10     Goxt. Inter College     Barelily     Ground Water     1     1985     OHT       10     Pump No. 10     Sark Tham (Goxt. Inter College)     Barelily     Ground Water     1     NA     OHT       11     Pump No. 12     Kishore Bazar     Barelily     Ground Water     1     NA     OHT       12     Pump No. 16     C.I. Park - 3     Barelily     Ground Water     1     2010     O	LSI.     (IILD)       1885     OHT     4.32       NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.16       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     5.04       2013     OHT     5.04       2014     OHT     2.88       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     3.31       NA     OHT     4.32       1995     OHT </th
1     Pump No. 2     Civil Lines - 6     Barelily     Ground Water     1     NA     OHT       3     Pump No. 2     Civil Lines - 7     Barelily     Ground Water     1     1884     OHT       4     Pump No. 4     Jublee Park - 2     Barelily     Ground Water     1     2000     OHT       7     Pump No. 6     Jublee Park - 9     Barelily     Ground Water     1     2995     OHT       7     Pump No. 7     Rampur Bagh     Barelily     Ground Water     1     1995     OHT       7     Pump No. 6     Gher Jafar Khan     Barelily     Ground Water     1     1995     OHT       7     Pump No. 10     Gov. Inter College     Barelily     Ground Water     1     1995     OHT       11     Pump No. 11     Sarit Kham (Gov. Inter College     Barelily     Ground Water     1     NA     OHT       12     Pump No. 13     Kirknor Bazar     Barelily     Ground Water     1     NA     OHT       13     Pump No. 14     C.I. Park	1885     OHT     4.32       NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       2001     OHT     4.32       1995     OHT     3.16       1985     OHT     3.16       1985     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       2014     OHT     2.88       2001     OHT     2.88       2002     OHT     3.16       1995     OHT     3.16       1995     OHT     3.16       2004     OHT     3.20       1995     OHT     3.31       NA     OHT     4.32       1995 </th
2     Pump No. 3     Civil Lines - 6     Barelily     Ground Water     1     NA     OHT       4     Pump No. 4     Jublee Park - 2     Barelily     Ground Water     1     2000     OHT       5     Pump No. 5     Jublee Park - 2     Barelily     Ground Water     1     2001     OHT       6     Pump No. 7     Rampur Bagh     Barelily     Ground Water     1     2001     OHT       7     Pump No. 8     Gher Jafar Khan     Barelily     Ground Water     1     1995     OHT       9     Pump No. 10     Gort. Inter College     Barelily     Ground Water     1     1995     OHT       11     Pump No. 13     Kishore Bazar     Barelily     Ground Water     1     NA     OHT       12     Pump No. 15     Hargian Park     Barelily     Ground Water     1     NA     OHT       13     Pump No. 15     Hargian Park     Barelily     Ground Water     1     NA     OHT       14     Pump No. 16     C. I. Park - 7 <t< td=""><td>NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.16       1985     OHT     4.32       1990     OHT     4.32       2013     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     3.16       2001     OHT     2.88       2002     OHT     3.16       1995     OHT     3.16       1995     OHT     3.31       NA     OHT     4.32       1995</td></t<>	NA     OHT     3.60       2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.16       1985     OHT     4.32       1990     OHT     4.32       2013     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     3.16       2001     OHT     2.88       2002     OHT     3.16       1995     OHT     3.16       1995     OHT     3.31       NA     OHT     4.32       1995
3     Pump No. 4     Juble Park - 2     Barelly     Ground Water     1     1884     OHT       5     Pump No. 5     Jublee Park - 8     Barelly     Ground Water     1     2000     OHT       6     Pump No. 6     Jublee Park - 8     Barelly     Ground Water     1     2001     OHT       7     Pump No. 7     Rampur Bagh     Barelly     Ground Water     1     1995     OHT       8     Pump No. 7     Rampur Bagh     Barelly     Ground Water     1     1995     OHT       9     Pump No. 9     Jagatpur     Barelly     Ground Water     1     1995     OHT       10     Pump No. 11     Sarit Kham (Gout.Inter College)     Barelly     Ground Water     1     NA     Direct Pumping       11     Pump No. 13     Kishore Bazar     Barelly     Ground Water     1     NA     DHT       14     Pump No. 14     C.I. Park - 3     Barelly     Ground Water     1     2013     OHT       15     Pump No. 16     C.I. Park - 8	2000     OHT     4.32       1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1999     OHT     3.16       2014     OHT     3.16       1995     OHT     3.16       1995     OHT     3.16       2004     OHT     3.28       2000     OHT     4.32       19
4     Pump No. 5     Jublee Park – 2     Barelly     Ground Water     1     1884     OHT       5     Pump No. 5     Jublee Park – 9     Barelly     Ground Water     1     2000     OHT       7     Pump No. 7     Rampur Bagh     Barelly     Ground Water     1     1995     OHT       8     Pump No. 8     Gher Jafar Khan     Barelly     Ground Water     1     1995     OHT       9     Pump No. 10     Gort. Inter College     Barelly     Ground Water     1     1995     OHT       12     Pump No. 13     Srikharn (Govt. Inter College)     Barelly     Ground Water     1     NA     OHT       12     Pump No. 13     Kishore Bazar     Barelly     Ground Water     1     NA     OHT       13     Pump No. 14     C.I. Park – 7     Barelly     Ground Water     1     NA     OHT       14     Pump No. 17     C.I. Park – 7     Barelly     Ground Water     1     2010     OHT       17     Pump No. 17     C.I. Park – 7	1884     OHT     4.32       2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       1999     OHT     5.04       1999     OHT     5.04       1999     OHT     3.16       2014     OHT     4.18       2001     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2020     OHT     4.32       1980 </td
5     Pump No. 5     Jublee Park ~ 8     Bareilly     Ground Water     1     2001     OHT       7     Pump No. 6     Jublee Park ~ 9     Bareilly     Ground Water     1     1995     OHT       7     Pump No. 8     Gher Jafar Khan     Bareilly     Ground Water     1     1995     OHT       8     Pump No. 9     Jagatpur     Bareilly     Ground Water     1     1995     OHT       10     Pump No. 11     Saft Kham (Govt. Inter College)     Bareilly     Ground Water     1     NA     Direct Pumpling       12     Pump No. 12     Kishore Bazar     Bareilly     Ground Water     1     NA     Direct Pumpling     NA     OHT       13     Pump No. 15     Harijan Park     Bareilly     Ground Water     1     2014     OHT       14     Pump No. 16     C. I. Park - 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 18     Brainpura     Bareilly     Ground Water     1     2014     OHT       18	2000     OHT     4.32       2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       2013     OHT     2.88       2001     OHT     2.88       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     4.32       1995     OHT     4.32       1986     OHT     4.32       19
6     Pump No. 6     Jublee Park – 9     Barelily     Ground Water     1     2001     OHT       7     Pump No. 8     Gher Jafar Khan     Barelily     Ground Water     1     1995     OHT       9     Pump No. 8     Gher Jafar Khan     Barelily     Ground Water     1     1995     OHT       10     Pump No. 10     Gout. Inter College     Barelily     Ground Water     1     1995     OHT       11     Pump No. 13     Kishore Bazar     Barelily     Ground Water     1     NA     OHT       12     Pump No. 14     Ci.I. Park – 3     Barelily     Ground Water     1     NA     OHT       13     Pump No. 15     Hanjan Park     Barelily     Ground Water     1     1999     OHT       14     Pump No. 15     C.I. Park – 7     Barelily     Ground Water     1     2014     OHT       17     Pump No. 16     C.I. Park – 8     Barelily     Ground Water     1     2004     OHT       18     Pump No. 20     Stadium	2001     OHT     4.32       1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       2013     OHT     5.04       1999     OHT     5.04       2014     OHT     2.88       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     4.32       1986     OHT     4.32       1986     OHT     4.32       1986 </td
7     Pump No. 7     Rampur Bagh     Barelily     Ground Water     1     1995     OHT       8     Pump No. 8     Cher Jafar Khan     Barelily     Ground Water     1     1995     OHT       10     Pump No. 10     Gott. Inter College     Barelily     Ground Water     1     1995     OHT       11     Pump No. 11     Sak Kham (Govt. Inter College)     Barelily     Ground Water     1     NA     Direct Pumping       12     Pump No. 13     Kishore Bazar     Barelily     Ground Water     1     NA     Direct Pumping       13     Pump No. 15     Laringin Park     Barelily     Ground Water     1     1990     OHT       14     Pump No. 16     Ci.1, Park - 3     Barelily     Ground Water     1     1999     OHT       17     Pump No. 16     Ci.1, Park - 8     Barelily     Ground Water     1     1999     OHT       18     Pump No. 18     Barnelily     Ground Water     1     2014     OHT       19     Pump No. 20     Stadium	1995     OHT     2.88       1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     5.04       1999     OHT     5.04       2014     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2004     OHT     5.04       1995     OHT     3.16       2004     OHT     3.16       2002     OHT     2.88       2000     OHT     4.32       1986     OHT     4.32       1986     OHT     4.32       1986
8     Pump No. 8     Gher Jafar Khan     Bareilly     Ground Water     1     1995     OHT       9     Pump No. 10     Govt. Inter College     Bareilly     Ground Water     1     1985     OHT       11     Pump No. 11     Sari Kham (Govt. Inter College)     Bareilly     Ground Water     1     NA     Direct Pumping       12     Pump No. 13     Kishore Bazar     Bareilly     Ground Water     1     NA     OHT       14     Pump No. 15     Harjan Park     Bareilly     Ground Water     1     NA     OHT       15     Pump No. 16     Cl. Park – 3     Bareilly     Ground Water     1     NA     OHT       16     Pump No. 16     Cl. Park – 8     Bareilly     Ground Water     1     2014     OHT       17     Pump No. 17     Cl. Park – 8     Bareilly     Ground Water     1     2004     OHT       18     Pump No. 20     Stadium     Bareilly     Ground Water     1     2004     OHT       21     Pump No. 22     Deen D	1995     OHT     3.16       1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2012     OHT     3.16       2002     OHT     3.16       2002     OHT     3.16       2004     OHT     3.16       2002     OHT     3.31       NA     OHT     4.32       1995     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1986 </td
9     Pump No. 10     Govt. Inter College     Bareilly     Ground Water     1     1985     OHT       10     Pump No. 11     Govt. Inter College     Bareilly     Ground Water     1     NA     Direct Pumping       12     Pump No. 11     Sari Kham (Govt. Inter College)     Bareilly     Ground Water     1     NA     OHT       13     Pump No. 13     Kishore Bazar     Bareilly     Ground Water     1     NA     OHT       14     Pump No. 14     C.I. Park – 3     Bareilly     Ground Water     1     1989     OHT       15     Pump No. 16     C.I. Park – 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 18     Bratimpura     Bareilly     Ground Water     1     2014     OHT       18     Pump No. 19     Modal Town - 1     Bareilly     Ground Water     1     2004     OHT       20     Pump No. 20     Stadium     Bareilly     Ground Water     1     2016     OHT       21     Pump No. 22	1985     OHT     4.17       1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     5.04       1989     OHT     5.04       2014     OHT     2.88       2001     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     3.16       2024     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972
10     Pump No. 10     Govi. Inter College     Bareilly     Ground Water     1     1995     OHT       11     Pump No. 11     Sari Kham (Govt. Inter College)     Bareilly     Ground Water     1     NA     Direct Pumping       12     Pump No. 12     Moti Park     Bareilly     Ground Water     1     NA     OHT       13     Pump No. 14     L. Park - 3     Bareilly     Ground Water     1     NA     OHT       14     Pump No. 16     L. Park - 7     Bareilly     Ground Water     1     NA     OHT       17     Pump No. 16     Cl. Park - 8     Bareilly     Ground Water     1     1999     OHT       18     Pump No. 17     Bareilly     Ground Water     1     2004     OHT       19     Pump No. 20     Stadium     Bareilly     Ground Water     1     2004     OHT       21     Pump No. 21     Deen Dayal Puran - 2     Bareilly     Ground Water     1     2005     OHT       22     Pump No. 23     Patel Nagar - 1	1995     OHT     3.17       NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     3.16       2014     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     4.32       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1986
11     Pump No. 11     Sari Kham (Govt. Inter College)     Bareilly     Ground Water     1     NA     Direct Pumping       12     Pump No. 13     Kishore Bazar     Bareilly     Ground Water     1     NA     OHT       13     Pump No. 13     Kishore Bazar     Bareilly     Ground Water     1     2013     OHT       14     Pump No. 16     C.I. Park – 3     Bareilly     Ground Water     1     1989     OHT       16     Pump No. 16     C.I. Park – 7     Bareilly     Ground Water     1     1999     OHT       17     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       18     Pump No. 21     Bean Dayal Puram - 1     Bareilly     Ground Water     1     2040     OHT       21     Pump No. 22     Deen Dayal Puram - 1     Bareilly     Ground Water     1     2040     OHT       22     Puen Dayal Puram - 2     Bareilly     Ground Water     1     2004     OHT       23     Pump No. 23     Patel Na	NA     Direct Pumping     3.16       NA     OHT     4.32       1990     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     3.16       2014     OHT     3.16       2002     OHT     3.16       2002     OHT     5.04       1882     OHT     4.32       1986     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1986     OHT     3.16       2000
12     Pump No. 12     Moti Park     Barelly     Ground Water     1     NA     OHT       13     Pump No. 13     Kishore Bazar     Barelly     Ground Water     1     1990     OHT       14     Pump No. 15     Harijan Park     Barelly     Ground Water     1     1990     OHT       15     Pump No. 15     Harijan Park     Barelly     Ground Water     1     NA     OHT       16     Pump No. 16     C.I. Park – 7     Barelly     Ground Water     1     1999     OHT       17     Pump No. 18     Brahmpura     Barelly     Ground Water     1     2014     OHT       19     Pump No. 20     Stadium     Barelly     Ground Water     1     2004     OHT       22     Pump No. 22     Deen Dayal Puram - 2     Barelly     Ground Water     1     2035     OHT       23     Pump No. 23     Patel Nagar - 1     Barelly     Ground Water     1     2014     OHT       24     Pump No. 26     Janakpuri     Barelly	NA     OHT     4.32       1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     3.16       1995     OHT     3.16       2012     OHT     3.16       2014     OHT     3.16       2005     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1986     OHT     5.04       NA     OHT     3.16       2000     Direct Pumping     3.16       1980 </td
13     Pump No. 13     Kishore Bazar     Bareilly     Ground Water     1     1990     OHT       14     Pump No. 14     Cl. Park - 3     Bareilly     Ground Water     1     2013     OHT       15     Pump No. 16     Cl. Park - 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 16     Cl. Park - 7     Bareilly     Ground Water     1     1999     OHT       18     Pump No. 19     Modal Town - 1     Bareilly     Ground Water     1     2014     OHT       20     Pump No. 21     Deen Dayal Puram - 1     Bareilly     Ground Water     1     2024     OHT       21     Pump No. 22     Deen Dayal Puram - 2     Bareilly     Ground Water     1     2050     OHT       23     Pump No. 24     PWD Colony     Bareilly     Ground Water     1     2060     OHT       24     Pump No. 25     Bankey Bihari     Bareilly     Ground Water     1     2000     OHT       25     Pump No. 27     Indra Nagar<	1990     OHT     4.32       2013     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2015     OHT     3.16       2014     OHT     3.16       2015     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     4.32       1982     OHT     4.32       1982     OHT     4.32       1972     OHT     4.32       1986     OHT     5.04       NA     OHT     3.16       2000     Direct Pumping     3.16
14     Pump No. 14     C.I. Park – 3     Bareilly     Ground Water     1     2013     OHT       15     Pump No. 15     Harijan Park     Bareilly     Ground Water     1     NA     OHT       16     Pump No. 15     C.I. Park – 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 13     Brahmpura     Bareilly     Ground Water     1     2014     OHT       18     Pump No. 19     Modal Town - 1     Bareilly     Ground Water     1     2001     OHT       20     Pump No. 20     Stadium     Bareilly     Ground Water     1     2004     OHT       21     Pump No. 22     Deen Dayal Puram - 2     Bareilly     Ground Water     1     1995     OHT       22     Pump No. 23     Patel Nagar - 1     Bareilly     Ground Water     1     2002     OHT       24     Pump No. 25     Bankey Bihari     Bareilly     Ground Water     1     2004     OHT       25     Pump No. 26     Janakpuri     <	2013     OHT     3.31       NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2015     OHT     3.16       2014     OHT     3.16       2014     OHT     3.16       2002     OHT     3.16       2002     OHT     5.04       2000     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1986     OHT     5.04       NA     OHT     3.16       2000     Direct Pumping     3.16       19
15     Pump No. 15     Harijan Park     Bareilly     Ground Water     1     NA     OHT       16     Pump No. 16     C.I. Park – 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       18     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       19     Pump No. 20     Stadium     Bareilly     Ground Water     1     2044     OHT       21     Pump No. 21     Deen Dayal Puram - 1     Bareilly     Ground Water     1     1995     OHT       22     Pump No. 22     Deen Dayal Puram - 2     Bareilly     Ground Water     1     2014     OHT       24     PUMD Colony     Bareilly     Ground Water     1     2002     OHT       25     Pump No. 26     Janakpuri     Bareilly     Ground Water     1     2004     OHT       27     Pump No. 29     Baqagrganj - 1     Bareilly     G	NA     OHT     3.31       1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2002     OHT     3.16       2002     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       182     OHT     5.04       2004     OHT     3.16       2002     OHT     4.32       1882     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       NA     OHT     3.16       1980
16     Pump No. 16     C.I. Park - 7     Bareilly     Ground Water     1     1989     OHT       17     Pump No. 18     Frahmpura     Bareilly     Ground Water     1     1999     OHT       18     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       19     Pump No. 20     Stadium     Bareilly     Ground Water     1     2001     OHT       20     Pump No. 20     Stadium     Bareilly     Ground Water     1     1995     OHT       21     Pump No. 22     Deen Dayal Puram - 1     Bareilly     Ground Water     1     1995     OHT       22     Pump No. 23     Patel Nagar - 1     Bareilly     Ground Water     1     2014     OHT       25     Pump No. 26     Bankey Bihari     Bareilly     Ground Water     1     2000     OHT       26     Pump No. 28     Baqarganj - 1     Bareilly     Ground Water     1     1882     OHT       28     Pump No. 31     Subhash Nagar - 1     <	1989     OHT     5.04       1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2015     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1982     OHT     4.32       1972     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       NA     OHT     3.16       1980
17     Pump No. 17     C.I. Park – 8     Bareilly     Ground Water     1     1999     OHT       18     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       19     Pump No. 18     Brahmpura     Bareilly     Ground Water     1     2014     OHT       20     Pump No. 20     Stadium     Bareilly     Ground Water     1     2004     OHT       21     Pump No. 21     Deen Dayal Puram - 2     Bareilly     Ground Water     1     1995     OHT       22     Pump No. 23     Patel Nagar - 1     Bareilly     Ground Water     1     2002     OHT       23     Pump No. 24     PWD Colony     Bareilly     Ground Water     1     2000     OHT       25     Pump No. 25     Bankey Bihari     Bareilly     Ground Water     1     1882     OHT       27     Pump No. 29     Baqarganj -1     Bareilly     Ground Water     1     1982     OHT       28     Pump No. 31     Subhash Nagar -1	1999     OHT     5.04       2014     OHT     4.18       2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2002     OHT     2.88       2000     OHT     2.88       2000     OHT     2.88       2000     OHT     2.88       2000     OHT     5.04       1882     OHT     3.16       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     Direct Pumping     3.16       2000     Direct Pumping     3.16       1980     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direct Pumping     <
1     1	1000     0HT     4.18       2014     0HT     2.88       2004     0HT     5.04       1995     0HT     3.16       1995     0HT     3.16       2014     0HT     3.16       2014     0HT     3.16       2002     0HT     3.88       2000     0HT     2.88       2000     0HT     2.88       2000     0HT     3.04       2024     0HT     3.31       NA     0HT     4.32       1982     0HT     4.32       1986     0HT     4.32       1986     0HT     3.16       NA     0HT     3.16       1980     Direct Pumping     3.16       1990     Direct Pumping     3.16       1990     Direct Pumping     3.16 <tr< td=""></tr<>
10     Pump No. 19     Modal Town - 1     Barelly     Ground Water     1     2011     OHT       20     Pump No. 20     Stadium     Barelly     Ground Water     1     2004     OHT       21     Pump No. 21     Deen Dayal Puram - 1     Barelly     Ground Water     1     1995     OHT       22     Pump No. 22     Deen Dayal Puram - 2     Barelly     Ground Water     1     1995     OHT       23     Pump No. 23     Patel Nagar - 1     Barelly     Ground Water     1     2002     OHT       24     Pump No. 24     PWD Colony     Barelly     Ground Water     1     2000     OHT       25     Pump No. 26     Janakpuri     Barelly     Ground Water     1     1882     OHT       27     Pump No. 27     Indra Nagar     Barelly     Ground Water     1     NA     OHT       29     Pump No. 30     Bagarganj - 1     Barelly     Ground Water     1     1986     OHT       31     Pump No. 32     Subhash Nagar - 1	2001     OHT     2.88       2004     OHT     5.04       1995     OHT     3.16       1995     OHT     3.16       2002     OHT     3.16       2002     OHT     2.88       2000     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     5.04       2004     OHT     5.04       2004     OHT     4.32       1982     OHT     4.32       1986     OHT     4.32       1986     OHT     3.16       NA     OHT     3.16       1996     OHT     3.16       2000     Direct Pumping     3.16       1980     Direct Pumping     3.16       2002     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direct Pumping </td
10Pump No. 20StadiumBareillyGround Water12001OHT20Pump No. 21Deen Dayal Puram - 1BareillyGround Water11995OHT21Pump No. 22Deen Dayal Puram - 2BareillyGround Water11995OHT23Pump No. 22Deen Dayal Puram - 2BareillyGround Water12014OHT24Pump No. 24PWD ColonyBareillyGround Water12002OHT25Pump No. 25Bankey BihariBareillyGround Water12000OHT26Pump No. 26JanakpuriBareillyGround Water11882OHT27Pump No. 27Indra NagarBareillyGround Water11882OHT28Pump No. 28HarttmanBareillyGround Water11986OHT29Pump No. 29Baqarganj - 2BareillyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11996OHT33Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT34Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT35Pump No. 36Gandhi UdhyanBareillyGround Water1NAOHT36Pump No. 37Nawada ShekhanBareillyGround Water11096Direct Pum	2001     OHT     2.30       2004     OHT     5.04       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1895     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     3.16       2000     OHT     3.16       2000     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1980     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direc
21Pump No. 21Deen Dayal Puram - 1DarellyGround Water12004Off21Pump No. 22Deen Dayal Puram - 2BareillyGround Water11995OHT23Pump No. 23Patel Nagar - 1BareillyGround Water12014OHT24Pump No. 24PWD ColonyBareillyGround Water12002OHT25Pump No. 25Bankey BihariBareillyGround Water12000OHT26Pump No. 27Indra NagarBareillyGround Water11882OHT27Pump No. 29Indra NagarBareillyGround Water11882OHT28Pump No. 20Indra NagarBareillyGround Water11882OHT29Pump No. 20Baqarganj - 1BareillyGround Water11986OHT30Pump No. 30Baqarganj - 2BareillyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water1NAOHT33Pump No. 33C B Ganj - 2BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT <td>2004     OHT     3.04       1995     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     3.16       2000     OHT     3.16       2000     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direc</td>	2004     OHT     3.04       1995     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     3.16       2000     OHT     3.16       2000     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direct Pumping     3.16       1996     Direc
1Pump No. 22Deen Dayal Puram - 2BareillyGround Water11993OHT22Pump No. 23Patel Nagar - 1BareillyGround Water12014OHT23Pump No. 23Patel Nagar - 1BareillyGround Water12014OHT24Pump No. 24PWD ColonyBareillyGround Water12002OHT25Pump No. 25Bankey BihariBareillyGround Water12000OHT26Pump No. 26JanakpuriBareillyGround Water12004OHT27Pump No. 27Indra NagarBareillyGround Water12004OHT28Pump No. 29Bagarganj - 1BareillyGround Water11982OHT30Pump No. 30Bagarganj - 2BareillyGround Water11982OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11986OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11972OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT35Pump No. 36Suresh Sharma Nagar - 1BareillyGround Water1NAOHT36Pump No. 37Nawada ShekhanBareillyGround Water12000OHT	1993     OHT     3.16       1995     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       1882     OHT     4.32       2004     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct
22Pump No. 22Deen Dayar Putal P2Datein yGround Water111950OHT23Pump No. 24PWD ColonyBareillyGround Water12002OHT24Pump No. 25Bankey BihariBareillyGround Water12000OHT26Pump No. 26JanakpuriBareillyGround Water12000OHT27Pump No. 27Indra NagarBareillyGround Water11882OHT28Pump No. 28HarttmanBareillyGround Water1NAOHT29Pump No. 29Bagarganj - 1BareillyGround Water11982OHT30Pump No. 30Bagarganj - 2BareillyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11986OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT36Pump No. 37Nawada ShekhanBareillyGround Water1NAOHT37Pump No. 38Gandhi UdhyanBareillyGround Water11996Direct Pumping <td>1993     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     3.16       1992     <t< td=""></t<></td>	1993     OHT     3.16       2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     3.16       1992 <t< td=""></t<>
23Pump No. 24PWD ColonyBareillyGround Water12014OH125Pump No. 25Bankey BihariBareillyGround Water12002OHT25Pump No. 26JanakpuriBareillyGround Water11882OHT27Pump No. 27Indra NagarBareillyGround Water12004OHT28Pump No. 28HarttmanBareillyGround Water1NAOHT29Pump No. 28HarttmanBareillyGround Water11982OHT30Pump No. 30Baqarganj - 2BareillyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000OHT37Pump No. 37Nawada ShekhanBareillyGround Water12000Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water12002Direct Pumping <td>2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       2000     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1998     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     3.16       <t< td=""></t<></td>	2014     OHT     3.16       2002     OHT     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       2000     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1998     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     3.16 <t< td=""></t<>
24Pump No. 24Pwb ColonyBarellyBarellyGround Water12002OHT25Pump No. 26Bankey BihariBarellyGround Water12000OHT26Pump No. 27Indra NagarBarellyGround Water11882OHT27Pump No. 28HartmanBarellyGround Water12004OHT28Pump No. 29Bagarganj - 1BarellyGround Water11982OHT30Pump No. 30Bagarganj - 2BarellyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BarellyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BarellyGround Water11996OHT33Pump No. 33C B Ganj - 1BarellyGround Water1NAOHT34Pump No. 34C B Ganj - 2BarellyGround Water1NAOHT35Pump No. 36Gandhi UdhyanBarellyGround Water12000Direct Pumping37Pump No. 38Azad Inter CollegeBarellyGround Water11980Direct Pumping39Pump No. 40Jatav PuraBarellyGround Water12002Direct Pumping39Pump No. 41GangapurBarellyGround Water12002Direct Pumping41Pump No. 43Nekpur Devi MandirBarellyGround Water11	2002     OH1     2.88       2000     OHT     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1998     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     3.16       1992     Direct Pumping     3.16
25Pump No. 26JanakpuriBareillyGround Water12000OH126Pump No. 27Indra NagarBareillyGround Water11882OHT27Pump No. 28HarttmanBareillyGround Water11882OHT28Pump No. 28HarttmanBareillyGround Water11982OHT30Pump No. 30Baqarganj - 1BareillyGround Water11982OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11986OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000OHT37Pump No. 37Nawada ShekhanBareillyGround Water11986Direct Pumping38Pump No. 39KoharapeerBareillyGround Water11996Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 43Nekpur Devi MandirBareillyGround Water11996 <td< td=""><td>2000     OH1     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       1992     Direct Pumping     3.16</td></td<>	2000     OH1     5.04       1882     OHT     5.04       2004     OHT     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       1992     Direct Pumping     3.16
26Pump No. 26JanakpunBareillyGround Water11882OH127Pump No. 27Indra NagarBareillyGround Water12004OHT28Pump No. 29Baqarganj - 1BareillyGround Water11982OHT30Pump No. 29Baqarganj - 2BareillyGround Water11982OHT31Pump No. 30Baqarganj - 2BareillyGround Water11986OHT32Pump No. 32Subhash Nagar - 1BareillyGround Water11996OHT33Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT34Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water1NAOHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000OHT37Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping38Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping39Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water12002Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Wat	1882     OH1     5.04       2004     OHT     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       <
27Pump No. 27Indra NagarBareillyGround Water12004OH128Pump No. 28HarttmanBareillyGround Water1NAOHT29Pump No. 29Baqarganj - 1BareillyGround Water11982OHT30Pump No. 30Baqarganj - 2BareillyGround Water11982OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000OHT37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water12002Direct Pumping39Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Water <td< td=""><td>2004     OH1     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16  <tr< td=""></tr<></td></td<>	2004     OH1     3.31       NA     OHT     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16 <tr< td=""></tr<>
28Pump No. 28HartmanBareillyGround Water1NAOH129Pump No. 29Baqarganj - 1BareillyGround Water11982OHT30Pump No. 30Baqarganj - 2BareillyGround Water11986OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 36Grandh UdhyanBareillyGround Water12000OHT36Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping37Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping38Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping39Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping40Pump No. 41GangapurBareillyGround Water12002Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water11995Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGrou	NA     OH1     4.17       1982     OHT     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2002     Direct Pumping     4.32<
29Pump No. 29Baqarganj - 1BareillyGround Water11982OH130Pump No. 30Baqarganj - 2BareillyGround Water11982OHT31Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 38Azad Inter CollegeBareillyGround Water11986Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 41GangapurBareillyGround Water11995Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Water11998Direct Pumping43Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping44Pump No. 45Balj	1982     OH1     4.32       1986     OHT     4.32       1972     OHT     4.32       1972     OHT     4.32       1996     OHT     5.04       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2000     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16       2002     Direct Pumping     3.16       2001     Direct Pumping     3.16 </td
30Pump No. 30Bagarganj - 2BareillyGround Water11986OH131Pump No. 31Subhash Nagar - 1BareillyGround Water11972OHT32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11986Direct Pumping38Pump No. 39KoharapeerBareillyGround Water11996Direct Pumping39Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water11998Direct Pumping44Pump No. 45BaljatiBareillyGround Water1NANA45Pump No. 46Police LineBareilly<	1986     OH1     4.32       1972     OHT     4.32       1976     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.16       1980     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16       2000     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     <
31Pump No. 31Subhash Nagar - 1BareillyGround Water119/2OH132Pump No. 32Subhash Nagar - 2BareillyGround Water11996OHT33Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11996Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water12002Direct Pumping39Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping40Pump No. 41GangapurBareillyGround Water12002Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water11995Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Water11998Direct Pumping43Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA44Pump No. 45BaljatiBareillyGround Water12001Direct Pumping46Pump No. 48S	19/2     OH1     4.32       1996     OHT     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.16       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     3.16       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32       NA     OHT     2.16
32Pump No. 32Subhash Nagar - 2BareillyGround Water11996OH133Pump No. 33C B Ganj - 1BareillyGround Water1NAOHT34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11986Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water12002Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water11995Direct Pumping42Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 45BaljatiBareillyGround Water11992Direct Pumping45Pump No. 46Police LineBareillyGround Water12001Direct Pumping46Pump No. 48SanoaBareillyGround Water12001Direct Pumping47Pump No. 48Sanoa	1996     OHI     5.04       NA     OHT     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.60       1996     Direct Pumping     5.76       2002     Direct Pumping     4.17       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1998     Direct Pumping     3.16       1992     Direct Pumping     4.17       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16       2001     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     3.16       2000     Direct Pumping     3.16
33Pump No. 33C B Ganj - 1BareillyGround Water1NAOH134Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water12002Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 42Tilak Inter CollegeBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA44Pump No. 46Police LineBareillyGround Water11992Direct Pumping46Pump No. 47Saidpur HakinsBareillyGround Water12001Direct Pumping47Pump No. 48SanoaBareillyGround Water12001Direct Pumping48Pump No	NA     OHI     3.16       NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.66       2002     Direct Pumping     5.76       2002     Direct Pumping     4.17       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     3.16       2001     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32
34Pump No. 34C B Ganj - 2BareillyGround Water1NAOHT35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping45Pump No. 46Police LineBareillyGround Water12000Direct Pumping46Pump No. 48SanoaBareillyGround Water12000Direct Pumping47Pump No. 48SanoaBareillyGround Water12000Direct Pumping48Pump No.	NA     OHT     3.16       2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     3.16       2002     Direct Pumping     5.76       2002     Direct Pumping     4.17       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     3.16       2001     Direct Pumping     4.18       2001     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32
35Pump No. 35Suresh Sharma Nagar - 1BareillyGround Water12000OHT36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12000Direct Pumping47Pump No. 48SanoaBareillyGround Water12000Direct Pumping48Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping49Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumpin	2000     OHT     2.88       2000     Direct Pumping     3.16       1980     Direct Pumping     3.60       1996     Direct Pumping     3.16       2002     Direct Pumping     5.76       2002     Direct Pumping     4.17       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     4.18       2001     Direct Pumping     4.18       2001     Direct Pumping     4.18
36Pump No. 36Gandhi UdhyanBareillyGround Water12000Direct Pumping37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 48SanoaBareillyGround Water12000Direct Pumping48Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping49Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping50Rump No. 50Ramganga Nagar No - 2BareillyGround Water12011Dire	2000Direct Pumping3.161980Direct Pumping3.601996Direct Pumping3.162002Direct Pumping5.762002Direct Pumping4.171995Direct Pumping3.161998Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
37Pump No. 37Nawada ShekhanBareillyGround Water11980Direct Pumping38Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 40Jatav PuraBareillyGround Water11995Direct Pumping42Pump No. 41GangapurBareillyGround Water11995Direct Pumping43Pump No. 42Tilak Inter CollegeBareillyGround Water1NANA44Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA45Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 48SanoaBareillyGround Water12000Direct Pumping48Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping49Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping50Rump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping </td <td>1980Direct Pumping3.601996Direct Pumping3.162002Direct Pumping5.762002Direct Pumping4.171995Direct Pumping3.161998Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16</td>	1980Direct Pumping3.601996Direct Pumping3.162002Direct Pumping5.762002Direct Pumping4.171995Direct Pumping3.161998Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
38Pump No. 38Azad Inter CollegeBareillyGround Water11996Direct Pumping39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 48SanoaBareillyGround Water12000Direct Pumping48Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping49Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping50Rumo No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	1996Direct Pumping3.162002Direct Pumping5.762002Direct Pumping4.171995Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
39Pump No. 39KoharapeerBareillyGround Water12002Direct Pumping40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping49Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	2002Direct Pumping5.762002Direct Pumping4.171995Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
40Pump No. 40Jatav PuraBareillyGround Water12002Direct Pumping41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA45Pump No. 44Tapeshvar Nath MandirBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOH49Pump No. 50Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	2002     Direct Pumping     4.17       1995     Direct Pumping     3.16       1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.18
41Pump No. 41GangapurBareillyGround Water11995Direct Pumping42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 50Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	1995Direct Pumping3.161998Direct Pumping3.16NANANANANANA1992Direct Pumping4.182001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
42Pump No. 42Tilak Inter CollegeBareillyGround Water11998Direct Pumping43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 50Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	1998     Direct Pumping     3.16       NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32       NA     OHT     2.16
43Pump No. 43Nekpur Devi MandirBareillyGround Water1NANA44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	NA     NA     NA       NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32       NA     OHT     2.16
44Pump No. 44Tapeshvar Nath MandirBareillyGround Water1NANA45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	NA     NA     NA       1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32       NA     OHT     2.16
45Pump No. 45BaljatiBareillyGround Water11992Direct Pumping46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	1992     Direct Pumping     4.18       2001     Direct Pumping     3.16       2000     Direct Pumping     4.32       NA     OHT     2.16
46Pump No. 46Police LineBareillyGround Water12001Direct Pumping47Pump No. 47Saidpur HakinsBareillyGround Water12000Direct Pumping48Pump No. 48SanoaBareillyGround Water1NAOHT49Pump No. 49Ramganga Nagar No - 1BareillyGround Water12011Direct Pumping50Pump No. 50Ramganga Nagar No - 2BareillyGround Water12011Direct Pumping	2001Direct Pumping3.162000Direct Pumping4.32NAOHT2.16
47 Pump No. 47 Saidpur Hakins Bareilly Ground Water 1 2000 Direct Pumping   48 Pump No. 48 Sanoa Bareilly Ground Water 1 NA OHT   49 Pump No. 49 Ramganga Nagar No - 1 Bareilly Ground Water 1 2011 Direct Pumping   50 Pump No. 50 Ramganga Nagar No - 2 Bareilly Ground Water 1 2011 Direct Pumping	2000Direct Pumping4.32NAOHT2.16
48     Pump No. 48     Sanoa     Bareilly     Ground Water     1     NA     OHT       49     Pump No. 49     Ramganga Nagar No - 1     Bareilly     Ground Water     1     2011     Direct Pumping       50     Pump No. 50     Ramganga Nagar No - 2     Bareilly     Ground Water     1     2011     Direct Pumping	NA OHT 2.16
49     Pump No. 49     Ramganga Nagar No - 1     Bareilly     Ground Water     1     2011     Direct Pumping       50     Pump No. 50     Ramganga Nagar No - 2     Bareilly     Ground Water     1     2011     Direct Pumping	
50 Pump No. 50 Ramganga Nagar No 2 Bareilly Ground Water 1 2011 Direct Pumping	2011 Direct Pumping 3.16
	2011 Direct Pumping 3.16
51 Pump No. 51 Qazi House Bareilly Ground Water 1 2014 Direct Pumping	2014 Direct Pumpina 3.16
52 Pump No. 52 Chawai Bareilly Ground Water 1 2014 Direct Pumping	2014 Direct Pumping 3.16
53 Pump No. 53 Thana Qila Bareilly Ground Water 1 2014 Direct Pumping	2014 Direct Pumping 2.88
54 Pump No. 54 Sithora No - 1 Bareilly Ground Water 1 2013 OHT	2013 OHT 3.6
55 Pump No. 55 Sithora No - 2 Bareilly Ground Water 1 NA NA	NA NA NA
56 Pump No. 56 Sithora No 3 Bareilly Ground Water 1 2013 OHT	2013 OHT NA
57 Pump No. 57 Veer Bhatti - 1 Bareilly Ground Water 1 NA OHT	
	NA UHI I316
58 Pump No. 58 Vankhandi Nath - 1 Bareilly Ground Water 1 2013 OHT	INA     OH I     3.16       2013     OHT     4.17











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SI. No.	Pump No.	Name of bore well station	Area covered for water distribution	Source of water	No. of pump at site	Year of Est.	Type of storage	Pump flow (MLD)
60	Pump No. 60	Veer Sawarkar Nagar	Bareilly	Ground Water	1	2013	OHT	3.16
61	Pump No. 61	Sanjay Nagar No - 1	Bareilly	Ground Water	1	NA	OHT	3.16
62	Pump No. 62	Sanjay Nagar No - 2	Bareilly	Ground Water	1	2013	OHT	4.17
63	Pump No. 63	Suresh Sharma Nagar - 2	Bareilly	Ground Water	1	2013	OHT	4.32
64	Pump No. 64	Karam Chari Nagar	Bareilly	Ground Water	1	2014	OHT	4.32

## **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 operating pumping stations have been estimated. The summary of results is provided in the table below.

Pump range and Efficiency evaluation metrics:

Type of pump	Pump capacity range (kW)	Weighted average pump efficiency %	Weighted average pump set efficiency %
Submersible	Below 10 kW	51.19	46.07
Submersible	10 kW - 25 kW	46.79	42.11
Submersible	25 kW - 45 kW	55.82	50.23
Vertical Turbine	55 kW	50.64	45.76











### **Performance Indicators**

Along with estimation of efficiency of pump sets, performance indicators such as specific energy consumption was also evaluated for pump of Pumping Stations. Details of performance indicators and other operating parameters is provided in the tables below:

#### Performance Indicators of pump sets of Pumping Stations:

SI. No.	Pump station name	Status of Pump	Rated power (kW)	Measured power consumption (kW)	Pumping quantity (m³/h)	Head developed (m)	Operating hours (h/ year)	Total quantity pumped per year(kL)	Total power consumption per year (kWh/year)	Annual Specific Energy consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency (%)
1	Civil Lines – 5	Running	37.3	42.1	167.7	47.3	7,300	1,223,991	307,330	0.25	56.26%	51.31%
2	Civil Lines – 6	Running	24.5	26.5	110.0	44.3	5,840	642,400	154,760	0.24	55.78%	50.14%
3	Civil Lines – 7	Running	37.3	29.2	111.3	47.3	5,840	649,934	170,645	0.26	53.86%	49.12%
4	Jublee Park – 2	Running	37.3	40.4	140.7	48.3	5,475	770,114	221,135	0.29	50.29%	45.86%
5	Jublee Park – 8	Running	37.3	40.5	162.9	48.3	6,205	1,010,795	251,178	0.25	58.11%	53.00%
6	Jublee Park – 9	Running	24.5	38.4	117.5	40.3	5,840	686,375	224,256	0.33	37.37%	33.59%
7	Gher Jafar Khan	Running	24.5	38.8	180.4	42.3	5,840	1,053,770	226,650	0.22	59.65%	53.63%
8	Jagatpur	Running	37.3	35.3	142.3	46.3	6,570	935,042	231,658	0.25	55.88%	50.96%
9	Govt. Inter College	Running	24.5	27.1	126.0	43.3	7,665	965,790	207,492	0.21	61.06%	54.90%
10	Sari Kham (Govt. Inter College)	Running	24.5	30.9	138.4	25.3	4,015	555,796	124,023	0.22	34.41%	30.93%
11	Moti Park	Running	37.3	26.9	128.6	43.3	6,570	844,902	176,536	0.21	61.89%	56.45%
12	Kishore Bazar	Running	55	45.9	172.9	50.3	6,935	1,198,715	317,970	0.27	56.08%	51.65%
13	C.I. Park – 3	Running	24.5	20.1	30.0	37.3	5,840	175,200	117,150	0.67	16.90%	15.19%
14	Harijan Park	Running	24.5	21.8	83.5	48.3	5,840	487,348	127,312	0.26	56.08%	50.41%
15	C.I. Park – 7	Running	55	53.6	164.2	47.3	7,300	1,198,733	391,061	0.33	42.93%	39.53%
16	C.I. Park – 8	Running	55	36.9	150.8	39.3	7,300	1,100,694	269,224	0.24	47.52%	43.76%











SI. No.	Pump station name	Status of Pump	Rated power (kW)	Measured power consumption (kW)	Pumping quantity (m³/h)	Head developed (m)	Operating hours (h/ year)	Total quantity pumped per year(kL)	Total power consumption per year (kWh/year)	Annual Specific Energy consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency (%)
17	Brahmpura	Running	37.3	42.3	184.2	46.3	5,840	1,075,553	246,857	0.23	60.25%	54.95%
18	Modal Town – 1	Running	24.5	20.8	45.4	50.0	5,840	265,078	121,180	0.46	33.17%	29.82%
19	Stadium	Running	55	52.9	126.1	52.3	6,935	874,573	367,139	0.42	36.88%	33.97%
20	Deen Dayal Puram – 1	Running	18.65	22.4	18.9	48.4	5,110	96,783	114,566	1.18	12.48%	11.15%
21	Deen Dayal Puram – 2	Running	18.65	22.6	72.2	46.6	5,475	395,076	123,899	0.31	45.37%	40.52%
22	Patel Nagar – 1	Running	24.5	39.7	128.5	48.1	6,205	797,405	246,276	0.31	47.24%	42.47%
23	PWD Colony	Running	24.5	32.5	145.2	45.4	5,475	795,025	178,157	0.22	61.38%	55.18%
24	Bankey Bihari	Running	55	59.1	250.2	46.0	7,300	1,826,752	431,649	0.24	57.57%	53.03%
25	Janakpuri	Running	55	33.7	147.0	46.4	7,300	1,073,100	245,937	0.23	59.88%	55.15%
26	Indra Nagar	Running	24.5	28.5	64.6	46.7	5,840	377,206	166,382	0.44	32.11%	28.87%
27	Harttman	Running	37.3	42.7	171.7	43.3	7,300	1,253,556	311,637	0.25	52.02%	47.44%
28	Baqarganj – 1	Running	37.3	35.6	145.3	52.3	7,300	1,060,398	259,588	0.24	63.81%	58.20%
29	Baqarganj – 2	Running	37.3	39.0	184.0	41.1	7,300	1,343,127	284,846	0.21	57.88%	52.78%
30	Subhash Nagar – 1	Running	37.3	37.4	210.0	39.3	6,570	1,379,700	245,390	0.18	65.99%	60.18%
31	Subhash Nagar – 2	Running	55	28.1	144.7	39.9	6,205	897,677	174,112	0.19	60.83%	56.03%
32	C B Ganj – 1	Running	24.5	19.7	103.4	37.2	5,840	603,564	114,990	0.19	59.25%	53.26%
33	C B Ganj – 2	Running	24.5	28.9	87.3	44.3	7,300	637,363	211,262	0.33	40.49%	36.40%
34	Suresh Sharma Nagar – 1	Running	14.92	18.6	76.9	41.3	2,555	196,480	47,625	0.24	52.38%	46.46%
35	Gandhi Udhyan	Running	24.5	31.2	162.7	27.3	5,840	950,226	181,916	0.19	43.27%	38.90%











SI. No.	Pump station name	Status of Pump	Rated power (kW)	Measured power consumption (kW)	Pumping quantity (m³/h)	Head developed (m)	Operating hours (h/ year)	Total quantity pumped per year(kL)	Total power consumption per year (kWh/year)	Annual Specific Energy consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency (%)
36	Nawada Shekhan	Running	30.586	36.5	167.5	30.3	6,205	1,039,275	226,731	0.22	41.77%	37.88%
37	Azad Inter College	Running	24.5	30.6	223.2	23.3	7,300	1,629,652	223,161	0.14	51.64%	46.43%
38	Koharapee r	Running	55	39.5	212.8	24.3	4,380	931,976	172,835	0.19	38.82%	35.75%
39	Jatav Pura	Running	37.3	40.7	223.4	25.3	6,205	1,386,197	252,419	0.18	41.56%	37.91%
40	Gangapur	Running	24.5	32.9	189.0	24.3	5,475	1,034,501	179,963	0.17	42.39%	38.11%
41	Tilak Inter College	Running	37.3	27.2	180.5	29.8	3,650	658,935	99,353	0.15	59.11%	53.91%
42	Baljati	Running	55	37.9	210.9	28.3	6,205	1,308,386	234,921	0.18	46.68%	43.00%
43	Police Line	Running	24.5	31.0	114.8	22.3	5,475	628,311	169,451	0.27	25.04%	22.51%
44	Saidpur Hakins	Running	30	34.1	147.1	26.3	1,825	268,458	62,233	0.23	34.12%	30.95%
45	Sanoa	Running	7.5	8.4	32.6	43.3	5,840	190,267	48,764	0.26	53.57%	46.07%
46	Ramganga Nagar No - 1	Running	18.65	29.7	155.4	39.3	5,840	907,478	173,390	0.19	62.73%	56.02%
47	Ramganga Nagar No - 2	Running	18.65	27.8	145.0	31.3	5,840	846,800	162,060	0.19	49.96%	44.61%
48	Qazi House	Running	24.5	26.8	171.1	25.3	7,300	1,248,665	195,421	0.16	49.06%	44.10%
49	Chawai	Running	24.5	32.6	136.2	28.0	3,285	447,286	107,025	0.24	35.51%	31.92%
50	Thana Qila	Running	24.5	31.1	179.0	30.6	4,015	718,685	124,947	0.17	53.40%	48.01%
51	Sithora No – 1	Running	37.3	41.3	184.7	45.4	2,190	404,471	90,403	0.22	60.67%	55.33%
52	Sithora No – 3	Running	37.3	38.9	144.3	49.6	1,460	210,678	56,838	0.27	54.97%	50.13%
53	Veer Bhatti – 1	Running	24.5	26.3	96.6	55.2	7,300	705,107	192,209	0.27	61.38%	55.18%
54	Vankhandi Nath – 1	Running	24.5	38.2	134.9	47.3	5,110	689,543	195,100	0.28	50.70%	45.58%
55	Vankhandi Nath – 2	Running	24.5	38.8	137.2	47.3	3,650	500,817	141,693	0.28	50.71%	45.59%











SI. No.	Pump station name	Status of Pump	Rated power (kW)	Measured power consumption (kW)	Pumping quantity (m³/h)	Head developed (m)	Operating hours (h/ year)	Total quantity pumped per year(kL)	Total power consumption per year (kWh/year)	Annual Specific Energy consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency (%)
56	Veer Sawarkar Nagar	Running	24.5	43.4	178.8	44.3	2,920	522,008	126,699	0.24	55.30%	49.71%
57	Sanjay Nagar No – 1	Running	24.5	39.0	148.2	46.3	5,840	865,488	227,643	0.26	53.39%	48.00%
58	Sanjay Nagar No – 2	Running	37.3	38.6	157.5	49.4	5,840	919,625	225,249	0.24	60.24%	54.94%
59	Suresh Sharma Nagar – 2	Running	24.5	42.2	180.4	44.3	3,650	658,351	153,848	0.23	57.50%	51.69%
60	Karam Chari Nagar	Running	24.5	42.0	180.5	39.3	5,840	1,054,237	245,338	0.23	51.16%	46.00%
	Total			2045	8627			49,173,438	11,679,482			











### **Summary of Project Cost Benefit Analysis**

The energy saving has been calculated on the basis of energy audit activity conducted at pumping stations of Nagar Nigam Bareilly. 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 efficiency measures identified during the audit

SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
	Pumping System					
1	Civil Lines – 5		48811	2.36	3.78	7
2	Civil Lines – 6		23232	1.84	1.85	12
3	Civil Lines – 7		28569	2.36	2.27	12
4	Jublee Park – 2	0	52096	2.36	4.14	7
5	Jublee Park – 8	li n	32947	2.36	2.62	11
6	Jublee Park – 9	ut p	92083	1.84	7.32	3
7	Gher Jafar Khan	ficie	32168	1.84	2.56	9
8	Jagatpur	ly ef	38136	2.36	3.03	9
9	Govt. Inter College	Jerg	17653	1.84	1.40	16
10	Sari Kham (Govt. Inter College)	vith er	54272	1.84	4.31	5
11	Moti Park	ets v	10459	2.36	0.83	34
12	Kishore Bazar	b se	89859	6.98	7.14	12
13	C.I. Park – 3	ung	78459	1.84	6.24	4
14	Harijan Park	ant p	16651	1.84	1.32	17
15	C.I. Park – 7	fficie	170196	6.98	13.53	6
16	C.I. Park – 8	inet	95965	6.98	7.63	11
17	Brahmpura	it of	29831	2.36	2.37	12
18	Modal Town – 1	mer	50320	1.84	4.00	6
19	Stadium	ace	169181	6.98	13.45	6
20	Deen Dayal Puram – 1	Repl	86800	1.63	6.90	3
21	Deen Dayal Puram – 2	Щ	32625	1.63	2.59	8
22	Patel Nagar – 1		69017	1.84	5.49	4
23	PWD Colony		16987	1.84	1.35	16
24	Bankey Bihari		126471	6.98	10.05	8











SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
25	Janakpuri		46490	6.98	3.70	23
26	Indra Nagar		74010	1.84	5.88	4
27	Harttman		69273	2.36	5.51	5
28	Baqarganj – 1		17880	2.36	1.42	20
29	Baqarganj – 2		38365	2.36	3.05	9
30	Subhash Nagar – 1		9101	2.36	0.72	39
31	Subhash Nagar – 2		30652	6.98	2.44	34
32	C B Ganj – 1		9388	1.84	0.75	30
33	C B Ganj – 2		71433	1.84	5.68	4
34	Suresh Sharma Nagar – 1		7392	1.59	0.59	32
35	Gandhi Udhyan		57763	1.84	4.59	5
36	Nawada Shekhan		76037	2.01	6.04	4
37	Azad Inter College		47561	1.84	3.78	6
38	Koharapeer		88192	6.98	7.01	12
39	Jatav Pura		90248	2.36	7.17	4
40	Gangapur		59636	1.84	4.74	5
41	Tilak Inter College		10082	2.36	0.80	35
42	Baljati		96556	6.98	7.68	11
43	Police Line		93158	1.84	7.41	3
44	Saidpur Hakins		27211	2.01	2.16	11
45	Sanoa		3833	1.32	0.30	52
46	Ramganga Nagar No - 1		14153	1.63	1.13	17
47	Ramganga Nagar No - 2		37414	1.63	2.97	7
48	Qazi House		44214	1.84	3.51	6
49	Chawai		44908	1.84	3.57	6
50	Thana Qila		23275	1.84	1.85	12
51	Sithora No – 1		13834	2.36	1.10	26
52	Sithora No – 3		20258	2.36	1.61	18
53	Veer Bhatti – 1		15439	1.84	1.23	18
54	Vankhandi Nath – 1		46878	1.84	3.73	6
55	Vankhandi Nath – 2		34039	1.84	2.71	8
56	Veer Sawarkar Nagar		23441	1.84	1.86	12
57	Sanjay Nagar No – 1		48517	1.84	3.86	6











Smart City

SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving per annum (Rs. Lakhs)	Payback Period (Months)
58	Sanjay Nagar No – 2		27257	2.36	2.17	13
59	Suresh Sharma Nagar – 2		23473	1.84	1.87	12
60	Karam Chari Nagar		60349	1.84	4.80	5
	Sub-Total (A)		2964494	163.61	235.57	8
Auxiliary	/ Load					
1	Lighting fixtures (CFL , Incandescent Lamp) at above 60 Pumping Stations & Rampur Bagh	Replacement with LED lighting fixtures	14914	1.19	0.22	2
	Sub-Total (B)	-	14914	1.19	0.22	2
	Net Total (A + B)		2979408	164.80	235.79	8

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 2964494 kWh per year which is 25.38% of the existing electricity consumption. This energy saving is equivalent to 255 toe and results in reduction  $2430.9^{11}$  tCO<sub>2</sub> per year.

Apart from pumping system, opportunities for electricity and cost savings were identified in auxiliary systems such as lighting and reactive power compensation system. ULB may implement recommendation identified for auxiliary systems which may result in annual energy savings of 14,914 kWh per year.

<sup>&</sup>lt;sup>1</sup> 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 i. 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;
- Cost of preparation of IGEA, as per actual tendered cost, plus EESL's service charge at 15%; iv.
- All applicable goods and services tax as on actual basis; and v.
- vi. 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.	60
Total Cost of Equipment including installation, commissioning and testing	INR lakhs	163.61
Cost of pump including motor	INR lakhs	118.46
Cost of NRV	INR lakhs	13.16
Cost of Gate valve	INR lakhs	17.40
Cost of Web based dashboard	INR lakhs	4.61
Installation and Commissioning Cost including testing charges	INR lakhs	9.98
EESL's administrative and establishment charge	%	5
Cost of preparation of IGEA report including EESL service charges and applicable GST	INR lakhs	4.80
Total Project Cost w/o Capitalized interest	INR lakhs	176.59
Commissioning Details		ſ
Total Months for Commissioning	months	9
Capitalized interest	INR lakhs	9.9
Total Project Cost	INR lakhs	186.49

#### **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 i. escalation of 5%; and
- ii. 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 Det	ails		Unit	Value	
EESL's admini	strative and establishment	t charges	%		4%
Nie	अमृत	HILE BOOM	Eé	51	











#### 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	32.24	30.19	28.14	26.09	24.03	21.98	19.93	182.60
Principal Repayment	INR lakh	18.65	18.65	18.65	18.65	18.65	18.65	18.65	130.55
Interest	INR lakh	13.59	11.54	9.49	7.44	5.39	3.33	1.28	52.06
Total Equity Repayments	INR lakh	20.95	18.99	17.04	15.08	13.13	11.17	9.21	105.57
Recovery of equity investment	INR lakh	7.99	7.99	7.99	7.99	7.99	7.99	7.99	55.95
Return on equity	INR lakh	12.96	11.00	9.04	7.09	5.13	3.18	1.22	49.62
R&M Charges	INR lakh	0.00	2.45	4.09	4.91	5.73	6.14	6.54	29.86
EESL's administrative and establishment charge	INR lakh	7.46	7.83	8.22	8.64	9.07	9.52	10.00	60.74
Annuity Payment to EESL	INR lakh	60.65	59.47	57.49	54.71	51.95	48.81	45.69	378.77
Goods and Services Tax on annuity payment	INR lakh	10.92	10.70	10.35	9.85	9.35	8.79	8.22	68.18
Annuity Payment to EESL incl. all applicable taxes	INR lakh	71.57	70.17	67.84	64.56	61.31	57.60	53.91	446.95
ULB Savings									
Total Savings	INR lakh	235.57	232.37	227.93	222.13	214.81	205.81	194.94	1533.56
Profit to ULB	INR lakh	164.01	162.20	160.10	157.57	153.50	148.21	141.03	1086.61



% of savings with ULBs



%







70.86%

#### 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%	73.54%
-5%	72.20%
0%	70.86%
5%	69.51%
10%	68.17%
Change in Interest(ROE, Interest, D/E ratio)	% of savings retained by the utility
-10%	67.62%
-5%	69.32%
0%	70.86%
5%	72.24%
10%	73.51%

### **Key facts of IGEA**

Key facts of the project are as follows:

Particular	Unit	Value
Total number of pump sets as per LOA	Nos.	64
Total number of pump sets under maintenance	Nos.	3
Total number of pump sets where measurement was not possible	Nos.	1
Total number of pump sets audited	Nos.	60
Total numbers of pumps sets considered for replacement	Nos.	60
Estimated present annual energy consumption (for 60 pump sets)	kWh	116,79,482
Estimated annual energy consumption with proposed EEPS (for 60 pump sets)	kWh	29,64,494
Percentage energy saving potential	%	25.38
Total project cost (including IGEA cost and capitalized interest)	Rs. Lakhs	186.49

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 pump sets to be replaced under this project

Pump Identification		Rate	d parame	eters	Operati	ng param	eters (individual o	Accessories to be installed			
Pump house	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)
Civil Lines - 5	Pump No. 1	180	51	37.3	168	47.3	42.1	51%	Yes	Yes	Yes
Civil Lines - 6	Pump No. 2	80-170	69-39	24.5	110	44.3	26.5	50%	Yes	Yes	Yes
Civil Lines - 7	Pump No. 3	180	51	37.3	111	47.3	29.2	49%	Yes	Yes	Yes
Jublee Park - 2	Pump No. 4	180	51	37.3	141	48.3	40.4	46%	Yes	Yes	Yes
Jublee Park - 8	Pump No. 5	180	51	37.3	163	48.3	40.5	53%	Yes	Yes	Yes
Jublee Park - 9	Pump No. 6	80-170	69-39	24.5	118	40.3	38.4	34%	Yes	Yes	Yes
Gher Jafar Khan	Pump No. 8	80-170	69-39	24.5	180	42.3	38.8	54%	Yes	Yes	Yes
Jagatpur	Pump No. 9	180	51	37.3	142	46.3	35.3	51%	Yes	Yes	Yes
Govt. Inter											
College	Pump No. 10	80-170	69-39	24.5	126	43.3	27.1	55%	Yes	Yes	Yes
Sari Kham (Govt. Inter College)	Pump No. 11	80-170	69-39	24.5	138	25.3	30.9	31%	Yes	Yes	Yes
Moti Park	Pump No. 12	180	51	37.3	129	43.3	26.9	56%	Yes	Yes	Yes
Kishore Bazar	Pump No. 13	NA	NA	55.0	173	50.3	45.9	52%	Yes	Yes	Yes
C.I. Park - 3	Pump No. 14	80-170	69-39	24.5	30	37.3	20.1	15%	Yes	Yes	Yes
Harijan Park	Pump No. 15	80-170	69-39	24.5	83	48.3	21.8	50%	Yes	Yes	Yes
C.I. Park - 7	Pump No. 16	NA	NA	55.0	164	47.3	53.6	40%	Yes	Yes	Yes
C.I. Park - 8	Pump No. 17	NA	NA	55.0	151	39.3	36.9	44%	Yes	Yes	Yes
Brahmpura	Pump No. 18	180	51	37.3	184	46.3	42.3	55%	Yes	Yes	Yes
Modal Town - 1	Pump No. 19	80-170	69-39	24.5	45	50.0	20.8	30%	Yes	Yes	Yes
Stadium	Pump No. 20	NA	NA	55.0	126	52.3	52.9	34%	Yes	Yes	Yes
Deen Daval											
Puram - 1	Pump No. 21	NA	NA	18.7	19	48.4	22.4	11%	Yes	Yes	Yes
Deen Dayal											
Puram - 2	Pump No. 22	NA	NA	18.7	72	46.6	22.6	41%	Yes	Yes	Yes
Patel Nagar - 1	Pump No. 23	80-170	69-39	24.5	129	48.1	39.7	42%	Yes	Yes	Yes
PWD Colony	Pump No. 24	80-170	69-39	24.5	145	45.4	32.5	55%	Yes	Yes	Yes
Bankey Bihari	Pump No. 25	NA	NA	55.0	250	46.0	59.1	53%	Yes	Yes	Yes
Janakpuri	Pump No. 26	NA	NA	55.0	147	46.4	33.7	55%	Yes	Yes	Yes
Indra Nagar	Pump No. 27	80-170	69-39	24.5	65	46.7	28.5	29%	Yes	Yes	Yes
Harttman	Pump No. 28	180	51	37.3	172	43.3	42.7	47%	Yes	Yes	Yes
Baqarganj - 1	Pump No. 29	180	51	37.3	145	52.3	35.6	58%	Yes	Yes	Yes
Baqarganj - 2	Pump No. 30	180	51	37.3	184	41.1	39.0	53%	Yes	Yes	Yes
Subhash Nagar -											
1	Pump No. 31	180	51	37.3	210	39.3	37.4	60%	Yes	Yes	Yes
Subhash Nagar -											
2	Pump No. 32	NA	NA	55.0	145	39.9	28.1	56%	Yes	Yes	Yes
C B Ganj - 1	Pump No. 33	80-170	69-39	24.5	103	37.2	19.7	53%	Yes	Yes	Yes
C B Ganj - 2	Pump No. 34	80-170	69-39	24.5	87	44.3	28.9	36%	Yes	Yes	Yes
Suresh Sharma	Dump No. 25	NA	NIA	14.0	77	11 2	10 6	169/	Voc	Voc	Voc
Ragal - 1 Candhi Udhyan	Pullip No. 35	00 1 70	60.20	14.9 24 E	162	41.5 27.2	21.2	40%	Yes	Yes	Yes
Nawada Shekhan	Pump No. 30	80-170 NA	09-39 NA	24.5	105	27.5	26.5	29%	Yes	Yos	Yos
		NA.	NA.	30.0	107	30.3	50.5	3070	163	163	163
	Pumn No. 38	80-170	69-20	24 5	222	22.2	30 6	46%	۷۵۲	Voc	Vec
Koharaneer	Pumn No. 39	NΔ	NΔ	55.0	223	23.5	20.5	36%	γ <sub>Δ</sub> ς	Υ <u>ρ</u> ε	Vec
latav Pura	Pump No. 40	180	51	33.0	213	25.3	40.7	38%	Yes	Yes	Yec
Ganganur	Pump No. 41	80-170	69-20	24.5	180	24.3	27 0	38%	Vec	Vec	Vec
Tilak Inter	- unip 140. 41	00 170	05-55	24.3	105	24.3	52.5	5076	163	183	105
College	Pump No. 42	180	51	37.3	181	29.8	27.2	54%	Yes	Yes	Yes
Baliati	Pump No. 45	NA	NA	55.0	211	28.3	37.9	43%	Yes	Yes	Yes
Police Line	Pump No. 46	80-170	69-39	24.5	115	22.3	31.0	23%	Yes	Yes	Yes
Saidpur Hakins	Pump No. 47	NA	NA	30.0	147	26.3	34.1	31%	Yes	Yes	Yes











j,

Pump Identification			Rated parameters			ng param	neters (individual o	Accessories to be installed			
Pump house	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)
Sanoa	Pump No. 48	NA	NA	7.5	33	43.3	8.4	46%	Yes	Yes	Yes
Ramganga Nagar No - 1	Pump No. 49	NA	NA	18.7	155	39.3	29.7	56%	Yes	Yes	Yes
Ramganga Nagar No - 2	Pump No. 50	NA	NA	18.7	145	31.3	27.8	45%	Yes	Yes	Yes
Qazi House	Pump No. 51	80-170	69-39	24.5	171	25.3	26.8	44%	Yes	Yes	Yes
Chawai	Pump No. 52	80-170	69-39	24.5	136	28.0	32.6	32%	Yes	Yes	Yes
Thana Qila	Pump No. 53	80-170	69-39	24.5	179	30.6	31.1	48%	Yes	Yes	Yes
Sithora No - 1	Pump No. 54	180	51	37.3	185	45.4	41.3	55%	Yes	Yes	Yes
Sithora No - 3	Pump No. 56	180	51	37.3	144	49.6	38.9	50%	Yes	Yes	Yes
Veer Bhatti - 1	Pump No. 57	80-170	69-39	24.5	97	55.2	26.3	55%	Yes	Yes	Yes
Vankhandi Nath - 1	Pump No. 58	80-170	69-39	24.5	135	47.3	38.2	46%	Yes	Yes	Yes
Vankhandi Nath - 2	Pump No. 59	80-170	69-39	24.5	137	47.3	38.8	46%	Yes	Yes	Yes
Veer Sawarkar Nagar	Pump No. 60	80-170	69-39	24.5	179	44.3	43.4	50%	Yes	Yes	Yes
Sanjay Nagar No - 1	Pump No. 61	80-170	69-39	24.5	148	46.3	39.0	48%	Yes	Yes	Yes
Sanjay Nagar No - 2	Pump No. 62	180	51	37.3	157	49.4	38.6	55%	Yes	Yes	Yes
Suresh Sharma Nagar - 2	Pump No. 63	80-170	69-39	24.5	180	44.3	42.2	52%	Yes	Yes	Yes
Karam Chari Nagar	Pump No. 64	80-170	69-39	24.5	181	39.3	42.0	46%	Yes	Yes	Yes
Total				1911	8627		2045				











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## **ABBREVIATIONS**

BMC	Nagar Nigam Bareilly
AMRUT	Atal Mission Rejuvenation and Urban Transformation
APFC	Automatic Power Factor Control
BEP	Best Efficiency Points
BPS	Booster Pumping Stations
CEA	Certified Energy Auditor
UPSPDCL	Uttar Pradesh State Power Distribution Corporation Limited
MITCON	MITCON Consultancy & Engineering Services Ltd.
DSM	Demand Side Management
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
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 28<sup>th</sup> 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, Government of Uttar Pradesh have jointly entered into an agreement on 9<sup>th</sup> 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 Bareilly City of Uttar Pradesh.













According to MoUD, energy audits 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 Department of Urban Development, Government of Uttar Pradesh and EESL was signed successfully on 09<sup>th</sup> February 2017, EESL initiated an open tendering process for hiring Energy Auditing Agency through competitive bidding. Based on











the bidding evaluation, M/s MITCON Consultancy & Engineering Services Ltd (MITCON) was selected for doing the energy audit for Bareilly city. EESL has engaged MITCON 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: EESL/06/2016-17/Energy Audit/Uttar Pradesh/LoA 1617358/9962 dated 16<sup>th</sup> 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, Uttar Pradesh 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.

**Department of Urban Development:** Department of Urban Development was setup to ensure the proper implementation and monitoring of the centrally assisted programme. Department of Urban Development 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 (SHPSC) 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 - MITCON:** EESL has engaged MITCON for preparation of IGEA reports for public water works in Bareilly, Uttar Pradesh with an objective to replace inefficient pump sets with energy efficient ones. MITCON had conducted energy audit activity at Bareilly and had made IGEA with financial projections for Bareilly 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 these 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.
  - o 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 Bareilly from  $12^{th}$  April –  $7^{th}$  May 2017. The energy audit team of MITCON comprised of BEE certified energy auditors/managers and pump experts. During the field visit, adequate number 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 chairmanship of Commissioner of Nagar Nigam Bareilly on 12<sup>th</sup> 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. MITCON 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.

The following important issues were discussed and appropriate guidance was provided to the team members. During the kick-off meeting and pre-site visit at Bareilly Nagar Nigam on 12<sup>th</sup> April 2017 following points were discussed:

- Support from the ULB will be given to the MITCON team for conducting energy audit
- Energy audit will be conducted by MITCON team in presence of EESL personnel and nodal official of ULB.
- Observations will be discussed with the appointed official of ULB and EESL
- MITCON 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 MITCON after finishing the site work
- MITCON 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
- MITCON will report the status of work on a daily basis to project-coordinator of EESL
- MITCON 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 MITCON 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

The district Bareilly (also known as Bareli or Bans Bareilly) forms a part of Rohilkhand division and is named after it's headquarter city i.e. Bareilly which was founded in 1537 by Bans Deo and Bareldo the two sons of Jagat Singh Katehriya a Rohela Rajput. The Bareilly district is located in the north western part of U.P. and lies between latitude 280 01' and 280 54' north and longitude 780 58' and 790 Tehsil 47' east. Its maximum length from north to south is about 96 Km and breadth from east to west is about 75 Km. For the administrative convenience the Bareilly district, a segment at the Rohilkhand commissioner (H.Q. Bareilly) has been divided into six tehsils and fifteen blocks. The city spreads over an area of 3841.9 km<sup>2</sup> and is governed by Municipal Corporation which comes under Nagar Nigam, Bareilly. As per the previous Census, the population of Bareilly city is provided in the table 1.

#### Table 1: Population of Bareilly city<sup>2</sup>

Census Year	Population (Nos.)
2001	3618589
2011	4448359

## 3.2 Accessibility to city from Metro cities & State capital

#### Rail

Bareilly is on the Moradabad-Lucknow route. Trains from the north (including Jammu Tawi and Amritsar) and Delhi running east and northeast (to Gorakhpur, Barauni, Howrah, Guwahati and Dibrugarh) pass through Bareilly, and the city is also on the route from Uttarakhand to Agra and Mathura via Budaun. Many trains to railway stations in Uttarakhand pass through Bareilly.

Six railway stations serve the city:

- Bareilly Junction (broad gauge)
- C.B. Ganj Station (broad gauge)
- Bareilly Cantt (broad gauge)
- Bareilly City Station (broad gauge)
- Izzatnagar Station (broad gauge)
- Bhojipura Station (broad gauge)

#### Road

Bareilly lies on the National Highway 30 (New renumbered National Highway system) (NH 30) (according to the new National Highway system in India). The newly numbered highway connects Sitarganj in Udham Singh Nagar district, Uttarakhand with Ibrahimpatnam in Andhra Pradesh. The 2040 km (1267.5 mi) highway starts at the junction of NH 9 at Sitarganj passes through Pilibhit, Bareilly, Shahjahanpur, Sitapur, Lucknow, Rae

<sup>&</sup>lt;sup>2</sup> Census of India, Uttar Pradesh, District Census Handbook Bareilly











Bareilly, Allahabad, Rewa, Jabalpur, Raipur, Dhamtari, Keskal, Jagdalpur, Konta, Nellipaka, Bhadrachalam, Kothagudem, Tiruvuru and ends at the junction of NH 65 in Ibrahimpatnam.

As part of the expansion of Old National Highway 24 (connecting Lucknow to New Delhi via Shahjahanpur, Bareilly, Rampur, Moradabad and Ghaziabad) to four lanes.

#### Air

AAI had signed an MOU with the State Government of Uttar Pradesh on 24.02.2014 to develop airports /Civil Enclaves at Bareilly. Domestic airports near Bareilly, India

- 167 km: Dhangadhi, Nepal (Dhangadhi Airport)
- 225 km: Agra, India (Agra Airport)
- 264 km: Lucknow, India (Chaudhary Charan Singh Airport)
- 274 km: Kanpur, India (Kanpur Airport)
- 274 km: Delhi, India (Indira Gandhi International Airport)
- 283 km: Dehradun, India (Jolly Grant Airport)
- 327 km: Nepalganj, Nepal (Nepalganj Airport)

### 3.3 Pumping Stations in the Bareilly city

Water source in Bareilly is the ground water that is used to meet the water demand for the city with the help of 64 bore wells. There are 55 water tanks in the city. Bore wells are used to fill the water tanks, while some bore wells also supply water directly to the underground water piping network. A general pipe line diagram of the water pumping station, feeding to network and overhead tank is provided in figure 1 and 2 respectively.







#### 3.4 Historical Water Pumped and Energy Consumption Analysis

Historical data about water pumped and energy consumption Pumping Stations of Bareilly Municipality Corporation is provided in table 2.

Table 2 Historical	water pumped and	energy consumption	n data for last three years kWh
--------------------	------------------	--------------------	---------------------------------

Description	Water flow (kL /Annum)	Energy consumption (kWh/Annum)	Specific energy consumption (kWh/kL)
March-14 to April-15	Not available	11,135,400	Not available
March-15 to April-16	Not available	11,138,957	Not available
March-16 to April-17	Not available	11,007,297	Not available

#### 3.5 Power Failure Data

Power failure data was not provided Nagar Nigam.

#### 3.6 Rainfall and Climate data

Rainfall and climate data of Bareilly is provided in table 3.

Table 3: Rainfall and Climate data of Bareilly City<sup>3</sup>

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max Temp (°C)	25	30	36	42	44	43	37	36	37	36	32	27

<sup>3</sup> https://www.worldweatheronline.com/bareilly-weather-averages/uttar-pradesh/in.aspx











Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temp (°C)	20	24	30	37	39	39	34	33	33	31	26	21
Min Temp (°C)	12	15	20	28	30	31	28	28	26	22	18	15
Avg. Rain (mm)	0	1.6	24.7	0	18.6	44.95	508.71	148.93	41.58	1.2	0	0.2
Avg. rainy days	0	2	6	0	18	17	30	27	17	2	0	1

## 3.7 Ground Water Profile

Data regarding net ground water availability of Bareilly district and allocation of different users is provided in table 4.

#### Table 4: Ground Water Profile<sup>4</sup>

SI. No.	Assessment units blocks	Annual ground water recharge (in ham)	Net annual ground water availability (in ham)	Existing gross ground water draft for all uses (in ham)	Net ground water availability for future irrigation development (in ham)	Stage of ground water developm ent (in %)	Category of block
1	Alampur Zafrabad	5752.79	5177.51	5649.36	-681.08	109.11	Over exploited
2	Baheri	13231.33	11908.19	6940.81	4710.32	58.29	Safe
3	Bhadpura	6257.25	5944.39	5885.44	-159.03	99.01	Semi critical
4	Bhojipura	5918.18	5622.27	4973.36	528.02	88.46	Safe
5	Bhutah	9600.08	9120.08	8903.09	-112.75	97.62	Semi critical
6	Bithrichainpur	6290.65	5661.58	4330.94	1170.24	76.5	Safe
7	Faridpur	10008.33	9507.91	8338.05	971.33	87.7	Safe
8	Fatehganj (W)	6492.72	6168.08	6002.41	22.76	97.31	Semi critical
9	Kiyara	3736.05	3362.44	3277.85	-40.51	97.48	Semi critical
10	Majhgawn	6237.22	5613.5	5043.81	449.6	89.85	Safe
11	Meerganj	6955.48	6259.93	6199.96	-169.66	99.04	Critical
12	Nawabganj	9092.08	8182.87	8174.65	-188.91	99.9	Semi critical
13	Ram Nagar	5751.07	5175.97	4804.73	193.29	92.83	Semi critical
14	Richha	9115.23	8203.7	4590.08	3443.62	55.95	Safe
15	Shergarh	8249.86	7424.87	7064.61	98.61	95.15	Semi critical
	Total	112688.31	103333.31	90179.15	10235.83	87.27	

### 3.8 Ground Water Levels at Different Seasons

The ground water level and fluctuation data of permanent hydrograph stations of CGWB and State Ground Water Department, U.P., have been analyzed and summarized in table no. 5.

<sup>&</sup>lt;sup>4</sup> Ground Water Brochure of District Bareilly, U.P. By R.K. Rajput Scientist 'B' 2007










SI. No.	Blocks	Water level range pre-monsoon (mbgl)	Water level range post-monsoon (mbgl)	Average Fluctuation (m)
1	Bithvi chainpur	3.53-5.89	3.20-5.15	0.49
2	Kyara	3.18-6.92	2.61-5.55	2.49
3	Bhuta	3.94-7.20	1.95-5.77	2.2
4	Faridpur	3.20-8.65	3.05-8.17	0.39
5	Kaira	5.92-7.08	3.75-5.55	+3.31 (data 2008)
6	Baheri	2.45-4.49	1.39-3.19	0.98
7	Richha	3.78-5.00	3.00-4.01	0.89
8	Bhadpura	2.50-2.93	0.94-1.12	1.39
9	Nawabganj	3.45-4.26	2.70-2.90	1.2
10	Shergarh	4.82-6.62	2.70-5.30	1.38
11	Bhojipura	3.25-4.05	2.94-3.00	1.1
12	Mirganj	4.47-6.70	3.30-5.15	1.4
13	Alampur Zafrabad	5.68-11.64	5.48-10.95	0.5
14	Ram Nagar	6.08-14.88	5.88-14.65	0.34
15	Majhgawan	5.00-6.32	4.45-6.10	0.21

Table 5: Block wise water level data (pre and post) and water level fluctuation for the year 2007<sup>5</sup>

## 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 is provided in the table 6.

Table 6: Water cost estimation

Particular	Units	Values
Repair & Maintenance	Rs. Lakhs	100
Energy & Operation (man power & raw material)	Rs. Lakhs	1676
Miscellaneous cost (Cost of major replacement)	Rs. Lakhs	52
Total cost	Rs. Lakhs	1828
Annual water pumped to City (estimated)	kL	49,173,438
Water cost	Rs./kL	3.71

<sup>5</sup> Ground Water Brochure of District Bareilly, U.P. By R.K. Rajput Scientist 'B' 2007 representing ground water level per & post monsoon condition.











# **4 Pumping Stations Performance Evaluation**

Drinking water in the Bareilly city is supplied by Municipal Corporation, Bareilly. Ground water is drawn through bore wells and then stored in the overhead tanks or supplied to end consumer. Details of connected load at 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 stations from Bareilly Municipal office, details of connected load of pumping stations is provided in the table 7.

Table 7: Connected load details for pumping stations

		Water Pump Set Load, kW			Auxi	liary L	_oad, '	w		oad,
Pumping Station Load	Pump No.	Chlorination Pump	Pump set	Street Light	Ceiling fan / Table Fan /	Tube Light / CFL	Sodium vapor Lamo	Incandescent bulb	LED	Connected L kW
Civil Lines – 5	Pump No. 1	0.03	37.3						5	37.4
Civil Lines – 6	Pump No. 2		24.5					100		25.5
Civil Lines - 7	Pump No. 3	0.03	37.3					100		38.3
Jublee Park - 2	Pump No. 4	0.03	37.3					60		37.9
Jublee Park - 8	Pump No. 5	0.03	37.3					60		37.9
Jublee Park - 9	Pump No. 6		24.5					60		25.1
Rampur Bagh	Pump No. 7		18.6					60		19.2
Gher Jafar Khan	Pump No. 8	0.03	24.5					100		25.5
Jagatpur	Pump No. 9	0.03	37.3	200	45			320		43.0
Govt. Inter College	Pump No. 10	0.03	24.5					60		25.1
Sari Kham (Govt. Inter College)	Pump No. 11	0.03	24.5		60	15			5	25.3
Moti Park	Pump No. 12	0.03	37.3					100		38.3
Kishore Bazar	Pump No. 13	0.03	55.0					60		55.6
C.I. Park - 3	Pump No. 14		24.5					60		25.1
Harijan Park	Pump No. 15		24.5					100		25.5
C.I. Park - 7	Pump No. 16	0.03	55.0		45			60		56.1
C.I. Park - 8	Pump No. 17	0.03	55.0					60		55.6
Brahmpura	Pump No. 18	0.03	37.3		200	25		60		40.2
Modal Town - 1	Pump No. 19	0.03	24.5					100		25.5
Stadium	Pump No. 20	0.03	55.0					100		56.0
Deen Dayal Puram - 1	Pump No. 21	0.03	18.6		75			120		20.5
Deen Dayal Puram - 2	Pump No. 22	0.03	18.6					100		19.6
Patel Nagar - 1	Pump No. 23	0.03	24.5		100			150		27.0
PWD Colony	Pump No. 24	0.03	24.5					100		25.5
Bankey Bihari	Pump No. 25	0.03	55.0					100		56.0
Janakpuri	Pump No. 26	0.03	55.0					100		56.0
Indra Nagar	Pump No. 27	0.03	24.5			16				24.7
Harttman	Pump No. 28	0.03	37.3		150			60		39.4











		Wa Pumi	iter o Set							
		Load	l, <b>kW</b>		Auxi	liary L	oad,	N		ad,
Pumping Station Load	Pump No.	Chlorination Pump	Pump set	Street Light	Ceiling fan / Table Fan /	Tube Light / CFL	Sodium vapor Lamp	Incandescent bulb	LED	Connected Lo kW
Baqarganj - 1	Pump No. 29	0.03	37.3					100		38.3
Baqarganj - 2	Pump No. 30	0.03	37.3							37.3
Subhash Nagar - 1	Pump No. 31	0.03	37.3					60		37.9
Subhash Nagar - 2	Pump No. 32	0.03	55.0					100		56.0
C B Ganj - 1	Pump No. 33	0.03	24.5					60		25.1
C B Ganj - 2	Pump No. 34	0.03	24.5		150			60		26.6
Suresh Sharma Nagar - 1	Pump No. 35	0.03	18.6		275			60		21.9
Gandhi Udhyan	Pump No. 36	0.03	24.5					60		25.1
Nawada Shekhan	Pump No. 37	0.03	37.3		150			60		39.4
Azad Inter College	Pump No. 38	0.03	24.5					100		25.5
Koharapeer	Pump No. 39	0.03	55.0					60		55.6
Jatav Pura	Pump No. 40	0.03	37.3					60		37.9
Gangapur	Pump No. 41	0.03	24.5					60		25.1
Tilak Inter College	Pump No. 42	0.03	37.3		75			100		39.1
Baljati	Pump No. 45		30.0					100		31.0
Police Line	Pump No. 46		24.5					60		25.1
Saidpur Hakins	Pump No. 47	0.03	30.0					100		31.0
Sanoa	Pump No. 48	0.03	7.5					60		8.1
Ramganga Nagar No - 1	Pump No. 49	0.03	24.5					60		25.1
Ramganga Nagar No - 2	Pump No. 50	0.03	24.5		150			60		26.6
Qazi House	Pump No. 51		24.5		150	40		60		27.0
Chawai	Pump No. 52	0.03	24.5					60		25.1
Thana Qila	Pump No. 53	0.03	24.5		45			100		26.0
Sithora No - 1	Pump No. 54	0.03	37.3					100		38.3
Sithora No - 3	Pump No. 56	0.03	37.3			41				37.7
Veer Bhatti - 1	Pump No. 57	0.03	24.5		150	60				26.6
Vankhandi Nath - 1	Pump No. 58	0.03	37.3		75			60	5	38.7
Vankhandi Nath - 2	Pump No. 59	0.03	37.3		45	15				37.9
Veer Sawarkar Nagar	Pump No. 60	0.03	24.5					60		25.1
Sanjay Nagar No - 1	Pump No. 61	0.03	24.5					60		25.1
Sanjay Nagar No - 2	Pump No. 62	0.03	37.3		150			60		39.4
Suresh Sharma Nagar - 2	Pump No. 63	0.03	24.5					60		25.1
Karam Chari Nagar	Pump No. 64	0.03	24.5		150			60		26.6
Total (kW)										371.92

## 4.2 Pumping Stations of Bareilly

## 4.2.1 Overview of existing systems

64 pumping stations operated by Nagar Nigam, Bareilly are selected for Energy Audit. All the pumping stations have one pump set to draw water from ground water bed. Energy audit was conducted on 60 pumps











out of 64 pumps, as 3 pumps were under maintenance and at one pumping station audit team was unable to perform measurement due to site restriction. Out of the 60 audited pump sets, 45 pump sets are used to transfer of water to overhead tanks, while 15 pump sets are used to supplying directly to the consumer end.

Entire piping system is underground except at the pumping station site and discharge line to the tanks. All the pumping stations have almost similar type of layout; generic layout for the same is shown in Figure 3 below:



Figure 3: Pumping Station Layout

## 4.2.2 Electrical Supply

Municipal Corporation, Bareilly gets power from State Electricity Board. All the transformers are maintained by State Electricity Board. 55 sites have dedicated transformers (11 kV / 433 V), however at 6 sites the supply of power is from common utility transformer. Details of the transformers are given in table 8:

SI. No.	Name of Site	Primary Voltage, kV	Secondary Voltage, V	Transformer, kVA
1	Civil Lines – 5	11	433	100
2	Civil Lines – 6	11	433	100
3	Civil Lines – 7	11	433	100
4	Jublee Park – 2	11	433	100
5	Jublee Park – 8	11	433	100
6	Jublee Park – 9	11	433	100
7	Rampur Bagh	11	433	100
8	Gher Jafar Khan	11	433	100
9	Jagatpur	11	433	100













SI.	Name of Site	Primary	Secondary	Transformer kVA
No.		Voltage, kV	Voltage, V	
10	Govt. Inter College	11	433	100
11	Sari Kham (Govt. Inter College)	11	433	100
12	Moti Park	11	433	100
13	Kishore Bazar	11	433	100
14	C.I. Park – 3	11	433	Common utility
				transformer
15	Harijan Park	11	433	100
16	C.I. Park – 7	11	433	100
17	C.I. Park – 8	11	433	100
18	Brahmpura	11	433	100
19	Modal Town – 1	11	433	100
20	Stadium	11	433	100
21	Deen Dayal Puram – 1	11	433	100
22	Deen Dayal Puram – 2	11	433	100
23	Patel Nagar – 1	11	433	100
24	PWD Colony	11	433	100
25	Bankey Bihari	11	433	100
26	Janakpuri	11	433	100
27	Indra Nagar	11	433	100
28	Harttman	11	433	100
29	Baqarganj – 1	11	433	250
30	Baqarganj – 2	11	433	Common utility
				transformer
31	Subhash Nagar – 1	11	433	100
32	Subhash Nagar – 2	11	433	100
33	C B Ganj – 1	11	433	100
34	C B Ganj – 2	11	433	100
35	Suresh Sharma Nagar – 1	11	433	Common utility
				transformer
36	Gandhi Udhyan	11	433	63
37	Nawada Shekhan	11	433	100
38	Azad Inter College	11	433	100
39	Koharapeer	11	433	Common utility
- 10			100	transformer
40	Jatav Pura	11	433	100
41	Gangapur	11	433	100
42	Tilak Inter College	11	433	100
43	Nekpur Devi Mandir	NA	NA	NA
44	Tapeshvar Nath Mandir	NA	NA	NA
45	Baljati	11	433	75
46	Police Line	11	433	100
47	Saidpur Hakins	11	433	100
48	Sanoa	11	433	Common utility
			400	transformer
49	Kamganga Nagar No – 1	11	433	Common utility
<b></b>		4.4	400	transformer
50	Kamganga Nagar No – 2	11	433	/5
51	Qazi House	11	433	100
52	Chawai	11	433	100











SI. No.	Name of Site	Primary Voltage, kV	Secondary Voltage, V	Transformer, kVA
53	Thana Qila	11	433	63
54	Sithora No – 1	11	433	63
55	Sithora No – 2	NA	NA	NA
56	Sithora No – 3	11	433	63
57	Veer Bhatti – 1	11	433	63
58	Vankhandi Nath – 1	11	433	75
59	Vankhandi Nath – 2	11	433	75
60	Veer Sawarkar Nagar	11	433	75
61	Sanjay Nagar No – 1	11	433	63
62	Sanjay Nagar No – 2	11	433	63
63	Suresh Sharma Nagar – 2	11	433	75
64	Karam Chari Nagar	11	433	100

Note: All the transformers at all pumping sites of Bareilly are owned by the DISCOM.

## 4.2.3 Tariff structure

Bareilly pumping stations draw power from State Electricity Board, and the present tariff is Rs. 7.95/kVAh. Despite the tariff metering the billed energy is being paid by Nagar Palika on the basis of flat rate for fixed quantum of energy only.

 Table 9: Tariff structure from March 2017 bills6

Description	Energy Parameters
Meter serial number	NA
Power supply	11 kV line
Energy charges	Rs. 7.95 Per kVAh

## 4.2.4 Electrical Bill Analysis

The bills for the last three years have been taken from the Municipal Corporation, Bareilly. Summary of same has been provided in Table 10:

Table 10: Energy cost and energy consumption

Period of energy bill	Energy consumption (kWh/Annum)	Percentage Increase of energy consumption over previous year (%)	Energy cost (Rs./Annum)
FY 2014-15	11135400		100054185
FY 2015-16	11138957	0.03%	107316970
FY 2016-17	11007297	-1.18%	118058277

Note: The details of the month wise electricity bill analysis is provided in Annexure - 4

Electricity bills of pumping stations of Bareilly are generated for inconsistent duration, due to this fact it was not possible to analyse and provide graph of monthly electricity consumption and monthly energy cost for last 3 years.

<sup>6</sup> Common to all











## 4.2.5 Energy consumption patter at Pumping Stations

During energy audit, three phase power analyzer was installed at main incomer of pumping station for logging electrical parameters. Results of analysis of logged data is provided in table 11.

SN	Pump Name/	Vo	Voltage (Volt) PF V thd (%)		)	l thd (%)							
	Location	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
1	JUBLEE PARK- 8	377	408	396	0.66	0.9	0.89	1.50	2.00	1.75	0.00	2.50	1.51
2	CIVIL LINE PUMP-5	426	449	434	0.77	0.88	0.87	1.40	1.90	1.62	0.00	3.20	1.32
3	CIVIL LINE PUMP-7	426	435	430	0.67	0.84	0.82	1.10	2.90	1.36	0.00	3.85	1.51
4	SUBHASH NAGAR-1	350	392	380	0.81	0.82	0.82	1.60	1.90	1.74	1.33	1.80	1.54
5	SUBHAS NAGAR-2	0	406	384	0.79	0.83	0.81	0.00	16.00	2.48	0.00	3.20	1.96
6	SITHORA NO-1	409	416	412	0.88	0.88	0.88	1.90	4.70	2.31	1.50	3.20	2.00
7	TILAK NAGAR	387	396	391	0.85	0.86	0.86	2.90	4.30	3.64	1.39	6.60	2.77
8	THANA QILA	0	413	355	0.77	0.89	0.87	0.00	2.00	1.30	0.00	22.00	1.53
9	SITHORA NO-3	420	430	425	0.86	0.87	0.86	1.10	1.40	1.28	1.20	1.50	1.41
10	BAQARGANJ-1	0	440	404	0.22	0.9	0.86	0.00	3.30	1.34	0.00	4.80	1.55
11	BAQARGANJ-2	0	405	322	0.52	0.89	0.88	0.00	3.70	1.76	0.00	6.50	1.38
12	BANKEY BIHARY	360	427	391	0.85	0.85	0.85	2.30	11.80	7.20	1.45	2.60	1.79
13	INDRA NAGAR	0	469	388	0.55	0.97	0.96	0.00	14.30	2.86	0.00	8.10	2.25
14	JANAKPURI	399	411	406	0.83	0.84	0.84	2.60	3.50	3.05	1.46	6.70	3.05
15	STADIUM	386	398	393	0.92	0.92	0.92	1.60	2.00	1.79	1.44	2.00	1.58
16	MODEL TOWN	389	413	405	0.91	0.93	0.93	1.20	1.80	1.54	1.00	1.60	1.42
17	PWD COLONY	206	435	380	0.43	0.84	0.71	2.00	3.50	2.75	1.48	4.10	2.14
18	PATEL NAGAR	0	434	407	0.84	0.92	0.89	0.00	3.70	2.05	0.00	3.90	1.84
19	DEEN DAYAL PURAM NO-1	365	410	396	0.76	0.77	0.77	2.10	2.90	2.21	1.50	7.40	3.41
20	DEEN DAYAL PURAM NO-2	0	392	331	0.75	0.83	0.82	0.00	3.10	2.01	0.00	6.70	1.88
21	CHAWAI	425	441	428	-0.01	0.92	0.85	0.00	4.80	2.05	0.00	3.90	1.84
22	KOHARAPEER	397	413	402	0.87	0.87	0.87	4.50	6.20	5.05	1.42	9.30	3.46
23	JATAV PURA	404	441	429	0.37	0.9	0.89	2.00	2.70	2.23	0.00	31.60	1.78
24	BRAHMPURA	408	429	420	0.88	0.9	0.89	2.20	2.70	2.48	1.45	2.40	1.69
25	C.I.PARK-7	399	408	403	0.9	0.9	0.9	1.60	1.80	1.69	1.30	1.47	1.44
26	GANGAPUR	393	408	399	0.89	0.9	0.9	1.50	2.00	1.83	1.45	2.80	1.89
27	KISHOR BAZAR	384	393	388	0.89	0.9	0.9	1.20	1.40	1.29	1.40	1.50	1.44
28	GOVT INTER COLLEGE	0	402	326	0.34	0.82	0.81	0.00	2.40	1.56	0.00	2.60	1.43
29	SARAI KHAM (GOVT INTER COLLEGE)	0	444	339	0.76	0.88	0.86	0.00	4.10	1.32	0.00	2.90	0.76
30	MOTI PARK	411	422	416	0.85	0.86	0.86	1.20	1.60	1.40	1.45	1.90	1.55

 Table 11 Power Quality Parameters of each pumping station











SN	Pump Name/	Vo	Itage (Vo	olt)		PF			V thd (%)	)		l thd (%)	
	Location	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG	MIN	MAX	AVG
31	JUBLEE PARK- 2	414	423	418	0.86	0.87	0.87	1.40	1.60	1.52	1.20	1.45	1.40
32	AZAD INTER COLLEGE	426	449	434	0.77	0.88	0.87	2.20	3.10	2.62	0.20	5.50	1.88
33	GHER JAFAR KHAN	400	420	410	0.88	0.89	0.89	1.80	2.10	1.89	1.46	1.80	1.52
34	JAGATPUR	303	419	404	0.74	0.87	0.86	1.50	9.00	2.07	1.44	3.80	2.11
35	BALJATI	101	428	403	0.69	0.87	0.85	0.30	2.00	1.49	0.00	2.87	0.58
36	NAWADA SHEKHAN	398	405	402	0.88	0.89	0.89	1.30	1.80	1.45	1.45	2.50	1.60
37	RAMGANGA NAGAR NO-2	0	400	326	0.79	0.86	0.86	0.00	8.20	1.82	0.00	3.20	1.55
38	RAMGANGA NAGAR NO-1	423	450	435	0.77	0.82	0.8	2.10	3.10	2.53	1.45	5.20	2.52
39	SURESH SHARMA NAGAR-1	0	434	340	0.72	0.89	0.81	0.00	8.30	1.84	0.00	5.30	0.39
40	SURESH SHARMA NAGAR-1	393	401	398	0.83	0.84	0.83	1.30	1.70	1.55	1.00	1.70	1.34
41	SURESH SHARMA NAGAR -2	387	409	399	0.88	0.89	0.88	1.70	2.00	1.81	1.42	2.30	1.63
42	VANKHADI NATH-1	397	425	405	0.33	0.88	0.87	1.70	2.20	1.80	0.00	5.90	1.46
43	VANKHADI NATH-2	412	423	419	0.74	0.87	0.86	1.50	1.90	1.68	1.45	2.10	1.62
44	SANJAY NAGAR-1	394	403	400	0.88	0.89	0.88	2.10	3.30	2.61	1.46	3.20	1.79
45	SANJAY NAGAR-2	0	424	349	0.83	0.86	0.85	0.00	5.40	3.16	0.00	5.00	2.10
46	QAZI HOUSE	394	406	400	0.89	0.89	0.89	4.00	4.80	4.49	1.47	3.20	2.03
47	VEER SAWARKAR NAGAR	204	444	385	0.37	0.8	0.66	2.20	3.10	2.83	1.44	4.30	2.25
48	HARIJAN PARK(C.I.PARK NO-5)	382	450	412	0.75	0.79	0.77	1.30	4.90	3.04	1.44	3.20	1.90
49	C B GANJ-1	429	447	437	0.88	0.89	0.89	1.00	1.60	1.29	1.40	2.10	1.53
50	C B GANJ-2	439	449	445	0.79	0.8	0.8	1.30	1.70	1.54	1.49	3.90	2.27
51	SANOA	0	417	358	0.78	0.9	0.9	0.00	2.80	1.50	0.00	2.40	1.49
52	HARTTMAN	210	418	397	0.79	0.9	0.89	1.70	2.30	2.05	1.44	2.70	1.80
53	KARAM CHARI NAGAR	404	419	411	0.87	0.88	0.87	1.80	2.30	2.11	1.41	4.20	2.25
54	JUBLEE PARK- 9	439	449	444	0.81	0.82	0.81	1.70	2.00	1.85	1.42	3.60	2.01
55	POLICE LINE	420	439	429	0.86	0.88	0.87	2.00	3.00	2.46	1.40	2.00	1.50
56	C.I PARK-8	380	403	393	0.85	0.86	0.85	0.00	6.00	1.81	0.00	5.20	1.76
57	C.I PARK-3	0	405	320	0.81	0.87	0.85	1.40	1.70	1.55	1.43	2.20	1.67
58	VEER BHATTI- 1	392	410	403	0.85	0.86	0.85	0.00	3.10	1.94	0.00	13.80	1.69
59	GANDHI UDHYAN	417	427	423	0.75	0.76	0.75	1.20	2.20	1.66	1.44	2.50	1.69
60	RAMPUR BAGH	0	464	402	0.5	0.8	0.78	0.00	4,8	2.86	0.00	8.10	2.25
61	SAIDPUR HAKINS	354	376	363	0.85	0.86	0.86	1.10	1.40	1.28	1.20	1.50	1.41











### Table 12: Transformer loading analysis

si			Total	Power	Total	Loading
No.	Name of Site	Transformer, kVA	Loading. kW	Factor	Load,	%
			Louding, ku	, actor	kVA	
1	Civil Lines – 5	100	42.10	0.87	48.39	48.39%
2	Civil Lines – 6	100	26.50	0.85	31.18	31.18%
3	Civil Lines – 7	100	29.22	0.84	34.79	34.79%
4	Jublee Park - 2	100	40.39	0.82	49.26	49.26%
5	Jublee Park - 8	100	40.48	0.89	45.48	45.48%
6	Jublee Park - 9	100	38.40	0.91	42.20	42.20%
7	Gher Jafar Khan	100	38.81	0.92	42.18	42.18%
8	Jagatpur	100	35.26	0.87	40.53	40.53%
9	Govt. Inter College	100	27.07	0.79	34.27	34.27%
10	Sari Kham (Govt. Inter College)	100	30.89	0.86	35.92	35.92%
11	Moti Park	100	26.87	0.78	34.45	34.45%
12	Kishore Bazar	100	45.85	0.92	49.84	49.84%
13	C.I. Park – 3	Common utility transformer	20.06	0.85	23.60	NA
14	Harijan Park	100	21.80	0.83	26.27	26.27%
15	C.I. Park – 7	100	53.57	0.81	66.14	66.14%
16	C.I. Park – 8	100	36.88	0.89	41.44	41.44%
17	Brahmpura	100	42.27	0.90	46.97	46.97%
18	Modal Town - 1	100	20.75	0.87	23.85	23.85%
19	Stadium	100	52.94	0.86	61.56	61.56%
20	Deen Dayal Puram - 1	100	22.42	0.82	27.34	27.34%
21	Deen Dayal Puram - 2	100	22.63	0.84	26.94	26.94%
22	Patel Nagar - 1	100	39.69	0.94	42.22	42.22%
23	PWD Colony	100	32.54	0.89	36.56	36.56%
24	Bankey Bihari	100	59.13	0.91	64.98	64.98%
25	Janakpuri	100	33.69	0.84	40.11	40.11%
26	Indra Nagar	100	28.49	0.81	35.17	35.17%
27	Harttman	100	42.69	0.82	52.06	52.06%
28	Baqarganj – 1	250	35.56	0.94	37.83	15.13%
29	Bagarganj – 2	Common utility transformer	39.02	0.87	44.85	NA
30	Subhash Nagar - 1	100	37.35	0.79	47.28	47.28%
31	Subhash Nagar - 2	100	28.06	0.84	33.40	33.40%
32	C B Ganj – 1	100	19.69	0.81	24.31	24.31%
33	C B Gani – 2	100	28.94	0.86	33.65	33.65%
34	Suresh Sharma Nagar - 1	Common utility transformer	18.64	0.82	22.73	NA
35	Gandhi Udhvan	63	31.15	0.86	36.22	57.49%
36	Nawada Shekhan	100	36.54	0.84	43.50	43.50%
37	Azad Inter College	100	30.57	0.87	35.14	35.14%
38	Koharapeer	Common utility transformer	39.46	0.88	44.84	NA
39	latav Pura	100	40.68	0.87	46.76	46.76%
40	Gangapur	100	32.87	0.89	36.93	36.93%
41	Tilak Inter College	100	27.22	0.88	30.55	30.93%
/2	Baliati	75	37.86	0.85	14 54	59 39%
42	Police Line	100	20.05	0.05	25 57	35.55%
45	Saidour Haking	100	34.10	0.07	27 /17	37 17%
44	Sanoa	Common utility transformer	24.10 Q 25	0.91	۲+.۲C ۵ ۵ ۵	57.4770 NIA
45	Ramganga Nagar No. 1	Common utility transformer	20.22	0.07	24.02	
40	Pamganga Nagar No. 2		29.09 77 75	0.00	23 01	NA /5 100/
4/		100	۲۲.75 ۲۲ عد	0.02	 ວວ.o4 ວວ.o∓	4J.12%
40	Chawai	100	20.77	0.03	32.23	32.23%
49 E0		100	52.38 21.13	0.01	40.22 26.61	40.22%
50		63	31.12	0.85	10.02	JO.1170











SI. No.	Name of Site	Transformer, kVA	Total Loading, kW	Power Factor	Total Load, kVA	Loading %
51	Sithora No - 1	63	41.28	0.85	48.56	77.09%
52	Sithora No - 3	63	38.93	0.89	43.74	69.43%
53	Veer Bhatti - 1	63	26.33	0.78	33.76	53.58%
54	Vankhandi Nath - 1	75	38.18	0.89	42.90	57.20%
55	Vankhandi Nath - 2	75	38.82	0.91	42.66	56.88%
56	Veer Sawarkar Nagar	75	43.39	0.88	49.31	65.74%
57	Sanjay Nagar No - 1	63	38.98	0.92	42.37	67.25%
58	Sanjay Nagar No - 2	63	38.57	0.93	41.47	65.83%
59	Suresh Sharma Nagar - 2	75	42.15	0.87	48.45	64.60%
60	Karam Chari Nagar	100	42.01	0.88	47.74	47.74%
	Total	1053	2044.95		2368.06	

As evident from the above table, the loading varies from 15.13% to 77.09%; three sites have supply from the common transformer as on date of audit.

## 4.2.6 Pumping Station System Mapping

PID station for all the pumping stations are similar and thus sample PID is shown in Figure 4.



Figure 4: P&ID diagram of all pumping stations

Diameter of discharge pipeline, Gate valve and NRV at all 60 pumping station was found to be 200 mm.

## 4.2.7 Pumps Performance Evaluation

As per the methodology described in section -1.4, the team had 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 pumping stations of Nagar Nigam Bareilly was conducted from 12<sup>th</sup> April to 7<sup>th</sup> May 2017. The general details of the site are provided in the table 14.

### Table 13: General detail of pumping station

Data	Value / Details
Name of site	Nagar Nigam, Bareilly
Name of Sub-section	Bore-wells having submersible or vertical turbine pump set
Classification	Drinking water
Pumps installed	64
No. of pumps in operation	61 (60 Pumps Audited + 1 Pump measurement not possible)
No. of pumps under maintenance	3
Other Details	
Basis of pump operation	Underground water to OHT
	Underground water to end consumers
VFD installed (Yes/No)	No

Photographs captured at the Pumping Stations to showcase the actual situation are provided in figure 5 to 8.



Figure 5: Subhash Nagar – 2 Pumping Station



Figure 6: Thana Quila Pumping Station















#### Figure 7: Baqarganj - 2 Pumping Station

#### Figure 8: Janakpuri Pumping Station

Performance evaluation for the pumping stations at Bareilly was calculated and summary of the same is given in Table 14 - 25.

Table 14: Performance Evaluation of pumps- I

Particulars Design data	Civil Lines - 5	Civil Lines - 6	Civil Lines - 7	Jublee Park - 2	Jublee Park - 8
Make of Pump	KSB	KSB	KSB	KSB	KSB
Make of Motor	KSB	KSB	KSB	KSB	KSB
Pump Type	Submersible	Submersible	Submersible	Submersible	Submersible
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	180	80-170	180	180	180
Rated head (m)	51	69-39	51	51	51
Motor Rating (kW)	37.3	24.5	37.3	37.3	37.3
Motor efficiency (%)	91.2	89.9	91.2	91.2	91.2
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	21.33	21.33	21.33	21.33
Gauge pressure at distribution line (m)	29	23	26	27	27
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	167.67	110	111.29	140.66	162.9
Motor input power (kW)	42.1	26.5	29.22	40.39	40.48
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	47.28	44.33	47.33	48.33	48.33
Head utilization (%)	83%	NA	57%	79%	79%
Flow utilization (%)	93%	NA	62%	78%	91%
Hydraulic power developed by pump					
(kW)	22	13	14	19	21
Motor input power (kW)	42	27	29	40	40
Calculated overall efficiency (%)	51%	50%	49%	46%	53%
Calculated pump efficiency (%)	56%	56%	54%	50%	58%
Specific power consumption (kWh/m <sup>3</sup> )	0.25	0.24	0.26	0.29	0.25

#### Table 15: Performance Evaluation of pumps- II

Particulars	Jublee Park	Gher Jafar	Jagatpur	Govt. Inter	Sari Kham (Govt.
Design data	- 9	Khan		College	Inter College)
Make of Pump	KSB	KSB	KSB	HINDUSTAN	HINDUSTAN
Make of Motor	KSB	KSB	KSB	HINDUSTAN	HINDUSTAN
Pump Type	Submersible	Submersible	Submersible	Submersible	Submersible
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	80-170	80-170	180	80-170	80-170
Rated head (m)	69-39	69-39	51	69-39	69-39
Motor Rating (kW)	24.5	24.5	37.3	24.5	24.5
Motor efficiency (%)	89.9	89.9	91.2	89.9	89.9
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	21.33	21.33	18.28	21.33











Particulars	Jublee Park - 9	Gher Jafar Khan	Jagatpur	Govt. Inter College	Sari Kham (Govt. Inter College)
Gauge pressure at distribution	22	21	25	25	4
line (m)					
Pump level below the ground	NA	NA	NA	NA	NA
(m)					
Total one hour flow (m <sup>3</sup> /h)	117.53	180.44	142.32	126	138.43
Motor input power (kW)	38.4	38.81	35.26	27.07	30.89
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	40.28	42.33	46.33	43.28	25.33
Head utilization (%)	NA	NA	69%	NA	NA
Flow utilization (%)	NA	NA	79%	NA	NA
Hydraulic power developed by	13	21	18	15	10
pump (kW)					
Motor input power (kW)	38	39	35	27	31
Calculated overall efficiency	34%	54%	51%	55%	31%
(%)					
Calculated pump efficiency	37%	60%	56%	61%	34%
(%)					
Specific power consumption	0.33	0.22	0.25	0.21	0.22
(kWh/m <sup>3</sup> )					

#### Table 16: Performance Evaluation of pumps-III

Particulars	Moti Park	Kishore Bazar	C.I. Park - 3	Harijan Park	C.I. Park - 7
Design data					
Make of Pump	KSB	CHANDRA	KSB	KSB	KIRLOSKAR
Make of Motor	KSB	CHANDRA	KSB	KSB	KIRLOSKAR
Pump Type	Submersible	Vertical Turbine	Submersible	Submersible	Vertical Turbine
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	180	NA	80-170	80-170	NA
Rated head (m)	51	NA	69-39	69-39	NA
Motor Rating (kW)	37.3	55	24.5	24.5	55
Motor efficiency (%)	91.2	92.1	89.9	89.9	92.1
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	18.28	18.28	21.33	21.33
Gauge pressure at distribution line (m)	25	32	19	27	26
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	128.6	172.85	30	83.45	164.21
Motor input power (kW)	26.87	45.85	20.06	21.8	53.57
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	43.28	50.28	37.28	48.33	47.33
Head utilization (%)	53%	NA	NA	NA	NA
Flow utilization (%)	71%	NA	NA	NA	NA
Hydraulic power developed by pump (kW)	15	24	3	11	21
Motor input power (kW)	27	46	20	22	54
Calculated overall efficiency (%)	56%	52%	15%	50%	40%
Calculated pump efficiency (%)	62%	56%	17%	56%	43%
Specific power consumption (kWh/m <sup>3</sup> )	0.21	0.27	0.67	0.26	0.33











### Table 17: Performance Evaluation of pumps-IV

	C.I. Park - 8	Brahmpura	Modal Town -	Stadium	Deen Dayal
Particulars			1		Puram - 1
Design normations					
Design parameters		KOD	1/05		KOD
Make of Pump	CHANDRA	KSB	KSB	KIRLOSKAR	KSB
Make of Motor	CHANDRA	KSB	KSB	KIRLOSKAR	KSB
Pump Type	Vertical Turbine	Submersible	Submersible	Vertical Turbine	Submersible
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	NA	180	80-170	NA	NA
Rated head (m)	NA	51	69-39	NA	NA
Motor Rating (kW)	55	37.3	24.5	55	18.65
Motor efficiency (%)	92.1	91.2	89.9	92.1	89.3
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	18.28	21.33	21.33	21.33
Gauge pressure at distribution line (m)	21	28	28.7	31	27.1
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	150.78	184.17	45.39	126.11	18.94
Motor input power (kW)	36.88	42.27	20.75	52.94	22.42
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	39.28	46.28	50.03	52.33	48.43
Head utilization (%)	NA	83%	NA	NA	NA
Flow utilization (%)	NA	102%	NA	NA	NA
Hydraulic power developed by pump (kW)	16	23	6	18	2
Motor input power (kW)	37	42	21	53	22
Calculated overall efficiency (%)	44%	55%	30%	34%	11%
Calculated pump efficiency (%)	48%	60%	33%	37%	12%
Specific power consumption (kWh/m <sup>3</sup> )	0.24	0.23	0.46	0.42	1.18

### Table 18: Performance Evaluation of pumps-V

Particulars	Deen Dayal Puram - 2	Patel Nagar - 1	PWD Colony	Bankey Bihari	Janakpuri
Design data					
Make of Pump	KSB	KSB	KSB	KIRLOSKAR	KIRLOSKAR
Make of Motor	KSB	KSB	KSB	KIRLOSKAR	KIRLOSKAR
	Submersible	Submersible	Submersib	Vertical	Vertical
Pump Type			le	Turbine	Turbine
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	NA	80-170	80-170	NA	NA
Rated head (m)	NA	69-39	69-39	NA	NA
Motor Rating (kW)	18.65	24.5	24.5	55	55
Motor efficiency (%)	89.3	89.9	89.9	92.1	92.1
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the	21.33	21.33	18.28	18.28	18.28
ground (m)					
Gauge pressure at distribution line (m)	25.3	26.8	27.1	27.7	28.1











Particulars Design data	Deen Dayal Puram - 2	Patel Nagar - 1	PWD Colony	Bankey Bihari	Janakpuri
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	72.16	128.51	145.21	250.24	147
Motor input power (kW)	22.63	39.69	32.54	59.13	33.69
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	46.63	48.13	45.38	45.98	46.38
Head utilization (%)	NA	NA	NA	NA	NA
Flow utilization (%)	NA	NA	NA	NA	NA
Hydraulic power developed by pump (kW)	9	17	18	31	19
Motor input power (kW)	23	40	33	59	34
Calculated overall efficiency (%)	41%	42%	55%	53%	55%
Calculated pump efficiency (%)	45%	47%	61%	58%	60%
Specific power consumption (kWh/m <sup>3</sup> )	0.31	0.31	0.22	0.24	0.23

## Table 19: Performance Evaluation of pumps-VI

Particulars	Indra Nagar	Harttman	Baqarganj - 1	Baqarganj - 2	Subhash Nagar - 1
				_	
Design data					
Make of Pump	KSB	KSB	KSB	KSB	KSB
Make of Motor	KSB	KSB	KSB	KSB	KSB
Pump Type	Submersibl e	Submersibl e	Submersible	Submersible	Submersible
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	80-170	180	180	180	180
Rated head (m)	69-39	51	51	51	51
Motor Rating (kW)	24.5	37.3	37.3	37.3	37.3
Motor efficiency (%)	89.9	91.2	91.2	91.2	91.2
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	21.33	18.28	18.28	18.28	18.28
Gauge pressure at distribution line (m)	25.4	25	34	22.8	21
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	64.59	171.72	145.26	183.99	210
Motor input power (kW)	28.49	42.69	35.56	39.02	37.35
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	46.73	43.28	52.28	41.08	39.28
Head utilization (%)	NA	84%	70%	77%	73%
Flow utilization (%)	NA	95%	81%	102%	117%
Hydraulic power developed by pump (kW)	8	20	21	21	22
Motor input power (kW)	28	43	36	39	37
Calculated overall efficiency (%)	29%	47%	58%	53%	60%
Calculated pump efficiency (%)	32%	52%	64%	58%	66%
Specific power consumption (kWh/m <sup>3</sup> )	0.44	0.25	0.24	0.21	0.18











### Table 20: Performance Evaluation of pumps-VII

Particulars	Subhash	C B Ganj	C B Ganj	Suresh Sharma	Gandhi
	Nagar - 2	- 1	- 2	Nagar - 1	Udhyan
Design data					
Make of Pump	CHANDRA	KSB	KSB	KSB	KSB
Make of Motor	CHANDRA	KSB	KSB	KSB	KSB
Pump Type	Vertical Turbine	Submersi	Submersi	Submersible	Submersible
Motor Serial No	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	NA	80-170	80-170	NA	80-170
Rated head (m)	NA	69-39	69-39	NA	69-39
Motor Rating (kW)	55	24.5	24.5	14.92	24.5
Motor efficiency (%)	92.1	89.9	89.9	88.7	89.9
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	15.24	18.28	21.33	21.33
Gauge pressure at distribution line (m)	21.6	22	26	20	6
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	144.67	103.35	87.31	76.9	162.71
Motor input power (kW)	28.06	19.69	28.94	18.64	31.15
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	39.88	37.24	44.28	41.33	27.33
Head utilization (%)	NA	NA	NA	NA	NA
Flow utilization (%)	NA	NA	NA	NA	NA
Hydraulic power developed by	16	10	11	9	12
pump (kW)					
Motor input power (kW)	28	20	29	19	31
Calculated overall efficiency (%)	56%	53%	36%	46%	39%
Calculated pump efficiency (%)	61%	59%	40%	52%	43%
Specific power consumption (kWh/m <sup>3</sup> )	0.19	0.19	0.33	0.24	0.19

### Table 21: Performance Evaluation of pumps-VIII

Particulars	Nawada Shekhan	Azad Inter College	Koharapeer	Jatav Pura	Gangapur
Design data					
Make of Pump	KSB	KSB	KIRLOSKAR	KSB	KSB
Make of Motor	KSB	KSB	KIRLOSKAR	KSB	KSB
	Submersible	Submersible	Vertical	Submersib	Submersib
Fullip Type			Turbine	le	le
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	NA	80-170	NA	180	80-170
Rated head (m)	NA	69-39	NA	51	69-39
Motor Rating (kW)	30.586	24.5	55	37.3	24.5
Motor efficiency (%)	90.7	89.9	92.1	91.2	89.9
Size of the discharge pipe (mm)	200	200	200	200	200











Particulars	Nawada Shekhan	Azad Inter College	Koharapeer	Jatav Pura	Gangapur
Parameters Measured					
Level of the water below the ground (m)	21.33	21.33	21.33	21.33	21.33
Gauge pressure at distribution line (m)	9	2	3	4	3
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	167.49	223.24	212.78	223.4	188.95
Motor input power (kW)	36.54	30.57	39.46	40.68	32.87
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	30.33	23.33	24.33	25.33	24.33
Head utilization (%)	NA	NA	NA	80%	NA
Flow utilization (%)	NA	NA	NA	124%	NA
Hydraulic power developed by pump (kW)	14	14	14	15	13
Motor input power (kW)	37	31	39	41	33
Calculated overall efficiency (%)	38%	46%	36%	38%	38%
Calculated pump efficiency (%)	42%	52%	39%	42%	42%
Specific power consumption (kWh/m <sup>3</sup> )	0.22	0.14	0.19	0.18	0.17

## Table 22: Performance Evaluation of pumps-IX

Particulars Design data	Tilak Inter College	Baljati	Police Line	Saidpur Hakins	Sanoa
Make of Pump	KSB	CHANDRA	KSB	KSB	KSB
Make of Motor	KSB	CHANDRA	KSB	KSB	KSB
Pump Type	Submersible	Vertical Turbine	Submersib le	Submersible	Submersib le
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	180	NA	80-170	NA	NA
Rated head (m)	51	NA	69-39	NA	NA
Motor Rating (kW)	37.3	55	24.5	30	7.5
Motor efficiency (%)	91.2	92.1	89.9	90.7	86
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	21.33	21.33	18.28	21.33	21.33
Gauge pressure at distribution line (m)	8.5	7	4	5	22
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	180.53	210.86	114.76	147.1	32.58
Motor input power (kW)	27.22	37.86	30.95	34.1	8.35
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	29.83	28.33	22.28	26.33	43.33
Head utilization (%)	53%	NA	NA	NA	NA
Flow utilization (%)	100%	NA	NA	NA	NA
Hydraulic power developed by pump (kW)	15	16	7	11	4
Motor input power (kW)	27	38	31	34	8











Particulars Design data	Tilak Inter College	Baljati	Police Line	Saidpur Hakins	Sanoa
Calculated overall efficiency (%)	54%	43%	23%	31%	46%
Calculated pump efficiency (%)	59%	47%	25%	34%	54%
Specific power consumption (kWh/m <sup>3</sup> )	0.15	0.18	0.27	0.23	0.26

#### Table 23: Performance Evaluation of pumps-X

Particulars	Ramganga Nagar No - 1	Ramganga Nagar No - 2	Qazi House	Chawai	Thana Qila
Design data					
Make of Pump	KSB	HINDUSTAN	KSB	KSB	KSB
Make of Motor	KSB	HINDUSTAN	KSB	KSB	KSB
Pump Type	Submersible	Submersible	Submersi ble	Submersi ble	Submersi ble
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	NA	NA	80-170	80-170	80-170
Rated head (m)	NA	NA	69-39	69-39	69-39
Motor Rating (kW)	18.65	18.65	24.5	24.5	24.5
Motor efficiency (%)	89.3	89.3	89.9	89.9	89.9
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	21.33	21.33	21.33	21.33
Gauge pressure at distribution line (m)	21	10	4	6.7	9.3
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	155.39	145	171.05	136.16	179
Motor input power (kW)	29.69	27.75	26.77	32.58	31.12
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	39.28	31.33	25.33	28.03	30.63
Head utilization (%)	NA	NA	NA	NA	NA
Flow utilization (%)	NA	NA	NA	NA	NA
Hydraulic power developed by pump (kW)	17	12	12	10	15
Motor input power (kW)	30	28	27	33	31
Calculated overall efficiency (%)	56%	45%	44%	32%	48%
Calculated pump efficiency (%)	63%	50%	49%	36%	53%
Specific power consumption (kWh/m <sup>3</sup> )	0.19	0.19	0.16	0.24	0.17

#### Table 24: Performance Evaluation of pumps-XI

Particulars Design data	Sithora No - 1	Sithora No - 3	Veer Bhatti - 1	Vankhandi Nath - 1	Vankhandi Nath - 2
Make of Pump	KSB	KSB	KSB	KSB	KSB
Make of Motor	KSB	KSB	KSB	KSB	KSB
Pump Type	Submersible	Submersible	Submersible	Submersible	Submersible
Motor Serial No.	NA	NA	NA	NA	NA











Particulars	Sithora No - 1	Sithora No - 3	Veer Bhatti - 1	Vankhandi Nath - 1	Vankhandi Nath - 2
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	180	180	80-170	80-170	80-170
Rated head (m)	51	51	69-39	69-39	69-39
Motor Rating (kW)	37.3	37.3	24.5	24.5	24.5
Motor efficiency (%)	91.2	91.2	89.9	89.9	89.9
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	21.33	18.2	21.33	21.33
Gauge pressure at distribution line (m)	27.1	28.3	37	26	26
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	184.69	144.3	96.59	134.94	137.21
Motor input power (kW)	41.28	38.93	26.33	38.18	38.82
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	45.38	49.63	55.2	47.33	47.33
Head utilization (%)	81%	76%	NA	NA	NA
Flow utilization (%)	103%	80%	NA	NA	NA
Hydraulic power developed by pump (kW)	23	20	15	17	18
Motor input power (kW)	41	39	26	38	39
Calculated overall efficiency (%)	55%	50%	55%	46%	46%
Calculated pump efficiency (%)	61%	55%	61%	51%	51%
Specific power consumption (kWh/m <sup>3</sup> )	0.22	0.27	0.27	0.28	0.28

### Table 25: Performance Evaluation of pumps-XII

Particulars	Veer Sawarkar Nagar	Sanjay Nagar No - 1	Sanjay Nagar No - 2	Suresh Sharma Nagar - 2	Karam Chari Nagar
Design data					
Make of Pump	KSB	KSB	KSB	KSB	KSB
Make of Motor	KSB	KSB	KSB	KSB	KSB
Pump Type	Submersible	Submersible	Submersible	Submersible	Submersible
Motor Serial No.	NA	NA	NA	NA	NA
Pump Serial No.	NA	NA	NA	NA	NA
Rated flow (m <sup>3</sup> /h)	80-170	80-170	180	80-170	80-170
Rated head (m)	69-39	69-39	51	69-39	69-39
Motor Rating (kW)	24.5	24.5	37.3	24.5	24.5
Motor efficiency (%)	89.9	89.9	91.2	89.9	89.9
Size of the discharge pipe (mm)	200	200	200	200	200
Parameters Measured					
Level of the water below the ground (m)	18.28	21.33	24.38	21.33	18.28
Gauge pressure at distribution line (m)	26	25	25	23	21
Pump level below the ground (m)	NA	NA	NA	NA	NA
Flow (m <sup>3</sup> /h)	178.77	148.2	157.47	180.37	180.52











Particulars	Veer Sawarkar Nagar	Sanjay Nagar No - 1	Sanjay Nagar No - 2	Suresh Sharma Nagar - 2	Karam Chari Nagar
Motor input power (kW)	43.39	38.98	38.57	42.15	42.01
Frequency (Hz)	50	50	50	50	50
Speed	NA	NA	NA	NA	NA
Calculation					
Total head developed (m)	44.28	46.33	49.38	44.33	39.28
Head utilization (%)	NA	NA	76%	NA	NA
Flow utilization (%)	NA	NA	87%	NA	NA
Hydraulic power developed by pump (kW)	22	19	21	22	19
Motor input power (kW)	43	39	39	42	42
Calculated overall efficiency (%)	50%	48%	55%	52%	46%
Calculated pump efficiency (%)	55%	53%	60%	58%	51%
Specific power consumption (kWh/m <sup>3</sup> )	0.24	0.26	0.24	0.23	0.23

## 4.2.8 Auxiliaries In Pumping Stations

During the energy audit, electrical energy consuming equipment at the stations other than water pumps were also studied and the same is given in Table 25:

Table 26: Transformer & Instrumentation

Parameters	Details
Transformer details	
Number of transformers	Out of 64 sites, 55 are having dedicated transformer
Capacity (kVA)	In the range of 63 - 250 kVA
Primary/Secondary voltages	11 kV/433 V
Instrumentation at site	
Suction pressure gauges	Not available
Discharge pressure gauges	Tapping points are available on main header (Not all were working
	well)
Flow meter	Not available
Energy meter	Available partially but not working

#### Table 27: Auxiliary loading details

		Auxiliary Load, W							
Pumping Station Load	Pump No.	Street Light	Ceiling fan / Table Fan / Cooler	Tube Light / CFL	Sodium vapor Lamp	Incandescent bulb	LED	Total Aux. Load	Avg. Operation Hr/day
Civil Lines - 5	Pump No. 1						1 x 5		12
Civil Lines - 6	Pump No. 2					1 x 100			12
Civil Lines - 7	Pump No. 3					1 x 100			12











			Au	xiliary Lo	oad, W	1			
Pumping Station Load	Pump No.	Street Light	Ceiling fan / Table Fan / Cooler	Tube Light / CFL	Sodium vapor Lamp	Incandescent bulb	LED	Total Aux. Load	Avg. Operation Hr/day
Jublee Park - 2	Pump No. 4					1 x 60			12
Jublee Park - 8	Pump No. 5					1 x 60			12
Jublee Park - 9	Pump No. 6					1 x 60			12
Rampur Bagh	Pump No. 7					1 x 60			12
Gher Jafar Khan	Pump No. 8					1 x 100			12
Jagatpur	Pump No. 9	1 x 200	1 x 45			1 x 200			12
			_			2 x 60			
Govt. Inter College	Pump No. 10					1 x 60			12
Sari Kham (Govt. Inter College)	Pump No. 11		1 x 60	1 x 15			1 x 5		12
Moti Park	Pump No. 12					1 x 100			12
Kishore Bazar	Pump No. 13					1 x 60			12
$C_{\rm L}$ Park – 3	Pump No. 14					1 x 60			12
Harijan Park	Pump No. 15					1 x 100			12
CL Park $= 7$	Pump No. 16		1 x 45			1 x 60			12
$C \perp Park = 8$	Pump No. 17		1 X 10			1 x 60			12
Brahmoura	Pump No. 18		1 x 200	1 v 25		1 x 60			12
Modal Town 1	Pump No. 10		1 x 200	1 \ 25		1 x 100			12
Stadium	Pump No. 19					1 x 100			12
Doon Dovel Durom 1	Pump No. 20		1 × 75			2 × 60			12
Deen Dayal Furam 2	Pump No. 21		1 X 7 5			$2 \times 00$			12
Deen Dayar Furan - 2	Pump No. 22		4 × 400			1 x 100			12
Pater Nagar - 1	Pump No. 23		1 X 100			1 x 150			12
PWD Coloriy	Pump No. 24					1 x 100			12
Bankey Binari	Pump No. 25					1 x 100			12
	Pump No. 26			4 4 0		1 X 100			12
Indra Nagar	Pump No. 27		4 450	1 X 16		4 00			12
Harttman	Pump No. 28	-	1 x 150			1 x 60			12
Baqarganj - 1	Pump No. 29					1 x 100			12
Baqarganj - 2	Pump No. 30								12
Subhash Nagar - 1	Pump No. 31					1 x 60			12
Subhash Nagar - 2	Pump No. 32					1 x 100			12
C B Ganj - 1	Pump No. 33					1 x 60			12
C B Ganj - 2	Pump No. 34		1 x 150			1 x 60			12
Suresh Sharma Nagar - 1	Pump No. 35		1 x 75 1 x 200			1 x 60			12
Gandhi Udhyan	Pump No. 36					1 x 60			12
Nawada Shekhan	Pump No. 37		1 x 150			1 x 60			12
Azad Inter College	Pump No. 38					1 x 100			12
Koharapeer	Pump No. 39					1 x 60			12
Jatav Pura	Pump No. 40					1 x 60			12
Gangapur	Pump No. 41					1 x 60			12
Tilak Inter College	Pump No. 42		1 x 75			1 x 100			12
Baliati	Pump No. 45								12
Police Line	Pump No. 46					1 x 60			12
Saidpur Hakins	Pump No 47					1 x 100			12
Sanoa	Pump No. 48					1 x 60			12
Ramganga Nagar No - 1	Pump No. 40	<u> </u>				1 x 60			12
Ramganga Nagar No - 2	Pump No. 50	<u> </u>	1 x 150			1 x 60			12
Qazi House	Pump No. 51		1 x 150	1 x 40		1 x 60			12
		1	1 1 1 1 0 0			1	1		











			Au	xiliary Lo	oad, W	1			
Pumping Station Load	Pump No.	Street Light	Ceiling fan / Table Fan / Cooler	Tube Light / CFL	Sodium vapor Lamp	Incandescent bulb	LED	Total Aux. Load	Avg. Operation Hr/day
Chawai	Pump No. 52					1 x 60			12
Thana Qila	Pump No. 53		1 x 45			1 x 100			12
Sithora No - 1	Pump No. 54					1 x 100			12
Sithora No - 3	Pump No. 56			1 x 15 1 x 26					12
Veer Bhatti - 1	Pump No. 57		1 x 150	1 x 60					12
Vankhandi Nath - 1	Pump No. 58		1 x 75			1 x 60	1 x 5		12
Vankhandi Nath - 2	Pump No. 59		1 x 45	1 x 15					12
Veer Sawarkar Nagar	Pump No. 60					1 x 60			12
Sanjay Nagar No - 1	Pump No. 61					1 x 60			12
Sanjay Nagar No - 2	Pump No. 62		1 x 150			1 x 60			12
Suresh Sharma Nagar - 2	Pump No. 63					1 x 60			12
Karam Chari Nagar	Pump No. 64		1 x 150			1 x 60			12

## 4.2.9 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 from the available log books at pumping stations to estimate annual energy. The details are given below in Table 28.

 Table 28: Energy consumption for pumping station

SI. No.	Pump station name	Status of Pump	Measured power consumption (kW)	Operating hours (hour/ year)	Total power consumption per year (kWh/year)
1	Civil Lines – 5	Running	42.1	7,300	307,330
2	Civil Lines – 6	Running	26.5	5,840	154,760
3	Civil Lines – 7	Running	29.2	5,840	170,645
4	Jublee Park – 2	Running	40.4	5,475	221,135
5	Jublee Park – 8	Running	40.5	6,205	251,178
6	Jublee Park – 9	Running	38.4	5,840	224,256
7	Gher Jafar Khan	Running	38.8	5,840	226,650
8	Jagatpur	Running	35.3	6,570	231,658
9	Govt. Inter College	Running	27.1	7,665	207,492
10	Sari Kham (Govt. Inter College)	Running	30.9	4,015	124,023
11	Moti Park	Running	26.9	6,570	176,536
12	Kishore Bazar	Running	45.9	6,935	317,970
13	C.I. Park – 3	Running	20.1	5,840	117,150
14	Harijan Park	Running	21.8	5,840	127,312
15	C.I. Park – 7	Running	53.6	7,300	391,061
16	C.I. Park – 8	Running	36.9	7,300	269,224











		Status	Measured	Operating	
SI No	Pump station name	Status	power	hours	
SI. NO.	Pump station name	Pump	consumption	(hour/	voar (kWh/voar)
			(kW)	year)	
17	Brahmpura	Running	42.3	5,840	246,857
18	Modal Town – 1	Running	20.8	5,840	121,180
19	Stadium	Running	52.9	6,935	367,139
20	Deen Dayal Puram – 1	Running	22.4	5,110	114,566
21	Deen Dayal Puram – 2	Running	22.6	5,475	123,899
22	Patel Nagar – 1	Running	39.7	6,205	246,276
23	PWD Colony	Running	32.5	5,475	178,157
24	Bankey Bihari	Running	59.1	7,300	431,649
25	Janakpuri	Running	33.7	7,300	245,937
26	Indra Nagar	Running	28.5	5,840	166,382
27	Harttman	Running	42.7	7,300	311,637
28	Baqarganj – 1	Running	35.6	7,300	259,588
29	Baqarganj – 2	Running	39.0	7,300	284,846
30	Subhash Nagar – 1	Running	37.4	6,570	245,390
31	Subhash Nagar – 2	Running	28.1	6,205	174,112
32	C B Ganj – 1	Running	19.7	5,840	114,990
33	C B Ganj – 2	Running	28.9	7,300	211,262
34	Suresh Sharma Nagar – 1	Running	18.6	2,555	47,625
35	Gandhi Udhyan	Running	31.2	5,840	181,916
36	Nawada Shekhan	Running	36.5	6,205	226,731
37	Azad Inter College	Running	30.6	7,300	223,161
38	Koharapeer	Running	39.5	4,380	172,835
39	Jatav Pura	Running	40.7	6,205	252,419
40	Gangapur	Running	32.9	5,475	179,963
41	Tilak Inter College	Running	27.2	3,650	99,353
42	Baljati	Running	37.9	6,205	234,921
43	Police Line	Running	31.0	5,475	169,451
44	Saidpur Hakins	Running	34.1	1,825	62,233
45	Sanoa	Running	8.4	5,840	48,764
46	Ramganga Nagar No - 1	Running	29.7	5,840	173,390
47	Ramganga Nagar No - 2	Running	27.8	5,840	162,060
48	Qazi House	Running	26.8	7,300	195,421
49	Chawai	Running	32.6	3,285	107,025
50	Thana Qila	Running	31.1	4,015	124,947
51	Sithora No – 1	Running	41.3	2,190	90,403
52	Sithora No – 3	Running	38.9	1,460	56,838
53	Veer Bhatti – 1	Running	26.3	7,300	192,209
54	Vankhandi Nath – 1	Running	38.2	5,110	195,100
55	Vankhandi Nath – 2	Running	38.8	3,650	141,693
56	Veer Sawarkar Nagar	Running	43.4	2,920	126,699
57	Sanjay Nagar No – 1	Running	39.0	5,840	227,643
58	Sanjay Nagar No – 2	Running	38.6	5,840	225,249
59	Suresh Sharma Nagar – 2	Running	42.2	3,650	153,848
60	Karam Chari Nagar	Running	42.0	5,840	245,338
	Total		2045		11,679,482











# 5 Baseline Assessment

Estimation of baseline is the key element in design and development of any energy efficiency project. It play 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 <sup>3</sup> /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 baselines 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:

Baseline Energy Consumption of a pump (kWh)=  $kW1 \times hours of operation1 + kW2 \times hours of operation2 + \cdots$ .

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

Baseline Energy Consumption of a ULB  $(kWh) = Baseline of pump1 + Baseline of pump2 + \cdots$ .

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 28 provides estimated present energy consumption of pumps operating at pumping stations in Bareilly based on data provided in this report.











#### Table 29: Baseline energy consumption for water pumping station

Pump station name	Status of Pump	Measured power consumption (kW)	Head developed (m)	Freque ncy (Hz)	Voltage (V)	Pumping quantity (m <sup>3</sup> /h)	Operating hours (h/ annum)	Total quantity pumped per annum (kL)	Total power consumption Per year (kWh/annum)
Civil Lines – 5	Running	42.1	47.28	50	408	168	7300	1,223,991	307,330
Civil Lines – 6	Running	26.5	44.33	50	397	110	5840	642,400	154,760
Civil Lines – 7	Running	29.22	47.33	50	406	111	5840	649,934	170,645
Jublee Park – 2	Running	40.39	48.33	50	428	141	5475	770,114	221,135
Jublee Park – 8	Running	40.48	48.33	50	421	163	6205	1,010,795	251,178
Jublee Park – 9	Running	38.4	40.28	50	411	118	5840	686,375	224,256
Gher Jafar Khan	Running	38.81	42.33	50	420	180	5840	1,053,770	226,650
Jagatpur	Running	35.26	46.33	50	411	142	6570	935,042	231,658
Govt. Inter College	Running	27.07	43.28	50	409	126	7665	965,790	207,492
Sari Kham (Govt. Inter College)	Running	30.89	25.33	50	429	138	4015	555,796	124,023
Moti Park	Running	26.87	43.28	50	414	129	6570	844,902	176,536
Kishore Bazar	Running	45.85	50.28	50	416	173	6935	1,198,715	317,970
C.I. Park – 3	Running	20.06	37.28	50	412	30	5840	175,200	117,150
Harijan Park	Running	21.8	48.33	50	403	83	5840	487,348	127,312
C.I. Park – 7	Running	53.57	47.33	50	417	164	7300	1,198,733	391,061
C.I. Park – 8	Running	36.88	39.28	50	394	151	7300	1,100,694	269,224
Brahmpura	Running	42.27	46.28	50	418	184	5840	1,075,553	246,857
Modal Town – 1	Running	20.75	50.03	50	417	45	5840	265,078	121,180
Stadium	Running	52.94	52.33	50	401	126	6935	874,573	367,139
Deen Dayal Puram – 1	Running	22.42	48.43	50	401	19	5110	96,783	114,566
Deen Dayal Puram – 2	Running	22.63	46.63	50	398	72	5475	395,076	123,899
Patel Nagar – 1	Running	39.69	48.13	50	403	129	6205	797,405	246,276
PWD Colony	Running	32.54	45.38	50	406	145	5475	795,025	178,157
Bankey Bihari	Running	59.13	45.98	50	420	250	7300	1,826,752	431,649
Janakpuri	Running	33.69	46.38	50	411	147	7300	1,073,100	245,937
Indra Nagar	Running	28.49	46.73	50	409	65	5840	377,206	166,382
Harttman	Running	42.69	43.28	50	429	172	7300	1,253,556	311,637
Baqarganj – 1	Running	35.56	52.28	50	414	145	7300	1,060,398	259,588
Baqarganj – 2	Running	39.02	41.08	50	408	184	7300	1,343,127	284,846
Subhash Nagar – 1	Running	37.35	39.28	50	397	210	6570	1,379,700	245,390
Subhash Nagar – 2	Running	28.06	39.88	50	406	145	6205	897,677	174,112
C B Ganj – 1	Running	19.69	37.24	50	428	103	5840	603,564	114,990
C B Ganj – 2	Running	28.94	44.28	50	421	87	7300	637,363	211,262
Suresh Sharma Nagar – 1	Running	18.64	41.33	50	411	77	2555	196,480	47,625
Gandhi Udhyan	Running	31.15	27.33	50	409	163	5840	950,226	181,916
Nawada Shekhan	Running	36.54	30.33	50	417	167	6205	1,039,275	226,731









Pump station name	Status of Pump	Measured power consumption (kW)	Head developed (m)	Freque ncy (Hz)	Voltage (V)	Pumping quantity (m <sup>3</sup> /h)	Operating hours (h/ annum)	Total quantity pumped per annum (kL)	Total power consumption Per year (kWh/annum)
Azad Inter College	Running	30.57	23.33	50	401	223	7300	1,629,652	223,161
Koharapeer	Running	39.46	24.33	50	401	213	4380	931,976	172,835
Jatav Pura	Running	40.68	25.33	50	398	223	6205	1,386,197	252,419
Gangapur	Running	32.87	24.33	50	403	189	5475	1,034,501	179,963
Tilak Inter College	Running	27.22	29.83	50	406	181	3650	658,935	99,353
Baljati	Running	37.86	28.33	50	429	211	6205	1,308,386	234,921
Police Line	Running	30.95	22.28	50	414	115	5475	628,311	169,451
Saidpur Hakins	Running	34.1	26.33	50	408	147	1825	268,458	62,233
Sanoa	Running	8.35	43.33	50	397	33	5840	190,267	48,764
Ramganga Nagar No - 1	Running	29.69	39.28	50	406	155	5840	907,478	173,390
Ramganga Nagar No - 2	Running	27.75	31.33	50	428	145	5840	846,800	162,060
Qazi House	Running	26.77	25.33	50	421	171	7300	1,248,665	195,421
Chawai	Running	32.58	28.03	50	411	136	3285	447,286	107,025
Thana Qila	Running	31.12	30.63	50	409	179	4015	718,685	124,947
Sithora No – 1	Running	41.28	45.38	50	417	185	2190	404,471	90,403
Sithora No – 3	Running	38.93	49.63	50	411	144	1460	210,678	56,838
Veer Bhatti – 1	Running	26.33	55.2	50	409	97	7300	705,107	192,209
Vankhandi Nath – 1	Running	38.18	47.33	50	417	135	5110	689,543	195,100
Vankhandi Nath – 2	Running	38.82	47.33	50	401	137	3650	500,817	141,693
Veer Sawarkar Nagar	Running	43.39	44.28	50	401	179	2920	522,008	126,699
Sanjay Nagar No – 1	Running	38.98	46.33	50	398	148	5840	865,488	227,643
Sanjay Nagar No – 2	Running	38.57	49.38	50	403	157	5840	919,625	225,249
Suresh Sharma Nagar – 2	Running	42.15	44.33	50	406	180	3650	658,351	153,848
Karam Chari Nagar	Running	42.01	39.28	50	429	181	5840	1,054,237	245,338
Total		2044.95						49,173,438	11,679,482







with /



# **6 Energy Efficiency Measures**

A summary of the proposed energy efficiency measures for water pumping stations is given in the Table:

## 6.1 Summary of Energy Efficiency Measures

Table 30: Summary of energy efficiency measures for water pumping stations

SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving (Rs. Lakhs) per Annum	Payback Period (Months)
	Pumping System					
1	Civil Lines – 5		48811	2.36	3.78	7
2	Civil Lines – 6		23232	1.84	1.85	12
3	Civil Lines – 7		28569	2.36	2.27	12
4	Jublee Park – 2		52096	2.36	4.14	7
5	Jublee Park – 8	٩	32947	2.36	2.62	11
6	Jublee Park – 9	lung	92083	1.84	7.32	3
7	Gher Jafar Khan	ant p	32168	1.84	2.56	9
8	Jagatpur	energy efficie	38136	2.36	3.03	9
9	Govt. Inter College		17653	1.84	1.40	16
10	Sari Kham (Govt. Inter College)		54272	1.84	4.31	5
11	Moti Park	vith	10459	2.36	0.83	34
12	Kishore Bazar	ets v	89859	6.98	7.14	12
13	C.I. Park – 3	b se	78459	1.84	6.24	4
14	Harijan Park	uno	16651	1.84	1.32	17
15	C.I. Park – 7	ant p	170196	6.98	13.53	6
16	C.I. Park – 8	flicie	95965	6.98	7.63	11
17	Brahmpura	inet	29831	2.36	2.37	12
18	Modal Town – 1	it of	50320	1.84	4.00	6
19	Stadium	mer	169181	6.98	13.45	6
20	Deen Dayal Puram – 1	ace	86800	1.63	6.90	3
21	Deen Dayal Puram – 2	tepl	32625	1.63	2.59	8
22	Patel Nagar – 1	Щ	69017	1.84	5.49	4
23	PWD Colony		16987	1.84	1.35	16
24	Bankey Bihari		126471	6.98	10.05	8
25	Janakpuri		46490	6.98	3.70	23
26	Indra Nagar		74010	1.84	5.88	4











SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving (Rs. Lakhs) per Annum	Payback Period (Months)
27	Harttman		69273	2.36	5.51	5
28	Baqarganj – 1		17880	2.36	1.42	20
29	Baqarganj – 2		38365	2.36	3.05	9
30	Subhash Nagar – 1		9101	2.36	0.72	39
31	Subhash Nagar – 2		30652	6.98	2.44	34
32	C B Ganj – 1		9388	1.84	0.75	30
33	C B Ganj – 2		71433	1.84	5.68	4
34	Suresh Sharma Nagar – 1		7392	1.59	0.59	32
35	Gandhi Udhyan		57763	1.84	4.59	5
36	Nawada Shekhan		76037	2.01	6.04	4
37	Azad Inter College		47561	1.84	3.78	6
38	Koharapeer		88192	6.98	7.01	12
39	Jatav Pura		90248	2.36	7.17	4
40	Gangapur		59636	1.84	4.74	5
41	Tilak Inter College		10082	2.36	0.80	35
42	Baljati		96556	6.98	7.68	11
43	Police Line		93158	1.84	7.41	3
44	Saidpur Hakins		27211	2.01	2.16	11
45	Sanoa		3833	1.32	0.30	52
46	Ramganga Nagar No - 1		14153	1.63	1.13	17
47	Ramganga Nagar No - 2		37414	1.63	2.97	7
48	Qazi House		44214	1.84	3.51	6
49	Chawai		44908	1.84	3.57	6
50	Thana Qila		23275	1.84	1.85	12
51	Sithora No – 1		13834	2.36	1.10	26
52	Sithora No – 3		20258	2.36	1.61	18
53	Veer Bhatti – 1		15439	1.84	1.23	18
54	Vankhandi Nath – 1		46878	1.84	3.73	6
55	Vankhandi Nath – 2		34039	1.84	2.71	8
56	Veer Sawarkar Nagar		23441	1.84	1.86	12
57	Sanjay Nagar No – 1		48517	1.84	3.86	6











SI. No	Pumping Station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Energy Cost Saving (Rs. Lakhs) per Annum	Payback Period (Months)
58	Sanjay Nagar No – 2		27257	2.36	2.17	13
59	Suresh Sharma Nagar – 2		23473	1.84	1.87	12
60	Karam Chari Nagar		60349	1.84	4.80	5
Sub-Total (a)			2964494	163.61	235.57	8
Auxiliary	/ Load					
1	Lighting fixtures (CFL , Incandescent Lamp) at above 60 Pumping Stations & Rampur Bagh	Replacement with LED lighting fixtures	14914	1.19	0.22	2
	Sub-Total (b)		14914	1.19	0.22	2
	Net Total (a + b)		2979408	164.80	235.79	8

## 6.2 Detailed Energy Efficiency Measures

Opportunities of energy saving identified at each pumping are discussed below.

## 6.2.1 EEM 1: Replacement of existing pumps with energy efficient pump

**Recommendations:** The present operating pumps' efficiencies are in range of 11% to 60%. The lower efficiencies of the pumps can be attributed to the fact that they are operated far away from their respective Best Efficiency Point (BEP). Therefore, it is suggested to replace the existing pump sets with energy efficient pump sets.

**Cost benefit analysis:** Expected savings from the replacement of the pumps in all the pumping stations are about 29,64,494 kWh per year, which would result in a cost benefit of about Rs. 235.57 Lakh per year. Estimated investment for implementation of this measure is about Rs. 163.61 Lakh, which basically includes cost of pump set, installation cost, cost of NRV, gate valve and cost of Web based dashboard. Simple payback period of this intervention is estimated to be about 8 months.

Rated Parameters	UOM	Civil Lines - 5	Civil Lines - 6	Civil Lines - 7	Jublee Park - 2	Jublee Park - 8
Flow Delivered	m³/h	180	80-170	180	180	180
Head Developed	m	51	69-39	51	51	51
Motor Power Consumption	kW	37.3	24.5	37.3	37.3	37.3

#### Table 31: Cost Benefit analysis for replacement of pumps –I











Rated Parameters	UOM	Civil Lines -	Civil Lines -	Civil Lines -	Jublee Park -	Jublee Park -				
Measured Parameters		Ŭ	Ŭ		-	Ŭ				
Flow Delivered	m³/h	168	110	111	141	163				
Total head	m	47.28	44.33	47.33	48.33	48.33				
Power of the motor	kW	42	27	29	40	40				
Calculated efficiency of pump set	%	51%	50%	49%	46%	53%				
Proposed Parameters										
Flow of the pump	m³/h	168	110	111	141	163				
Total head	m	47.28	44.33	47.33	48.33	48.33				
Power of the motor on exiting duty point	kW	35.41	22.52	24.33	30.87	35.17				
Proposed Efficiency of pump set on exiting duty point	%	65%	64%	63%	64%	65%				
Operating hours of the pump	h/y	7300	5840	5840	5475	6205				
Annual energy saving	kWh/y	48,811	23,232	28,569	52,096	32,947				
Electricity Tariff	Rs./kW h	7.95	7.95	7.95	7.95	7.95				
Investment of new pump set (including GST)	Rs. Lakh	1.63	1.15	1.63	1.63	1.63				
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22				
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29				
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08				
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.14	0.1	0.14	0.14	0.14				
Total Investment	Rs. Lakh	2.36	1.84	2.36	2.36	2.36				
Payback Period	Months	7	12	12	7	11				

### Table 32: Cost Benefit analysis for replacement of pumps-II

Rated Parameters	UOM	Jublee Park – 9	Gher Jafar Khan	Jagatp ur	Govt. Inter College	Sari Kham (Govt. Inter College)
Flow Delivered	m³/h	80-170	80-170	180	80-170	80-170
Head Developed	m	69-39	69-39	51	69-39	69-39
Motor Power Consumption	kW	24.5	24.5	37.3	24.5	24.5
Measured Parameters						
Flow Delivered	m³/h	118	180	142	126	138
Total head	m	40.28	42.33	46.33	43.28	25.33
Power of the motor	kW	38	39	35	27	31
Calculated efficiency of pump set	%	34%	54%	51%	55%	31%
Proposed Parameters						
Flow of the pump	m³/h	118	180	142	126	138
Total head	m	40.28	42.33	46.33	43.28	25.33
Power of the motor on exiting duty point	kW	22.63	33.30	29.46	24.77	17.37
Proposed Efficiency of pump set on exiting duty point	%	61%	67%	65%	65%	59%
Operating hours of the pump	h/y	5840	5840	6570	7665	4015
Annual energy saving	kWh/y	92,083	32,168	38,136	17,653	54,272
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95











Rated Parameters	UOM	Jublee Park – 9	Gher Jafar Khan	Jagatp ur	Govt. Inter College	Sari Kham (Govt. Inter College)
Investment of new pump set (including GST)	Rs. Lakh	1.15	1.15	1.63	1.15	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.1	0.1	0.14	0.1	0.1
Total Investment	Rs. Lakh	1.84	1.84	2.36	1.84	1.84
Payback Period	Months	3	9	9	16	5

### Table 33: Cost Benefit analysis for replacement of pumps - III

Rated Parameters	UOM	Moti Park	Kishore Bazar	C.I. Park - 3	Harijan Park	C.I. Park - 7
Flow Delivered	m³/h	180	NA	80-170	80-170	NA
Head Developed	m	51	NA	69-39	69-39	NA
Motor Power Consumption	kW	37.3	55	24.5	24.5	55
Measured Parameters						
Flow Delivered	m³/h	129	173	30	83	164
Total head	m	43.28	50.28	37.28	48.33	47.33
Power of the motor	kW	27	46	20	22	54
Calculated efficiency of pump set	%	56%	52%	15%	50%	40%
Proposed Parameters						
Flow of the pump	m³/h	129	173	30	83	164
Total head	m	43.28	50.28	37.28	48.33	47.33
Power of the motor on exiting duty point	kW	25.28	32.89	6.63	18.95	30.26
Proposed Efficiency of pump set on exiting duty point	%	64%	76%	50%	63%	74%
Operating hours of the pump	h/y	6570	6935	5840	5840	7300
Annual energy saving	kWh/y	10,459	89,859	78,459	16,651	170,196
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.63	5.9	1.15	1.15	5.9
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.14	0.5	0.1	0.1	0.5
Total Investment	Rs. Lakh	2.36	6.98	1.84	1.84	6.98
Payback Period	Month s	34	12	4	17	6











#### Table 34: Cost Benefit analysis for replacement of pumps - IV

Rated Parameters	UOM	C.I. Park - 8	Brahm pura	Modal Town - 1	Stadi um	Deen Dayal Puram - 1
Flow Delivered	m³/h	NA	180	80-170	NA	NA
Head Developed	m	NA	51	69-39	NA	NA
Motor Power Consumption	kW	55	37.3	24.5	55	18.65
Measured Parameters						
Flow Delivered	m³/h	151	184	45	126	19
Total head	m	39.28	46.28	50.03	52.33	48.43
Power of the motor	kW	37	42	21	53	22
Calculated efficiency of pump set	%	44%	55%	30%	34%	11%
Proposed Parameters						
Flow of the pump	m³/h	151	184	45	126	19
Total head	m	39.28	46.28	50.03	52.33	48.43
Power of the motor on exiting duty point	kW	23.73	37.16	12.13	28.54	5.43
Proposed Efficiency of pump set on exiting duty point	%	72%	67%	55%	67%	50%
Operating hours of the pump	h/y	7300	5840	5840	6935	5110
Annual energy saving	kWh/ y	95,965	29,831	50,320	169,1 81	86,800
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	5.9	1.63	1.15	5.9	0.96
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.5	0.14	0.1	0.5	0.08
Total Investment	Rs. Lakh	6.98	2.36	1.84	6.98	1.63
Payback Period	Mont hs	11	12	6	6	3

### Table 35: Cost Benefit analysis for replacement of pumps - V

Rated Parameters	UOM	Deen Dayal Puram - 2	Patel Nagar - 1	PWD Colony	Bankey Bihari	Janak puri
Flow Delivered	m³/h	NA	80-170	80-170	NA	NA
Head Developed	m	NA	69-39	69-39	NA	NA
Motor Power Consumption	kW	18.65	24.5	24.5	55	55
Measured Parameters						
Flow Delivered	m³/h	72	129	145	250	147
Total head	m	46.63	48.13	45.38	45.98	46.38
Power of the motor	kW	23	40	33	59	34
Calculated efficiency of pump set	%	41%	42%	55%	53%	55%
Proposed Parameters						
Flow of the pump	m³/h	72	129	145	250	147
Total head	m	46.63	48.13	45.38	45.98	46.38
Power of the motor on exiting duty point	kW	16.67	28.57	29.44	41.81	27.32
Proposed Efficiency of pump set on exiting duty point	%	60%	64%	66%	80%	72%











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Rated Parameters	UOM	Deen Dayal Puram - 2	Patel Nagar - 1	PWD Colony	Bankey Bihari	Janak puri
Operating hours of the pump	h/y	5475	6205	5475	7300	7300
Annual energy saving	kWh/ y	32,625	69,017	16,987	126,471	46,490
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	0.96	1.15	1.15	5.9	5.9
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.08	0.1	0.1	0.5	0.5
Total Investment	Rs. Lakh	1.63	1.84	1.84	6.98	6.98
Payback Period	Mont hs	8	4	16	8	23

## Table 36: Cost Benefit analysis for replacement of pumps - VI

Rated Parameters	UOM	Indra Nagar	Hartt man	Baqarga nj - 1	Baqarga nj - 2	Subhash Nagar - 1
Flow Delivered	m³/h	80-170	180	180	180	180
Head Developed	m	69-39	51	51	51	51
Motor Power Consumption	kW	24.5	37.3	37.3	37.3	37.3
Measured Parameters						
Flow Delivered	m³/h	65	172	145	184	210
Total head	m	46.73	43.28	52.28	41.08	39.28
Power of the motor	kW	47	43	52	41	39
Calculated efficiency of pump set	%	29%	47%	58%	53%	60%
Proposed Parameters						
Flow of the pump	m³/h	65	172	145	184	210
Total head	m	46.73	43.28	52.28	41.08	39.28
Power of the motor on exiting duty point	kW	15.82	33.20	33.11	33.76	35.96
Proposed Efficiency of pump set on exiting duty point	%	56%	65%	67%	65%	67%
Operating hours of the pump	h/y	5840	7300	7300	7300	6570
Annual energy saving	kWh/ y	74,010	69,27 3	17,880	38,365	9,101
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.15	1.63	1.63	1.63	1.63
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.1	0.14	0.14	0.14	0.14











Rated Parameters	UOM	Indra Nagar	Hartt man	Baqarga nj - 1	Baqarga nj - 2	Subhash Nagar - 1
Total Investment	Rs. Lakh	1.84	2.36	2.36	2.36	2.36
Payback Period	Mont hs	4	5	20	9	39

Table 37: Cost Benefit analysis for replacement of pumps - VII

Rated Parameters	UOM	Subhash Nagar - 2	C B Ganj - 1	C B Ganj - 2	Suresh Sharma Nagar - 1	Gandhi Udhyan
Flow Delivered	m³/h	NA	80-170	80-170	NA	80-170
Head Developed	m	NA	69-39	69-39	NA	69-39
Motor Power Consumption	kW	55	24.5	24.5	14.92	24.5
Measured Parameters						
Flow Delivered	m³/h	145	103	87	77	163
Total head	m	39.88	37.24	44.28	41.33	27.33
Power of the motor	kW	28	20	29	19	31
Calculated efficiency of pump set	%	56%	53%	36%	46%	39%
Proposed Parameters						
Flow of the pump	m³/h	145	103	87	77	163
Total head	m	39.88	37.24	44.28	41.33	27.33
Power of the motor on exiting duty point	kW	23.12	18.08	19.15	15.75	21.26
Proposed Efficiency of pump set on exiting duty point	%	72%	63%	59%	60%	61%
Operating hours of the pump	h/y	6205	5840	7300	2555	5840
Annual energy saving	kWh/ y	30,652	9,388	71,433	7,392	57,763
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	5.9	1.15	1.15	0.92	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.5	0.1	0.1	0.08	0.1
Total Investment	Rs. Lakh	6.98	1.84	1.84	1.59	1.84
Payback Period	Mont hs	34	30	4	32	5

#### Table 38: Cost Benefit analysis for replacement of pumps - VIII

Rated Parameters	UOM	Nawada Shekhan	Azad Inter College	Kohara peer	Jatav Pura	Ganga pur
Flow Delivered	m³/h	NA	80-170	NA	180	80-170
Head Developed	m	NA	69-39	NA	51	69-39
Motor Power Consumption	kW	30.586	24.5	55	37.3	24.5
Measured Parameters						
Flow Delivered	m³/h	167	223	213	223	189
Total head	m	30.33	23.33	24.33	25.33	24.33










Rated Parameters	UOM	Nawada Shekhan	Azad Inter College	Kohara peer	Jatav Pura	Ganga pur
Power of the motor	kW	37	31	39	41	33
Calculated efficiency of pump set	%	38%	46%	36%	38%	38%
Proposed Parameters						
Flow of the pump	m³/h	167	223	213	223	189
Total head	m	30.33	23.33	24.33	25.33	24.33
Power of the motor on exiting duty point	kW	24.29	24.05	19.32	26.14	21.98
Proposed Efficiency of pump set on exiting duty point	%	61%	64%	77%	63%	61%
Operating hours of the pump	h/y	6205	7300	4380	6205	5475
Annual energy saving	kWh/ y	76,037	47,561	88,192	90,248	59,636
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.31	1.15	5.9	1.63	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.11	0.1	0.5	0.14	0.1
Total Investment	Rs. Lakh	2.01	1.84	6.98	2.36	1.84
Payback Period	Mont hs	4	6	12	4	5

Table 39: Cost Benefit analysis for replacement of pumps - IX

Rated Parameters	UOM	Tilak Inter College	Baljati	Police Line	Saidpur Hakins	Sanoa
Flow Delivered	m³/h	180	NA	80-170	NA	NA
Head Developed	m	51	NA	69-39	NA	NA
Motor Power Consumption	kW	37.3	55	24.5	30	7.5
Measured Parameters						
Flow Delivered	m³/h	181	211	115	147	33
Total head	m	29.83	28.33	22.28	26.33	43.33
Power of the motor	kW	27	38	31	34	8
Calculated efficiency of pump set	%	54%	43%	23%	31%	46%
Proposed Parameters						
Flow of the pump	m³/h	181	211	115	147	33
Total head	m	29.83	28.33	22.28	26.33	43.33
Power of the motor on exiting duty point	kW	24.46	22.30	13.93	19.19	7.69
Proposed Efficiency of pump set on exiting duty point	%	64%	77%	54%	59%	55%
Operating hours of the pump	h/y	3650	6205	5475	1825	5840
Annual energy saving	kWh/y	10,082	96,556	93,158	27,211	3,833
Electricity Tariff	Rs./k Wh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.63	5.9	1.15	1.31	0.68
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22











Rated Parameters	UOM	Tilak Inter College	Baljati	Police Line	Saidpur Hakins	Sanoa
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.14	0.5	0.1	0.11	0.06
Total Investment	Rs. Lakh	2.36	6.98	1.84	2.01	1.32
Payback Period	Month s	35	11	3	11	52

Table 40: Cost Benefit analysis for replacement of pumps - X

Rated Parameters	UOM	Ramganga Nagar No - 1	Ramganga Nagar No - 2	Qazi House	Chawai	Thana Qila
Flow Delivered	m³/h	NA	NA	80-170	80-170	80-170
Head Developed	m	NA	NA	69-39	69-39	69-39
Motor Power Consumption	kW	18.65	18.65	24.5	24.5	24.5
Measured Parameters						
Flow Delivered	m³/h	155	145	171	136	179
Total head	m	39.28	31.33	25.33	28.03	30.63
Power of the motor	kW	30	28	27	33	31
Calculated efficiency of pump set	%	56%	45%	44%	32%	48%
Proposed Parameters						
Flow of the pump	m³/h	155	145	171	136	179
Total head	m	39.28	31.33	25.33	28.03	30.63
Power of the motor on exiting duty point	kW	27.27	21.34	20.71	18.91	25.32
Proposed Efficiency of pump set on exiting duty point	%	66%	63%	61%	59%	64%
Operating hours of the pump	h/y	5840	5840	7300	3285	4015
Annual energy saving	kWh/y	14,153	37,414	44,214	44,908	23,275
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	0.96	0.96	1.15	1.15	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.08	0.08	0.1	0.1	0.1
Total Investment	Rs. Lakh	1.63	1.63	1.84	1.84	1.84
Payback Period	Months	17	7	6	6	12

Table 41: Cost Benefit analysis for replacement of pumps - XI











Rated Parameters	UOM	Sithora	Sithora No	Veer Bhatti	Vankhandi	Vankhandi Nath - 2
Flow Delivered	m <sup>3</sup> /h	180	180	80-170	80-170	80-170
Head Developed	m	51	51	69-39	69-39	69-39
Motor Power						
Consumption	kVV	37.3	37.3	24.5	24.5	24.5
Measured Parameters						
Flow Delivered	m³/h	185	144	97	135	137
Total head	m	45.38	49.63	55.2	47.33	47.33
Power of the motor	kW	41	39	26	38	39
Calculated efficiency	%	55%	50%	55%	46%	46%
of pump set	70	5578	5078	5578	4078	4078
Proposed Parameters						
Flow of the pump	m³/h	185	144	97	135	137
Total head	m	45.38	49.63	55.2	47.33	47.33
Power of the motor on exiting duty point	kW	36.54	31.99	24.22	29.01	29.49
Proposed Efficiency of pump set on exiting duty point	%	67%	65%	65%	65%	65%
Operating hours of the pump	h/y	2190	1460	7300	5110	3650
Annual energy saving	kWh/y	13,834	20,258	15,439	46,878	34,039
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.63	1.63	1.15	1.15	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.14	0.14	0.1	0.1	0.1
Total Investment	Rs. Lakh	2.36	2.36	1.84	1.84	1.84
Payback Period	Months	26	18	18	6	8

Table 42: Cost Benefit analysis for replacement of pumps - XII

Rated Parameters	UOM	Veer Sawarkar Nagar	Sanjay Nagar No - 1	Sanjay Nagar No - 2	Suresh Sharma Nagar - 2	Karam Chari Nagar
Flow Delivered	m³/h	80-170	80-170	180	80-170	80-170
Head Developed	m	69-39	69-39	51	69-39	69-39
Motor Power Consumption	kW	24.5	24.5	37.3	24.5	24.5
Measured Parameters						
Flow Delivered	m³/h	179	148	157	180	181
Total head	m	44.28	46.33	49.38	44.33	39.28











Rated Parameters	UOM	Veer Sawarkar Nagar	Sanjay Nagar No - 1	Sanjay Nagar No - 2	Suresh Sharma Nagar - 2	Karam Chari Nagar
Power of the motor	kW	43	39	39	42	42
Calculated efficiency of pump set	%	50%	48%	55%	52%	46%
Proposed Parameters						
Flow of the pump	m³/h	179	148	157	180	181
Total head	m	44.28	46.33	49.38	44.33	39.28
Power of the motor on exiting duty point	kW	35.36	30.67	33.90	35.72	31.68
Proposed Efficiency of pump set on exiting duty point	%	66%	66%	67%	66%	66%
Operating hours of the pump	h/y	2920	5840	5840	3650	5840
Annual energy saving	kWh/y	23,441	48,517	27,257	23,473	60,349
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Investment of new pump set (including GST)	Rs. Lakh	1.15	1.15	1.63	1.15	1.15
Investment of NRV replacement (including GST)	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment of gate valve replacement (including GST)	Rs. Lakh	0.29	0.29	0.29	0.29	0.29
Investment of apparatus for web based dashboard (including GST)	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of Installation and Commission Cost (including GST)	Rs. Lakh	0.1	0.1	0.14	0.1	0.1
Total Investment	Rs. Lakh	1.84	1.84	2.36	1.84	1.84
Payback Period	Months	12	6	13	12	5

#### 6.2.2 EEM : Lighting Optimization for Pumping stations

**Existing Condition:** Presently, there are only 100 W & 60 W and incandescent bulbs that are used to illuminate the pumping stations of Bareilly.

**Recommendation:** It is recommended to replace all existing lighting system with energy efficient lighting system.

**Cost Benefit Analysis:** Estimated annual energy savings is about 14914 kWh per year which is would amount to Rs. 1.19 Lakh per year in the monetary terms. Estimated investment, would be about Rs. 0.22 Lakh and the simple payback period is less than 3 months.

The calculations leading to estimation of savings and payback period is presented in Table 42:

Table 43: Cost benefit analysis for replacement of illuminations

Pumping Station	Pumping Station		LED as replacement of Bulb		Average Operating hours per annum	Annual saving (kWh/ Y)	Tariff (Rs. /kWh)	Annual saving (Rs. / y)	Investment Rs.	Payback (months)
	No.	Rating (W)	Rating (W)	Rs./ Unit		.,				
Civil Lines – 6	1	100	15	400	4380	372	7.95	2960	400	2
Civil Lines – 7	1	100	15	400	4380	372	7.95	2960	400	2











Pumping Station	E	Bulb	LED replace of Bu	as ment Jb	Average Operating hours per annum	Annual saving (kWh/ Y)	Tariff (Rs. /kWh)	Annual saving (Rs. / y)	Investment Rs.	Payback (months)
	No.	Rating (W)	Rating (W)	Rs./ Unit		.,				
Jublee Park – 2	1	60	15	400	4380	197	7.95	1567	400	3
Jublee Park – 8	1	60	15	400	4380	197	7.95	1567	400	3
Jublee Park – 9	1	60	15	400	4380	197	7.95	1567	400	3
Rampur Bagh	1	60	15	400	4380	197	7.95	1567	400	3
Gher Jafar Khan	1	100	15	400	4380	372	7.95	2960	400	2
Jagatpur	1	200	30	650	4380	745	7.95	5920	650	1
Govt. Inter College	1	60	15	400	4380	197	7.95	1567	400	3
Moti Park	1	100	15	400	4380	372	7.95	2960	400	2
Kishore Bazar	1	60	15	400	4380	197	7.95	1567	400	3
C.I. Park – 3	1	60	15	400	4380	197	7.95	1567	400	3
Harijan Park	1	100	15	400	4380	372	7.95	2960	400	2
C.I. Park – 7	1	60	15	400	4380	197	7.95	1567	400	3
C.I. Park – 8	1	60	15	400	4380	197	7.95	1567	400	3
Brahmpura	1	60	15	400	4380	197	7.95	1567	400	3
Modal Town – 1	1	100	15	400	4380	372	7.95	2960	400	2
Stadium	1	100	15	400	4380	372	7.95	2960	400	2
Deen Dayal Puram – 1	2	60	15	400	4380	197	7.95	1567	800	6
Deen Dayal Puram – 2	1	100	15	400	4380	372	7.95	2960	400	2
Patel Nagar – 1	1	150	15	400	4380	591	7.95	4701	400	1
PWD Colony	1	100	15	400	4380	372	7.95	2960	400	2
Bankey Bihari	1	100	15	400	4380	372	7.95	2960	400	2
Janakpuri	1	100	15	400	4380	372	7.95	2960	400	2
Harttman	1	60	15	400	4380	197	7.95	1567	400	3
Bagarganj – 1	1	100	15	400	4380	372	7.95	2960	400	2
Subhash Nagar – 1	1	60	15	400	4380	197	7.95	1567	400	3
Subhash Nagar – 2	1	100	15	400	4380	372	7.95	2960	400	2
C B Ganj – 1	1	60	15	400	4380	197	7.95	1567	400	3
C B Ganj – 2	1	60	15	400	4380	197	7.95	1567	400	3
Suresh Sharma										
Nagar – 1	1	60	15	400	4380	197	7.95	1567	400	3
Gandhi Udhyan	1	60	15	400	4380	197	7.95	1567	400	3
Nawada Shekhan	1	60	15	400	4380	197	7.95	1567	400	3
Azad Inter College	1	100	15	400	4380	372	7.95	2960	400	2
Koharapeer	1	60	15	400	4380	197	7.95	1567	400	3
Jatav Pura	1	60	15	400	4380	197	7.95	1567	400	3
Gangapur	1	60	15	400	4380	197	7.95	1567	400	3
Tilak Inter College	1	100	15	400	4380	372	7.95	2960	400	2
Baljati	1	100	15	400	4380	372	7.95	2960	400	2
Police Line	1	60	15	400	4380	197	7.95	1567	400	3
Saidpur Hakins	1	100	15	400	4380	372	7.95	2960	400	2
Sanoa	1	60	15	400	4380	197	7.95	1567	400	3
Ramganga Nagar No - 1	1	60	15	400	4380	197	7.95	1567	400	3
Ramganga Nagar No	_		45	400	4000	407	7.05	4507	400	<u>^</u>
- 2	1	60	15	400	4380	197	7.95	1567	400	3
Qazi House	1	60	15	400	4380	197	7.95	1567	400	3











M

Pumping Station	Bulb		LED as replacement of Bulb		Average Operating hours per	Annual saving (kWh/ Y)	Tariff (Rs. /kWh)	Annual saving (Rs. / y)	Investment Rs.	Payback (months)
	No.	Rating (W)	Rating (W)	Rs./ Unit	annann	• ,				
Chawai	1	60	15	400	4380	197	7.95	1567	400	3
Thana Qila	1	100	15	400	4380	372	7.95	2960	400	2
Sithora No – 1	1	100	15	400	4380	372	7.95	2960	400	2
Vankhandi Nath – 1	1	60	15	400	4380	197	7.95	1567	400	3
Veer Sawarkar Nagar	1	60	15	400	4380	197	7.95	1567	400	3
Sanjay Nagar No – 1	1	60	15	400	4380	197	7.95	1567	400	3
Sanjay Nagar No – 2	1	60	15	400	4380	197	7.95	1567	400	3
Suresh Sharma										
Nagar – 2	1	60	15	400	4380	197	7.95	1567	400	3
Karam Chari Nagar	1	60	15	400	4380	197	7.95	1567	400	3
Total						14905		118572	22250	











## 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 collected for last three financial years along with other cost related with operation of pumping station. Details of R & M and other cost associated with pumping stations are provided in table 43.

Table 44: R&M and O&M expenses for Bareilly

Financial Data	Units	Values
Cost of Repair & Maintenance in FY2014 - 2015	Rs. Lakh	95.50
Cost of Repair & Maintenance in FY2015 - 2016	Rs. Lakh	97.00
Cost of Repair & Maintenance in FY2016- 2017	Rs. Lakh	100
Cost of Energy & Operation in FY2014 -2015	Rs. Lakh	1416.46
Cost of Energy & Operation in FY2015-2016	Rs. Lakh	1663.55
Cost of Energy & Operation in FY2016-2017	Rs. Lakh	1676.00
Cost of Purchase of new pump/motors/accessories in FY2014-2015	Rs. Lakh	37.49
Cost of Purchase of new pump/motors/accessories in FY2015-2016	Rs. Lakh	41.73
Cost of Purchase of new pump/motors/accessories in FY2016 -2017	Rs. Lakh	51.96

As per the above table, the cost of operation includes cost associated with the contract persons involved in terms of their salaries and the chemicals used during repair and maintenance of the pump sets.

After implementation of energy efficiency interventions provided in this report, the repair and maintenance cost for the pumps will reduce drastically due to replacement of existing pumps with new pumps. The equipment manufacturers selected by EESL will be responsible for carrying out repair and maintenance activities during the contract period.











# 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 6.



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:

i. 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 tax as on actual basis; and
- vi. Capitalized interest during the Project Implementation Period.

Details of project capital cost are provided in Table 44 below:

#### Table 45 : Project Capital Cost

Capital Cost Related assumption	Unit	Value
Number of Pumps	No.	60
Total Cost of Equipment including installation, commissioning and testing	INR lakhs	163.61
Cost of pump including motor	INR lakhs	118.46
Cost of NRV	INR lakhs	13.16
Cost of Gate valve	INR lakhs	17.40
Cost of Web based dashboard	INR lakhs	4.61
Installation and Commissioning Cost including testing charges	INR lakhs	9.98
EESL's administrative and establishment charge	%	5
Cost of preparation of IGEA report including EESL service charges and applicable GST	INR lakhs	4.80
Total Project Cost w/o Capitalized interest	INR lakhs	176.59
Commissioning Details		
Total Months for Commissioning	months	9
Capitalized interest	INR lakhs	9.9
Total Project Cost	INR lakhs	186.49

### 8.2 Operating Costs (OPEX)

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

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

Details about project operating cost are provided in Table 32.

Table 46 : 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. Financing terms and tax related assumptions are provided in Table 46:











#### Table 47 : 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		
Income tax rate		34.6
Income tax rate	%	30
Surcharge	%	12
Education Cess	%	3
Goods and Service Tax (GST)	%	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 are provided in Table 47.

Table 48 : Annuity payment to EESL

Year		1	2	3	4	5	6	7	Total
Calculations of annuity payme	Calculations of annuity payment								
Total Debt to be repaid	INR lakh	32.24	30.19	28.14	26.09	24.03	21.98	19.93	182.60
Principal Repayment	INR lakh	18.65	18.65	18.65	18.65	18.65	18.65	18.65	130.55
Interest	INR lakh	13.59	11.54	9.49	7.44	5.39	3.33	1.28	52.06
Total Equity Repayments	INR lakh	20.95	18.99	17.04	15.08	13.13	11.17	9.21	105.57
Recovery of equity	INR lakh								
investment		7.99	7.99	7.99	7.99	7.99	7.99	7.99	55.95
Return on equity	INR lakh	12.96	11.00	9.04	7.09	5.13	3.18	1.22	49.62
R&M Charges	INR lakh	0.00	2.45	4.09	4.91	5.73	6.14	6.54	29.86
EESL's administrative and	INR lakh								
establishment charge		7.46	7.83	8.22	8.64	9.07	9.52	10.00	60.74
Annuity Payment to EESL	INR lakh	60.65	59.47	57.49	54.71	51.95	48.81	45.69	378.77
Goods and Services Tax on	INR lakh								
annuity payment		10.92	10.70	10.35	9.85	9.35	8.79	8.22	68.18
Annuity Payment to EESL incl.	INR lakh	74 57	70.47	07.04	04 50	04.04	<b>F7</b> 00	50.04	140.05
all applicable taxes		/1.5/	70.17	67.84	64.56	61.31	57.60	53.91	446.95
ULB Savings									
Total Savings	INR lakh	235.57	232.37	227.93	222.13	214.81	205.81	194.94	1533.56
Profit to ULB	INR lakh	164.01	162.20	160.10	157.57	153.50	148.21	141.03	1086.61
% of savings with ULBs	%								70.86%











### 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. Project sensitivity analysis is provided in Table 48.

Change in Capital Cost	% of savings retained by the utility
-10%	73.54%
-5%	72.20%
0%	70.86%
5%	69.51%
10%	68.17%
Change in Interest(ROE, Interest, D/E ratio)	% of savings retained by the utility
-10%	67.62%
-5%	69.32%
0%	70.86%
5%	72.24%
10%	73.51%

#### Table 49 : Project sensitivity analysis

#### 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.

#### 8.6.1 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). The BEP is the most stable operating point for a centrifugal pump. At the BEP, the hydrodynamic unbalanced load of the centrifugal 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.

#### 9.1 Observation

- 1. The electrical connections are found to be unsafe with no proper insulation. Electrical distribution panels & motor control panel are found to be in bad condition.
- 2. It was observed during the audit that there were water leakages in the pumping system. The leakage can be closed by maintenance and replacement of existing gate valve and NRVs. After seeing this kind of condition, it was understood that there is certain possibility of energy saving in the water system



























Figure 10: Key Observations at the Bareilly Pumping Stations

- 3. It has been observed that due to the ageing of the pumps currently present in the plant premise, its efficiency and performance is badly affected as the installed pump are around 10-12 years old. It is suggested that installation of new energy efficient pump will lead to energy savings.
- 4. The installed lighting system in the premises were also analyzed and it was suggested that the energy efficient lighting system would lead to significant amount of energy savings.











# **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

- 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 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

### 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

#### 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

### 3. Pre and post implementation assessment

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

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

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

#### ii. Flow rate (m3/hr)

Data Unit	m <sup>3</sup> /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

### 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 49.

Table 50: 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	$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$
		$\frac{P_1}{P_2} = (\frac{N_1}{N_2})^3$
		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 increases by 0.75%
		If the post implementation voltage is 10% lower than pre











Factor Affecting	Rationale for adjustment	Adjustment to be made
		implementation voltage, power consumption will increase by 2%

#### 5. Determination of Savings

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

$$\% \ savings \ (s1) = \frac{\left(\left(kWpre1 - kWpost1\right)Xh1\right) + \left(\left(kWpre2 - kWpost2\right)Xh2\right) + \dots \dots}{\left(kWpre1Xh1\right) + \left(kWpre2Xh2\right) + \dots \dots}$$

- 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<sub>pre</sub> 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

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

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

 $e1 = kWpre1 X hour1 + kWpre2 X hour2 + \cdots \dots \dots$ 

- 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, as shown in Table 50.

Risk	Key Incidence of risk	Description	Mitigation Measure	
<b>Operational Risk:</b> Us These risks are usuall	age risks are usu y beyond the con	ally a direct consequence of use of equip trol of the ESCO	ment by the end users.	
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, a 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 a	and factors includi	ng suppliers of technology, maturity of te	chnology and consumers	

Table 51: Financial Risk Analysis and Mitigation











Risk	Key Incidence of risk	Description	Mitigation Measure
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 increases the project risk, where the project is dependent on capability of single vendor to supply quality products in required quantity in a pre-determined time frame. Ineffective competition may lead to installation of inferior quality product and also cause delay in implementation.	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 mature industry with many suppliers
Age of the technology	EESL	Mature technologies are by nature stable and more dependable than new technologies. The performance standards for mature technologies are also well defined. There are many inherent risks associated with a new technology, which include price fluctuations, rapid technology improvements (which could lead to project being more effective later, i.e. early adopters curse <sup>7</sup> ), lesser awareness about technology shortcomings and effects.	Pumping is a mature technology with key technical parameters and fundamentals remaining relatively constant during the past century.
Financial Risk: The f	inancial risk mair gated properly, a	ly deals with the cost escalations associa ffect the profitability and feasibility of the r	ted with 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, manufacturers' budgetary quotations are taken while developing the IGEA.

<sup>7</sup> 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	Description	Mitigation Measure
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 labour 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 and annual maintenance at the rate mentioned in its bids. The risk is transferred to the technology provider post bidder selection.	For the ULB, the mitigation measures are same as above
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
<b>Design and construc</b> ESCO project.	tion risk: Impro	pper design and delays in constructions are	a significant risk to
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 minimizing 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 to 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	The manufacturers and technology suppliers are engaged since the project inception including overseeing energy audit activities and selection of











Risk	Key Incidence of risk	Description	Mitigation Measure
		of savings as estimated. It could also lead to not meeting the performance parameters from the baseline scenario	technology. Further, the manufacturers should be encouraged to visit the facility before bidding for the project.
Performance risks: F performance could lear returns for the project	Related to perfor ad to reduced sa	mance of energy efficient equipment post vings from the ESCO project. This may re-	implementation. Poor sult in poor financial
Equipment performance depreciation	EESL / Technology Supplier	<ul> <li>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 depreciation.</li> <li>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.</li> <li>External conditions: These conditions include various external parameters including power quality and operating condition (flow output and pump submergence) deviating from the design</li> </ul>	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 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	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











Risk	Key Incidence of	Description	Mitigation Measure	
	risk			
		EESL/technology supplier's 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.	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 L	egal Risk	1		
Reduction of water level Utilization of old	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, it might result in other long term effects including desertification. If the collected inefficient pumps are not destroyed, they could be used again	Change in operation guidelines, i.e. reduction in water supply hours if the flow is increased.	
inventory in other areas	EESL	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.	inventory.	
Health, Safety and S	ocial risk			
Health Safety and Social risk	ULB and EESL	<ul> <li>As principal employer, EESL is responsible for these risks including:</li> <li>Nonpayment of minimum wages</li> <li>Child labour</li> <li>Insurance for workers</li> <li>Emergency preparedness, fire &amp; electrical safety</li> <li>Safety of tools and equipment used</li> </ul>	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 51.

Table 52: Project Implementation Schedule

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

Sr. No	Activity	ТО	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.











## Annexure

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. Vendor Quotes









