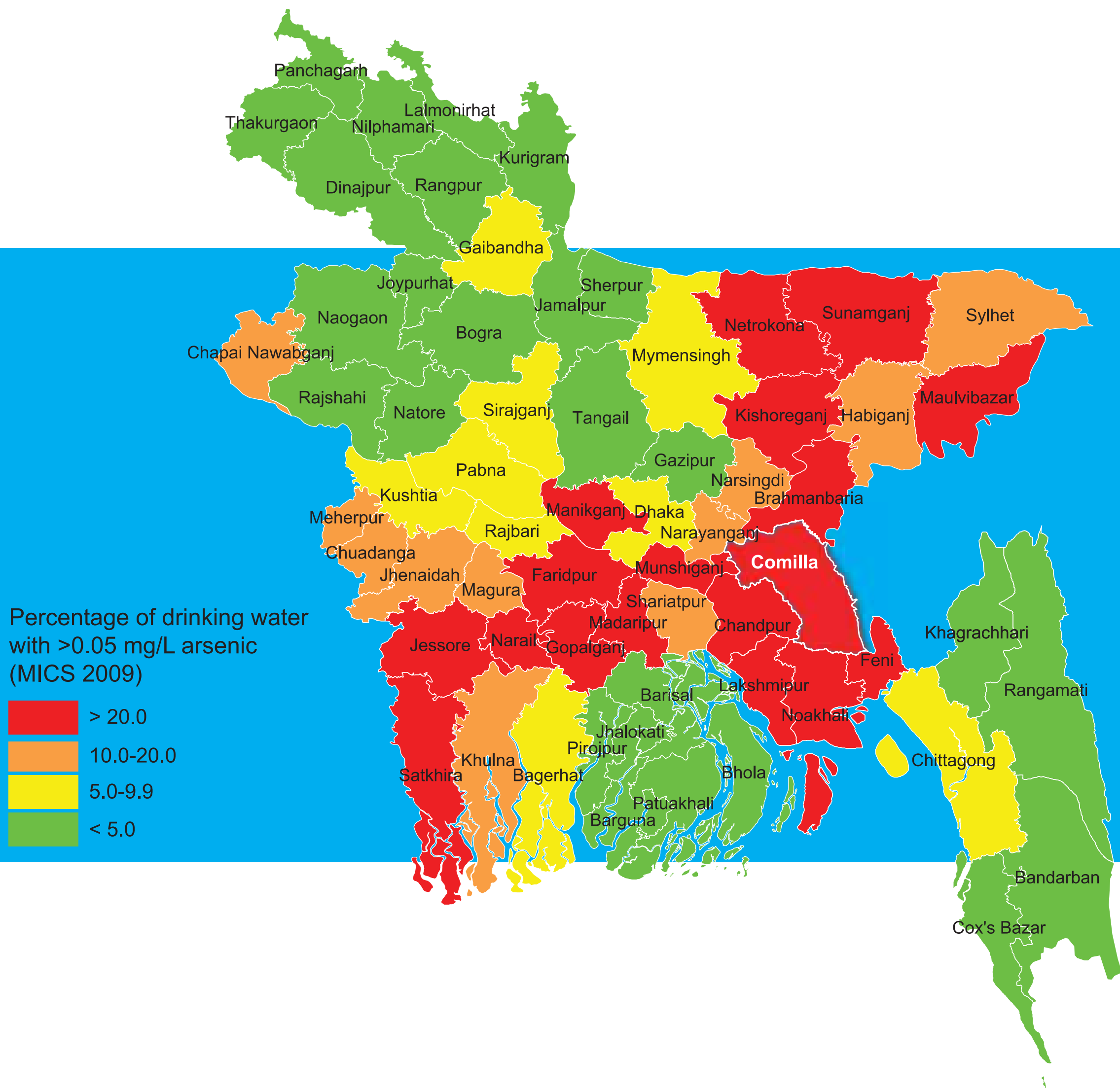
Making Economic Sense for Arsenic Mitigation: A Case Study of Comilla District, Bangladesh



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Abstract

Naturally occurring Arsenic in the groundwater of Bangladesh is a significant public health problem for millions of people. Using new arsenic in drinking water survey data obtained during the 2009 Multiple Indicator Cluster Survey (MICS) and all-cause mortality hazard ratios recently established by the Health Effects of Arsenic Longitudinal Study (HEALS) based on arsenic exposure in a Bangladesh population, it is possible to estimate the population fraction of mortality attributable to arsenic in Bangladesh. The lost productivity due to this mortality burden as a fraction of Gross Domestic Product (GDP) can also be estimated.

Using the distribution of arsenic concentrations in the MICS drinking water survey of 2009 and the district populations from the Bangladesh Bureau of Statistics 2001 census (country total 124,272,764), the population exposed to concentrations greater than 50 μg/L is estimated to be 17.9 million. If using the projected total population of 150 million in 2009, the population exposed to greater than 50 μg/L would then be 21.6 million. With the HEALS mortality hazard ratios, the population fraction estimates of district-level mortality attributable to arsenic range between less than 1% to as high as 17.5%. Based on 2001 census population data, these fractions can be translated into almost 68,000 arsenic-attributable deaths per year across the country and is likely to be higher. Thus, a conservative estimate of the portion of GDP to be lost from arsenic-attributable mortality over the next 20 years is between US$ 6.1-20.1 billion depending on discount rate selected.

When the cost analysis of lost productivity due to pre-mature death was similarly performed at sub-district level for a hard hit district Comilla where a large fraction of existing tube wells are contaminated with concentration reaching hundreds of μg/L, losses ranged from US$ 0.5 to 1.67 billion for a discount rate from 5% to 15% over 20 years. To provide 100% safe water coverage to the 2.9 million people in Comilla who are still in need of safe water options, the investment costs for water supply over the next 20 years ranges from US$ 49.2-85.4 million depending on the technology scenario and discount rate selected. Thus, the estimated economic losses due to arsenic exposure in drinking water at current levels are at least 10 times of the costs of providing complete safe water coverage to the exposed population in Comilla. Whereas cost is an important factor, selection of the most appropriate safe-water technology for an area will depend on hydrogeochemical conditions, public health risks, and social acceptability by the community.

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1. Background

Arsenic is a naturally occurring element in the environment which can have profound effects on a population that is chronically exposed through a common route like drinking water. Exposure to arsenic through groundwater is a public health problem facing many countries, but the extent of the problem faced by Bangladesh stands out. According to the British Geological Survey (BGS), "the groundwater Arsenic (As) problem in Bangladesh arises because of an unfortunate combination of three factors: a source of As (As is present in the aquifer sediments), mobilization (As is released from the sediments to the groundwater) and transport (As is flushed in the natural groundwater circulation)" (BGS 2000).

Described as the largest mass poisoning of a population in history, survey data from the early 2000s estimated 35-77 million people in the country have been chronically exposed to elevated concentrations of arsenic in their drinking water (Smith 2000). The high dependence on hand-pumped tube wells, up to 95% of the population in rural areas (Caldwell 2003), installed since the 1970s with the intention of reducing water-borne diseases, has resulted in a highly exposed population with limited options for arsenic-safe alternatives. These affordable shallow tube wells draw groundwater from a shallow aquifer 10-70 m below the surface and in some areas over 99% of the wells are contaminated with arsenic concentrations higher than the Bangladesh national standard of 50 μg/L (DPHE & JICA 2010). After a national effort to test and identify arsenic-safe wells, efforts to promote well-switching have had partial success, but often the behavior change is not sustainable and has social limitations. And in the most contaminated areas there may be few if any arsenic-safe water options available and so alternatives need to be provided. Effective mitigation of arsenic exposure will likely require a sizeable investment into the water supply infrastructure of the country.

Epidemiologic studies have linked chronic arsenic exposure to a range of visible symptoms from skin lesions to death caused by cancers and cardiovascular diseases, etc. Given the extent of exposure in the Bangladesh population, widespread mitigation interventions may seem a costly enterprise, but viewed from an economic standpoint the costs associated with this health burden to the population can be just as sizeable, and in fact may far outweigh the required investment in mitigation technology to avoid these future costs. However, such cost analysis has rarely been done.

Bangladesh is divided into 64 Districts, with Comilla district one of the hardest hit by arsenic contamination in groundwater. The Bangladesh National Water Standard for Arsenic is 50 μg/L, whereas the WHO guideline value is only 10 μg/L. Using the Bangladesh standard to designate a "contaminated" well, a DPHE/JICA situation analysis in 2009 found that the percentage of contaminated wells is over 70% in 9 of the 16 Upazilas of Comilla district (DPHE & JICA 2010). Similarly, an analysis on the limited number of currently active arsenic-safe water points in the district found that 8 Upazilas lack enough public points to provide safe water coverage for more than 30% of the population.

This paper aims to focus on Comilla district specifically, as an example of a district-level analysis of the costs of current arsenic exposure if left unaddressed as compared to the costs of implementing various mitigation technology scenarios. Given the level of exposure and shortage of safe-water options available in the district, it is a particularly relevant exercise that can be recreated in other high-priority areas, as well as country-wide.

2. The Cost of Current Arsenic Exposure

2.1 Health Effects of Arsenic in Drinking Water

The health effects of drinking arsenic-contaminated water are often delayed, with a latency period of as short as several years to as long as several decades. This means that the incidence of arsenic related diseases and mortality can reasonably be expected to increase in the future as a result of past and continuing exposure to arsenic in this large population (Smith 2000).

The most noticeable result of arsenic exposure is skin lesions, which are believed to have a latency period of around 10 years, but have been found in children at a younger age (Milton & Rahman 1999). Skin lesions, along with other arsenic related diseases appear to be dose-dependent. Other long-term health effects of exposure to arsenic include various cancers like skin, bladder, kidney, and lung (Chen, Kuo & Wu 1988, Chen, Chen, Wu & Kuo 1992, Smith, Goycolea, Haque & Biggs 1998), which can have a latency period of several decades, as well as hypertension and cardiovascular disease, pulmonary disease, peripheral vascular disease, diabetes mellitus, and neurological effects (Smith 2000). Formerly most of the health impact assessments in Bangladesh were based on transferring the results of population studies in Taiwan or other countries to make estimates about the local population. For example using dose-specific relative risk estimates from Taiwan, Chen and Ahsan estimated at least a doubling of lifetime mortality risk from liver, bladder, and lung cancers (Chen & Ahsan 2004). But applying risk estimates from a different population has shortcomings. In fact, per capita water consumption for drinking purposes in a rural arsenic-affected population in Bangladesh has been found to be higher than for populations in both the US and Taiwan, which might contribute to much higher lifetime cancer mortality and other morbidity risks due to a higher burden of arsenic among the Bangladesh population compared to these other countries (Milton, Rahman, Smith, Shrestha & Dear 2006).

Despite the epidemiological evidence associating arsenic exposure with various adverse health effects, a quantitative assessment of the health impacts linked to elevated arsenic concentrations in drinking water is difficult. Studies that compare mortality rates of populations differentially exposed to arsenic concentrations risk the "ecological fallacy" in assuming that relationships visible at the population level would also hold at the individual level (Wu, Kuo, Hwang & Chen 2004). Other studies have focused on testing whether arsenic in drinking water is associated with an elevated risk of a specific cancer or disease, but few papers have attempted to analyze the risk of all-cause mortality with arsenic contamination (Maddison, Catala-Luque & Pearce 2005).

New findings from the Health Effects of Arsenic Longitudinal Study (HEALS) in Bangladesh provide information on increased overall mortality and chronic-disease mortality associated with arsenic, quantifying a range of arsenic exposures as well as other confounding characteristics to the individual level, a significant advance over previous ecological studies (Argos et al 2010). A nearly 70% increase in all-cause mortality was observed among those exposed to the highest concentration of arsenic (150.1-864.0 μg/L) compared to those exposed to not more than 10.0 μg/L. The prospective cohort study found that mortality rate increased at all concentrations of arsenic in well water, indicating an increasing risk trend rather than threshold effect. After adjustment for potential confounding factors, the investigators estimated the summary attributable proportion of all-cause and chronic-disease mortalities based on the arsenic concentration in well water to be 21% and 24% respectively (Argos et al 2010). In other words, 21% of all-cause deaths in this study population in Araihazar, Bangladesh, could be attributed to arsenic exposure in well water.

The HEALS study used their mortality data to calculate adjusted mortality hazard ratios for 3 levels of increasing arsenic exposure, in comparison to the reference exposure group of 0.1-10 μg/L. Since these results provide significant advances over previous arsenic risk studies by quantifying exposures to the individual level, measuring all-cause mortality, and being based on a population cohort in Bangladesh, these mortality hazard ratios offer an updated tool for estimating the country-wide arsenic-attributable mortality burden. Table 1 shows the calculated mortality hazard ratios related to baseline arsenic exposure in well water, which are multivariate estimates adjusted for age, sex, body-mass index, systolic blood pressure, education, and smoking status. The ratios in relation to individual arsenic dose (μg per day) and total arsenic in urine (μg/g) were also reported in the study and were found to have similar mortality risks as exposure from well water.

Table 1: Hazard Ratio (HR) for mortality in participants in relation to baseline arsenic exposure

Arsenic (μg/L) in well water	All-cause mortality, HR (95% CI)	Chronic-disease mortality, HR (95% CI)
0.1 – 10.0	1.0	1.00
10.1 – 50.0	1.34 (0.99 – 1.82)	1.33 (0.94 – 1.87)
50.1 – 150.0	1.09 (0.81 – 1.47)	1.22 (0.87 – 1.70)
150.1 – 864.0	1.68 (1.26 – 2.23)	1.68 (1.21 – 2.33)

2.2 Estimating Population Exposure and Arsenic-Attributable Mortality

For estimating the health and mortality impact of arsenic, the population attributable fraction (PAF) can be calculated. Specifically, this measure estimates how much of the disease burden in a population could be eliminated if the effects of a certain causal exposure were eliminated from that population (Rockhill, Newman & Weinberg 1998). In this analysis the disease of interest is actually all-cause mortality, and the exposure is arsenic concentration in drinking-water. A population attributable fraction can also be quantitatively distributed into exposure-level fractions, individually comparing different exposure level categories to the unexposed reference group. The PAF calculation is a function of the proportion of total cases (deaths) in the population (*pdi*) arising from the each exposure category *i* and the relative risk for that exposure category (*RRi*).

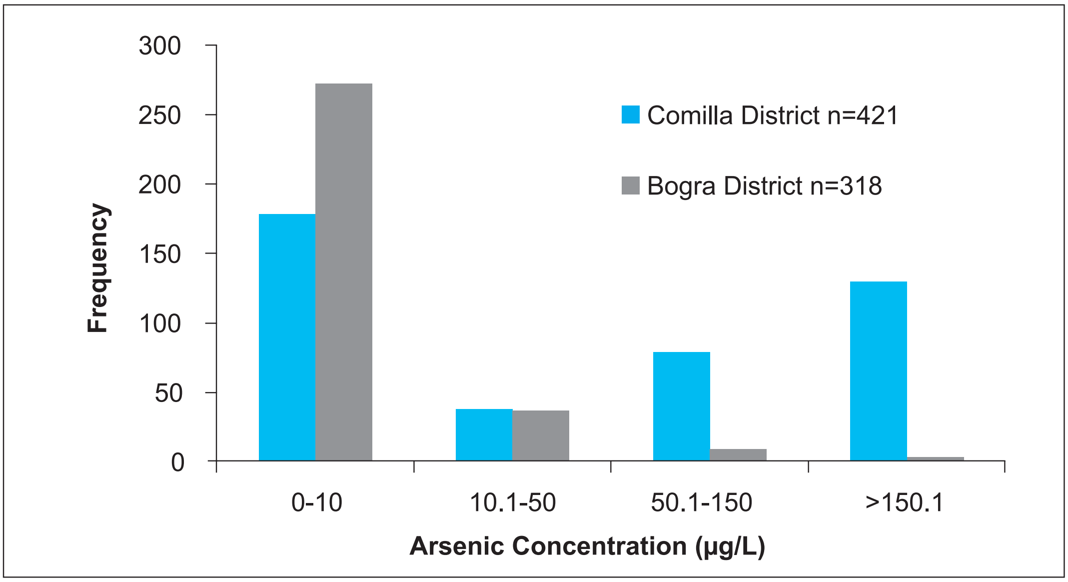
Figure 1: Population Attributable Fraction (PAF) Equation

$$\sum_{i=0}^{k} pdi \left(\frac{RRi-1}{RRi}\right)$$

This particular PAF equation in Figure 1 is for use with multi-category exposures to produce an internally valid estimate when confounding exists and adjusted relative risks must be used (Rockhill, Newman & Weinberg 1998). Treating the HEALS mortality hazard ratios as the risk ratios for calculating a PAF, 0.1-10 μg/L becomes the reference category (RR=1), so 10.1-50 μg/L is the low exposure level, 50.1-150 μg/L is medium exposure level, and >150.1 μg/L is high exposure level.

To estimate the population fraction of arsenic attributable mortality using these ratios however, it is necessary to determine the proportion of the case population exposed to each level of arsenic concentration. The Multiple Indicator Cluster Survey (MICS) in 2009 included a national drinking water quality survey in which arsenic tests were performed on samples of drinking water obtained from randomized households, selected to the upazila level (UNICEF 2010a). Using these randomized samples as an indicator for actual population exposure, it is possible to estimate the proportion of district populations exposed to each level of arsenic concentration. Number of samples collected from each of the 64 districts in the MICS survey ranges from 100 to 421. Furthermore, the distribution of arsenic concentrations varies greatly across the districts when individual districts are compared as an example (Figure 2). Using these distributions and the district populations from the Bangladesh Bureau of Statistics 2001 census (country total 124,272,764), the population exposed to concentrations greater than 50 μg/L is estimated to be 17.9 million, which is similar to previous estimations of country-wide arsenic exposure. Given that the 2011 census is expected to find a significant increase in population over the past decade, the exposed population can be considered an underestimation.

Figure 2: Frequency of Drinking Water Arsenic Concentrations in 2 Districts



Source: MICS data 2010

The PAF estimate considers both the risk at a given arsenic concentration and the proportion of cases exposed to that concentration. In this estimation "case" refers to a death, so when considering the future health impact from arsenic across districts the entire present population can be considered an expected case. Using the HEALS mortality ratios and the distribution of drinking water samples from the MICS survey as an indicator of district exposure levels, a PAF estimate can be calculated for each district of Bangladesh, as seen below in Table 2. These fractions range between less than 1% and up to 17.5% of district-level mortality as attributable to arsenic. Seven of 64 districts have PAFs greater than 15%, and 22 of 64 have PAFs greater than 10%. Although these are just estimates using available relevant data, they still demonstrate a significant role of population arsenic exposure at current levels on mortality. Using the national crude death rate of 7 deaths/1000 population (UNICEF 2009), this fraction estimate can be translated into over 68,000 arsenic-attributable deaths per year across the country.

Table 2: Population Attributable Fraction for Arsenic Mortality in 64 districts of Bangladesh

District	PAF
	Highest (≥15%)
Gopalganj	0.175
Faridpur	0.169
Comilla	**0.161**
Madaripur	0.153
Chandpur	0.147
Satkhira	0.146
Sunamganj	0.145
	High (10% - 15%)
Netrokona	0.137
Noakhali	0.137
Meherpur	0.135
Habiganj	0.119
Jessore	0.119
Lakshmipur	0.118
Chuadanga	0.117
Manikganj	0.115
Brahmanbaria	0.114
Narail	0.111
Kishoreganj	0.109
Gaibandha	0.106
Jenaidah	0.103
Magura	0.100
Maulvibazar	0.098
	Medium (5% - 10%)
Sirajganj	0.086
Feni	0.080
Kurigram	0.079
Kushtia	0.077
Pirojpur	0.075
Shariatpur	0.074
Khulna	0.073
Mymensingh	0.072
Chittagong	0.066
Rajbari	0.066
Munshiganj	0.066
Narsingdi	0.066
Jamalpur	0.065

District	PAF
Sherpur	0.063
Tangail	0.063
Sylhet	0.059
Pabna	0.059
Nawabganj	0.055
Nilphamari	0.054
Narayanganj	0.054
Bagerhat	0.045
	Lowest (< 5%)
Naogaon	0.043
Patuakhali	0.043
Rangpur	0.040
Jhalokathi	0.038
Bogra	0.033
Panchagarh	0.032
Lalmonirhat	0.031
Barisal	0.031
Joypurhat	0.029
Dhaka	0.029
Rajshahi	0.029
Bandarban	0.025
Rangamati	0.024
Dinajpur	0.013
Gazipur	0.010
Thakurgaon	0.007
Bhola	0.006
Cox's Bazar	0.006
Natore	0.005
Barguna	0.005
Khagrachari	0.003

Source: Calculations based on Argos et al 2010 and MICS 2009 data

The focus of this paper is on Comilla district specifically. With a district-level PAF of 16.1% and with the highest population among the top 7 districts, Comilla represents the greatest attributable mortality burden in the country. The DPHE/JICA Situation Analysis 2009 reported over 12,000 arsenic skin lesion patients in the district, out of the 37,039 reported nationally within the study area. By using the MICS drinking water sample data collected at upazila-level, the distribution of arsenic exposures and therefore PAFs can be found at this more localized level, and clearly varies just as greatly within the district as in the country (Table 3). From this perspective, the PAF ranges from again less than 1%, to as high as

31.5% in Chandina Upazila. The lowest fractions are for Comilla Sadar, which uses piped systems relying on deep groundwater for the district town instead of the more common shallow tube wells used in rural areas across the district. Without specific district-level mortality data, again the national crude death rate of 7/1000 (UNICEF 2009) must be used in order to estimate a number of arsenic attributable deaths, in this case 5690 per year, based on the current union-level population estimates in the DPHE/JICA 2009 situation analysis.

Table 3: Population Attributable Fraction of Arsenic Mortality for 16 Upazilas of Comilla District

Upazila	PAF
	Highest (≥15%)
Chandina	0.315
Debidwar	0.284
Laksam	0.281
Muradnagar	0.259
Monoharganj	0.246
Daudkandi	0.206
Brahmanpara	0.175
Homna	0.168
Barura	0.157
	High (10% - 15%)
Nangalkot	0.113
	Medium (5% - 10%)
Titas	0.093
Meghna	0.083
Chauddagram	0.074
Burichang	0.065
	Lowest (> 5%)
Sadar Dakshin	0.037
Comilla Sadar	0.01

Source: Calculations based on Argos et al 2010 and MICS 2009 data

2.3 Estimating the Costs of Arsenic Attributable Mortality

Such a significant loss of life attributable to arsenic would have a marked economic impact across the country, especially for the 7 districts with the highest PAF (Table 2). There are many ways of valuing this burden, taking into account the varying forms of economic loss resulting from health impacts and loss of life. But to get a simple estimate of the magnitude of economic loss due to mortality burden alone, since that is what the calculations above have estimated, the perspective of lost work output using GDP per capita can be used. The 2009 GDP for Bangladesh in Purchasing Power Parity (PPP) was estimated to be US $224.9 billion by the IMF (2010). That is an estimated US$ 1,465 per capita GDP for 2009. A few assumptions go into the calculation of predicted GDP lost from arsenic mortality:

- The approximately 5% growth of per capita GDP forecasted by the IMF for the next 5 years will continue over the next 20 years.
- Average years of work output lost per arsenic-attributable life lost is 10 years.

This last assumption is reasonable for several reasons. Aside from visible skin lesions, the most substantial body of evidence for long-term health effects of arsenic relates to various forms of cancer, including skin, bladder, kidney, and lung, and although our present analysis is based on all-cause mortality estimates, cancer is the principle known cause of arsenic-related mortality. Average years of life lost per person dying of cancer in the United States is found to be 15.4 years for all types of cancer, and for the 4 previously mentioned types of cancer the loss ranges from 11-18 years (National Cancer Institute 2006). Life expectancy in the US is higher than in Bangladesh (78 years vs. 65 years, WHO 2009), but considering that with a shorter life expectancy the portion of working-years in Bangladesh is likely higher compared to the US, any significant portion of life lost would significantly reduce lifetime work output. Additionally, given that the prohibitive cost and unavailability of most treatments in Bangladesh may result in earlier deaths compared to the US, as well as a potential period of illness or disability before death in which a person is also unable to work, 10 years of work output lost per arsenic mortality seems like a conservative assumption. Valuing the total costs using only lost productivity from mortality will also likely result in an underestimation of the real health costs of arsenic since treatment costs and other indirect effects on society are not included.

Using these assumptions to calculate the productivity loss as a portion of GDP over the next 20 years, keeping the estimated 5690 deaths per year in Comilla district due to current levels of arsenic exposure constant despite the reasonable expectation for population growth, total costs amount to $1.67 billion, $867 million, and $504 million, discounted at 5%, 10%, and 15% rates respectively. Similarly expanding the calculation to all districts and relying on the most recent district census data from 2001 (BBS 2001), a significant underestimation of present population, the total estimated GDP loss from arsenic mortality is $20.1 billion, $10.5 billion, and $6.1 billion, discounted at 5%, 10%, and 15% rates respectively over a 20 year time-horizon. For the same reasons listed above, these can be considered relatively conservative estimates of the future health costs if current arsenic exposure levels are maintained across the population.

3. The Cost of Arsenic Mitigation

These predicted arsenic-attributable mortality costs over the next 20 years are based on the assumption that arsenic exposure in drinking water remains at current levels. This exposure comes primarily from the high dependence on tube wells across the country drawing from the shallow aquifer in Bangladesh which is heavily contaminated with naturally occurring arsenic. Over 10% of Union Parishads in Bangladesh have over 80% of their tube wells contaminated with arsenic concentrations above the Bangladesh National Standard of 50 µg/L, and many have as high as 99% contamination (DPHE & JICA 2010). In such places where safe water option coverage is low, communities often have no drinking alternatives between arsenic-contaminated tube well water and contaminated surface waters which risk exposure to waterborne diseases. To mitigate the impact of groundwater arsenic contamination, other technologies must be utilized to provide safe water options to the population at risk.

3.1 Mitigation Technology Options

Apart from technologies removing arsenic from contaminated water, potential alternatives for arsenic-safe water options include: Deep Tube Well, Dug Well or Ring Well, Rain Water Harvesting, Pond Sand Filter, and Piped Water Supply Systems. These different water technologies have different installation costs as well as annual maintenance and operation costs as shown later in Table 5.

3.11 Deep Tube Well (DTW)

Deep aquifers in Bangladesh are often separated from aquifers above by a relatively impermeable layer that manages to keep them mostly free of the arsenic contamination found at shallower depths. The BGS/DPHE 2001 study in Bangladesh found that of tube wells with a depth of greater than 150 m, only about 1% have levels of arsenic greater than 50 µg/L, and 5% had arsenic content above 10 µg/L (BGS & DPHE 2001). Suitable deep aquifers can be a dependable source of arsenic-safe water making deep tube wells a valuable arsenic mitigation technology in many areas. Other than a difference in depth, deep tube wells have the same functionality and convenience as the widespread shallow tube wells, indicating high social acceptability and ease of introduction.

Deep tube wells, however, may not always be feasible in an area depending on the hydrogeology and water chemistry. Pockets of salinity have been found within Comilla district, rendering some deep tube wells unusable. Groundwater with high levels of iron, manganese, or sulfide for example, may also discourage use of a deep tube well in a community in favor of a shallow tube well contaminated with more harmful but tasteless and odorless arsenic. Identifying the appropriate depth specific to an area for drinking water with low levels of such chemicals is important for ensuring that new wells will be maintained and used by the community.

In areas where deep tube wells are a feasible option, multiple connections to a single tube well can provide increased safe water options to a larger community at a fraction of the cost of installing multiple deep tube wells. It is possible to make 3-4 additional connections with hand pumps up to 600 ft away from the central well. In places where the water table has dropped below 25 ft, a more expensive Tara-dev head pump must be used on the deep tube well instead of the standard # 6 pump, and unfortunately multiple connections are not possible.

3.12 Dug Well (DW)

Water from dug wells in Bangladesh has been found to be relatively free from dissolved arsenic or iron, even in areas of tube well contamination, most likely due to the shallow depth accessing the top layer of the water table. Dug wells, however, are susceptible to bacterial contamination, most commonly through percolation of contaminated surface water. Completely closed dug wells have the best sanitary protection but lose some of the potential benefit of oxygen in reduction of arsenic. After construction water in the well will need to be chlorinated for disinfection. Water can be withdrawn through a manually operated hand pump.

3.13 Pond Sand Filter (PSF)

The National Policy for Arsenic Mitigation has given priority to the use of surface water as arsenic-safe water supply (GOB 2004). Community slow sand filters developed to treat surface waters have been found to produce water that is normally bacteriologically safe if properly maintained. The water from a pond or river is pumped by a manually operated tube well to feed the filter, and the treated water is collected through a tap. The sand in the filter usually needs to be cleaned and replaced every two months. Highly attentive care and maintenance is crucial to produce quality water and community involvement in operation and maintenance is essential to keep the system working. A protected surface water source with low bacterial contamination and low turbidity is ideal.

3.14 Rainwater Harvesting (RWH)

The quality of rainwater is comparatively good and arsenic free, though also lacking in other minerals which may affect the taste experience of users. It can be collected close to the home and the system is easy to maintain. In most of the country adequate rainwater is available for about half of the year, so an uninterrupted water supply throughout the year would require a large storage tank related to the water requirement and rainfall intensity of the area. The storage tank constitutes the main cost of the system. The catchment area for rainwater collection is usually the roof which is connected to the storage tank by a gutter system. Concrete, tile, and metal roofs give clean water but thatched roofs of poorer populations may not be suitable for rainwater collection without the use of plastic sheeting. Collection should begin only after the first rain runoff has washed impurities from the roof. Cleanliness of the roof and storage tank is critical to maintaining good quality water. The storage tank requires cleaning and disinfection at least once in a year. If the tank capacity does not meet the water requirement of the users, the rainwater may not last through the entire dry season.

3.15 Piped Water Supply

Piped water supply is the ideal system of water supply in densely populated areas because water from a safe source can be delivered direct to consumers, protected from external contamination and in adequate quantity. In addition to heavily arsenic-contaminated areas, piped systems also are an option in heavily iron-contaminated areas, which often overlaps with the arsenic areas. Piped water provides similar convenience in collection and use as existing tube wells and can be made available through house connection, yard connection, or stand-post depending on the consumer's ability to pay. Only a single arsenic-safe tube well or water source is needed to provide safe water to an entire community. Motorized pumps can be used to raise water from ground wells to overhead tanks for piped water supply. Careful maintenance and monitoring of water quality is important given the number of users supplied by the system. A monthly user tariff is the expected source of revenue for operation and maintenance costs. This piped water supply option is most feasible for clustered rural populations and is a very promising arsenic mitigation technology.

An evaluation of 112 rural piped water schemes installed between 2001 and 2008 by JICA and DPHE has identified the following reasons for 47 non-operational systems: poor management (n=41), lack of resources for operation and maintenance (n=30), poor maintenance (n=27), want to use but do not want to pay (n=27), other water sources available (n=24), level of arsenic contamination is low (n=23), not willing to use (n=22), irregular subscription (n=18), level of iron contamination is low (n=18), low household density (n=7), piped water not available on a regular basis (n=7), and poor quality of water (n=3). For the systems that are found working well, not surprisingly, the reasons for success are opposite to the reasons of failure (DPHE & JICA 2008). This is just a confirmation that although piped water offers the most promising supply system for the future, there are a number of practical barriers in place now that would need to be addressed for establishing any properly functioning system at this time.

3.2 District Need for Safe Water Options

Each of these arsenic-safe water technologies are options to incorporate into an arsenic mitigation plan for Comilla district. Given the district levels of arsenic contamination and the low coverage of safe water options, there is a considerable need for new water points. In 12 of the 16 Upazilas less than half of the population has access to safe water options, and several Unions have coverage of less than 10% (DPHE & JICA 2010).

Using the Union-level safe water coverage and populations reported in the 2009 DPHE/JICA situation analysis, it is possible to determine the population in need of safe water options and the approximate number of water points necessary to ensure 100% safe water coverage. The number of options needed in Table 4 is calculated based on the Bangladesh national policy of 50 persons served per water option (GOB 1998), an ideal that is still not common practice yet.

Table 4: Need for Safe Water Options in Comilla District, Bangladesh

Upazila	Population in 2009	Population in Need of Safe Water	Proportion in Need	Safe Water Options Needed
Barura	386,426	272,516	70.52%	5450
Brahman Para	198,389	141,580	71.36%	2832
Burichang	283,427	69,355	24.46%	1387
Chandina	294,056	212,912	72.41%	4258
Chauddagram	417,285	161,072	38.60%	3221
Daudkandi	336,728	169,486	50.33%	3390
Debidwar	415,535	337,308	81.17%	6746
Homna	209,289	178,675	85.37%	3574
Laksam	265,039	189,056	71.33%	3781
Meghna	106,006	56,021	52.85%	1120
Monoharganj	230,457	194,903	84.57%	3898
Muradnagar	513,002	344,171	67.09%	6883
Nangalkot	349,523	251,807	72.04%	5036
Sadar Dakshin	485,247	260,417	53.67%	5208
Titas	187,137	77,156	41.23%	1543
Total	**4,677,546**	**2,916,415**		**58,328**

Source: DPHE/JICA 2010, not included: Comilla Sadar (population 516,319)

3.3 Mitigation Technology Unit Costs

Unit costs for each technology option vary by the necessary capital costs for installation, as well as the costs of operations and maintenance annually, which are more of a rough estimation. Total costs are discounted over 20 years since that is the same time-horizon used for calculating expected health costs and because that is perhaps the longest reasonable lifetime for a water point if properly cared for and maintained. The choice of discount rate is based on the current lending rate in Bangladesh, 16.4% (World Bank 2008), but which is traditionally between 10-15%. A 5% discount rate is also used later to match the health costs calculated earlier, which include this lower discount rate to reflect the ongoing debate about discounting long-term health outcomes in which some recommend discounting health benefits at rates lower than costs, such as at less than 5% or not at all (Severens 2004).

Table 5: Technology Option Unit Costs

Technology Option	# People Served	Capital Costs ($)	Annual O&M ($)	DR* 15% for 20 years ($)	Cost/ Capita ($)
Shared Water Point					
Deep Tube well (DTW)	50	745	10	807	16.14
DTW Tara-Dev	50	893	14	981	20.25
Rainwater Harvest (RWH)	50	855	25.5	1015	21.45
Pond Sand Filter (PSF)	50	559	80	1060	24.80
Dug Well (DW)	50	773	80	1273	29.07
Community System					
Pond Sand Filter (30 Households)	150	559	80	1060	7.06
DTW – Multiple Connection	200	1344	40	1594	7.97
Mini-Piped Deep Well	500	9000	1350	17,450	34.90
Village System					
Piped Deep Well	2500	43,285	6780	85,723	34.29
Piped River Abstraction	2500	44,533	6780	86,971	34.79
Piped Impoundment	2500	48,244	7627	95,939	38.39

Sources: GOB 2010, UNICEF 2010a, Koundouri 2005; *DR = Discount Rate

Using the unit costs and total number of water points needed it is possible to calculate the cost of hypothetical mitigation technology scenarios that would provide 100% safe water coverage for the population of Comilla district. Each technology differs in cost but also has its own advantages and disadvantages. Expansion of a single technology option across the district would not be feasible or appropriate for all areas, but to compare the range of costs this scenario is presented in Table 6. Multiple Connection Deep Tube Wells are the most economically efficient when appropriate. Otherwise the total capital costs of most other technologies are very similar, and only when incorporating annual operation and maintenance costs over 20 years do they differ more. A system like piped water supply may have more expensive operations cost that can be covered by user fees, but the convenience and quality of water it provides if properly maintained needs to be taken into consideration also.

Table 6: Hypothetical 100% Coverage Costs of Single Technologies

Technology Option	Total Capital Costs ($ thousands)	Total Present Value, 5% DR* over 20 years ($ thousands)	Total PV, 10% DR over 20 yrs ($ thousands)	Total PV, 15% DR over 20 yrs ($ thousands)
DTW – Multiple Connection (40 HH)	19,595	26,864	4,561	23,246
Deep Tube Well (DTW)	43,431	50,700	48,397	47,082
DTW Tara-Dev	52,093	62,270	59,045	57,204
Rainwater Harvest	49,889	68,425	62,552	59,199
Pond Sand Filter	32,594	90,745	72,320	61,801
Dug Well	45,064	103,216	84,791	74,272
Piped System (500 HH)	50,495	149,062	117,831	100,001

Source: Calculations based on unit costs and water options needed, 50 persons/option except Piped System; *DR=Discount Rate

This scenario is not realistic however, and instead it would be more appropriate to present the scenario hardware costs of a combination of mitigation technologies.

3.4 Mitigation Scenario Costs

3.41 Scenario 1

The first cost scenario is to provide the number of new water points needed in the district by scaling-up only existing technologies. A survey of existing water options was compiled in the Situation Analysis of Arsenic Mitigation 2009 (DPHE & JICA 2010). Based on current proportions of active (operational and arsenic-safe) water points and new water points needed at union-level, a district level combination of necessary technologies can be extrapolated and a total scenario cost reached. Of the 58,328 new water points determined to be needed for 100% safe-water coverage in Comilla at 50 persons per point, the scale-up scenario would require 27,744 deep tube wells, 28,574 deep tube wells with Tara pumps, 1275 rainwater harvesting systems, and 736 dug wells. The technology capital costs would amount to $47.8 million, and total costs over a 20 year horizon are $57.4 million, $54.4 million, and $52.6 million discounted at rates of 5%, 10%, and 15% respectively, as seen in Table 7.

3.42 Scenario 2

The second cost scenario incorporates prioritizing certain technology options to the union level, based on local conditions. DPHE performed union-wise technology mapping for 6 of the most arsenic-affected Upazilas in Comilla. Starting with the previous scale-up scenario and replacing the total new water points necessary for each Union with the identified first priority technology option for that Union, within all 6 of these mapped Upazilas, results in a new scenario breakdown of 17,796 deep tube wells, 17,008 deep tube wells with Tara pumps, 18,496 dug wells, 138 rain water harvesting systems, and 4895 pond sand filters. This amounts to total capital costs of $45.6 million, with total costs over 20 years at $74.1 million, $65.1 million, and $59.9 million, discounted at rates of 5%, 10%, and 15% respectively. The higher 20-year costs here reflect the higher estimated maintenance costs of pond sand filters and dug wells required to ensure water quality as compared to tube wells.

Repeating this process with the identified 2nd priority for each Union in the 6 mapped Upazilas results in 18,142 deep tube wells, 26,198 deep tube wells with Tara pumps, 544 dug wells, 133 rainwater harvesting systems, and 12,024 pond sand filters. Total capital costs are $44.2 million again, with 20 year total costs at $63.6 million, $57.4 million, and $53.9 million at 5%, 10%, and 15% discount rates.

3.43 Scenario 3

Incorporating multiple connections where appropriate is a reasonable way to reduce the costs of several clustered water points. With this method an additional 3 connections can be made up to 600 ft away from the main deep tube well, but only if the water table is still high enough so that a Tara pump is not required. For this scenario's calculation the assumption is made that 30% of the proposed deep tube wells (#6 pump only) from scenario 1 would meet the requirements for a multiple connection system. Given the total number of deep tube wells proposed for this district and the current low coverage of water points it is possible that there would be many more areas where a multiple connection system would be appropriate, so 30% is potentially a conservative assumption. Under this assumption incorporating 2081 multiple connection deep tube wells reduces total capital costs for the scenario to $44.4 million, or $54 million, $51 million, and $49.2 million discounted at 5%, 10%, and 15% rates over 20 years.

3.44 Scenario 4

Given the wide-spread need for safe water options the final scenario is to incorporate piped water systems into the district mitigation plans. Rural piped water supply systems are still at the early stages in Bangladesh and so there is still variability in the cost and size of the few different systems that have been attempted across the country. For the first version of this scenario the assumption was made that 30% of all proposed water points in scenario 1 could be replaced by small-scale piped systems serving about 100 households, or 500 people (Cost estimate based on GOB-Danida model of 3 systems). This assumption resulted in 1750 proposed mini-piped systems and a total scenario cost of $49.2 million, or $85.4 million, $73.9 million, and $67.4 million over 20 years discounted at 5%, 10%, and 15%.

The second version of this scenario incorporates larger piped supply systems that would serve about 500 households, or 2500 people (based on existing systems developed by DPHE-GOB). The assumption made for this version is that 20% of all proposed water points could be replaced by these village supply systems. Incorporating these 233 new piped systems, total district mitigation costs would be $48.4 million, or over 20 years $75.7 million, $67.1 million, and $62.1 million, discounted at 5%, 10%, and 15% rates.

Table 7: Comparing Mitigation Technology Scenarios

District Scenario	Mitigation Technology	Total Capital Costs ($ thousands)	Present Value of Total Costs ($ thousands)		
			5% DR over 20 years	10% DR over 20 years	15% DR over 20 years
1	Scale-Up Existing Technologies	47,836	57,418	54,382	52,649
2	1st Priority for 6 Upazilas	45,560	74,129	65,083	59,919
2	2nd Priority for 6 Upazilas	44,160	63,564	57,416	53,906
3	Multiple Connection DTW	44,435	54,017	50,981	49,247
4	30% Mini-Piped System (100 HH)	49,234	85,381	73,927	67,389
4	20% Village Piped System (500 HH)	48,368	75,747	67,072	62,119

The total capital costs for all 4 scenarios are very similar, ranging from $44.1-49.2 million. This indicates that priority should be placed on identifying the most feasible and acceptable safe-water option in an area to receive maximum value from expenditures. Prices over 20 years reflect operation and maintenance costs of options selected, meaning user willingness to pay should also be taken into account when selecting mitigation technologies that will need to be maintained to remain operation over a long period.

4. Cost Comparison and Discussion

The present value of the expected GDP loss from arsenic-attributable mortality in Comilla District over the next 20 years ranges from $0.5-1.67 billion depending on a discount rate of 5-15%. The cost for providing complete safe water coverage to the district ranges from $49.2-85.4 million depending on the technology scenario and discount rate selected. This would indicate that the future economic costs of arsenic exposure at current levels are at least 10 times the cost of providing complete safe water coverage to the population.

4.1 Other Considerations

4.11 Risk Substitution and Safety of Water Options

Given the similarity of all mitigation technology scenario costs, factors other than cost alone should be taken into account when selecting an area's technology priority. The Risk Assessment of Arsenic Mitigation Options (RAAMO) 2005 final report found that there is a significant health risk substitution for dug wells and pond sand filters as arsenic mitigation options with respect to microbial pathogens. There is a much lower risk substitution in deep tube wells and rainwater harvesting systems, with deep tube well having the highest aggregate water quality (Ahmed, Shamsuddin, Mahmud, Rashid, Deere & Howard 2005). This indicates that where there is a suitable deep aquifer and conditions are appropriate, deep tube wells may be the safest option in terms of public health risks from both arsenic and microbial contamination. But where they are not feasible and alternative technologies must be used, there needs to be greater emphasis on maintaining water quality and preventing contamination, especially during the monsoon season when greater microbial contamination is found. Any installation of new water points should follow strict standards of design, construction, and operation and maintenance if they are to provide safe drinking water.

On a positive note the RAAMO study did find high public awareness on the adverse health impact of arsenic as well as high social acceptability of all options and willingness to switch to new mitigation options. Of households who did not start using newly installed mitigation options immediately, distance was the primary factor, although dug well and pond sand filter users cited uncertainty about the water quality as another factor affecting their decision (Ahmed, Shamsuddin, Mahmud, Rashid, Deere & Howard 2005).

Given public health risks from arsenic and microbial contaminated water, as well as issues of distance and convenience that may discourage users from mitigation option uptake, serious consideration should be given to strengthening capacities for piped supply systems. Although many barriers still remain in practice, this is still a promising method of safe water provision for the future.

4.12 Factors Predicted to Increase Costs

When predicting the costs for arsenic mitigation over a future time period it is important to acknowledge the hydrogeology and water chemistry trends of the area. Already many areas in Comilla district have a water table too low for the standard # 6 hand pump and requiring the more expensive Tara-dev head pump. As the water table continues to lower from the number of tube wells installed and the high agricultural irrigation demand for groundwater, the number of Tara pumps required will be expected to rise, increasing overall costs for mitigation. Multiple connection tube wells will also not be feasible for these areas anymore.

It is also possible that deep tube wells will remain the best mitigation option for an area, despite high levels of iron, manganese, or some other chemical in the water, since the removals of certain chemicals is still easier than removing arsenic from the groundwater. In this case the need for iron removal units will also increase mitigation technology costs. This may be a common situation as many of the most arsenic-effected upazilas also have been found in BGS, PMID, and MICS surveys to have high levels of iron in the groundwater as well (UNICEF 2010a, BGS & DPHE 2001).

Additionally there are also expected software costs involved in educating about the health effects of arsenic and creating awareness and capacity-building for the use and maintenance of new safe-water options. UNICEF unit cost estimates for sanitation and hygiene promotion of $5/person can be applied to the number of people needing new safe water options in Comilla, to reach a district-wide mitigation software cost estimate of $14.6 million (UNICEF 2010b). Community health programs creating awareness about arsenic are already active in many areas though. And in many of the most highly contaminated areas, where many people personally know those affected by arsenic or are themselves affected, awareness is less of an issue and it is now simply a matter of providing the safe-water alternatives that the community needs.

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Annexes

Table A1. Arsenic Exposure and Attributable Mortality for Bangladesh by District

District	2001 Pop	MICS Samples	Frequency				Population Proportion				PAF	As Attrib. Deaths/ Year	Pop >10 ppb	Pop >50 ppb
			0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb	0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb				
Bagerhat	1,549,031	245	193	30	17	5	0.788	0.122	0.069	0.020	0.0451	488.6	328774	139097
Bandarban	298,120	206	186	20	0	0	0.903	0.097	0.000	0.000	0.0246	51.4	28944	0
Barguna	848,554	154	151	3	0	0	0.981	0.019	0.000	0.000	0.0049	29.4	16530	0
Barisal	2,355,967	322	284	30	3	5	0.882	0.093	0.009	0.016	0.0307	506.2	278033	58533
Bhola	1,703,117	196	191	5	0	0	0.974	0.026	0.000	0.000	0.0065	77.2	43447	0
Bogra	3,013,056	318	272	36	8	2	0.855	0.113	0.025	0.006	0.0333	703.3	435851	94750
Brahmanbaria	2,398,254	237	137	27	29	44	0.578	0.114	0.122	0.186	0.1142	1916.4	1011922	738703
Chandpur	2,271,229	239	125	9	30	75	0.523	0.038	0.126	0.314	0.1469	2336.1	1083348	997820
Chittagong	6,612,140	335	242	77	12	4	0.722	0.230	0.036	0.012	0.0661	3059.9	1835609	315804
Chuadanga	1,007,130	128	59	47	18	4	0.461	0.367	0.141	0.031	0.1174	827.8	542906	173100
Comilla	4,595,557	421	178	37	78	128	0.423	0.088	0.185	0.304	0.1607	5168.3	2652542	2248657
Cox's Bazar	1,691,201	172	168	4	0	0	0.977	0.023	0.000	0.000	0.0059	69.9	39330	0
Dhaka	8,511,228	274	240	22	8	4	0.876	0.080	0.029	0.015	0.0287	1709.4	1056138	372755
Dinajpur	2,642,850	346	328	18	0	0	0.948	0.052	0.000	0.000	0.0132	244.2	137489	0
Faridpur	1,756,470	254	70	94	54	36	0.276	0.370	0.213	0.142	0.1688	2075.7	1272403	622371
Feni	1,240,384	177	98	28	42	9	0.554	0.158	0.237	0.051	0.0803	697.3	553618	357399
Gaibandha	2,138,181	206	113	73	15	5	0.549	0.354	0.073	0.024	0.1058	1582.8	965295	207590
Gazipur	2,031,891	155	149	4	1	1	0.961	0.026	0.006	0.006	0.0097	137.9	78654	26218
Gopalganj	1,165,273	150	38	39	41	32	0.253	0.260	0.273	0.213	0.1749	1426.5	870071	567100
Habiganj	1,757,665	220	97	81	35	7	0.441	0.368	0.159	0.032	0.1194	1469.5	982695	335554
Jamalpur	2,107,209	204	149	44	7	4	0.730	0.216	0.034	0.020	0.0655	966.1	568120	113624
Jessore	2,471,554	231	110	61	38	22	0.476	0.264	0.165	0.095	0.1191	2061.1	1294624	641962
Jhalokathi	694,231	131	110	19	2	0	0.840	0.145	0.015	0.000	0.0381	185.0	111289	10599
Jhenaidah	1,579,490	168	87	58	21	2	0.518	0.345	0.125	0.012	0.1027	1135.9	761540	216240
Joypurhat	846,696	159	141	18	0	0	0.887	0.113	0.000	0.000	0.0287	170.2	95852	0
Khagrachari	525,664	231	228	2	1	0	0.987	0.009	0.004	0.000	0.0026	9.4	6827	2276
Khulna	2,378,971	289	193	68	23	5	0.668	0.235	0.080	0.017	0.0733	1220.2	790246	230489
Kishoreganj	2,594,954	367	183	116	53	15	0.499	0.316	0.144	0.041	0.1087	1973.9	1301012	480809
Kurigram	1,792,073	259	174	75	8	2	0.672	0.290	0.031	0.008	0.0792	992.9	588132	69192
Kushtia	1,740,155	151	100	43	8	0	0.662	0.285	0.053	0.000	0.0766	933.4	587734	92194
Lakshmipur	1,489,901	160	81	42	21	16	0.506	0.263	0.131	0.100	0.1179	1229.8	735639	344540
Lalmonirhat	1,109,343	154	135	19	0	0	0.877	0.123	0.000	0.000	0.0313	243.1	136867	0
Madaripur	1,146,349	128	49	37	21	21	0.383	0.289	0.164	0.164	0.1533	1230.1	707512	376146

District	2001 Pop	MICS Samples	Frequency				Population Proportion				PAF	As Attrib. Deaths/ Year	Pop >10 ppb	Pop >50 ppb
			0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb	0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb				
Magura	824,311	128	67	40	18	3	0.523	0.313	0.141	0.023	0.1004	579.3	392836	135239
Manikganj	1,285,089	194	86	67	35	6	0.443	0.345	0.180	0.031	0.1150	1034.9	715410	271591
Maulvibazar	1,612,374	191	97	56	34	4	0.508	0.293	0.178	0.021	0.0976	1101.2	793524	320786
Meherpur	591,436	100	43	42	10	5	0.430	0.420	0.100	0.050	0.1351	559.2	337119	88715
Mymensingh	4,489,726	318	219	83	14	2	0.689	0.261	0.044	0.006	0.0724	2275.6	1397745	225898
Munshiganj	1,293,972	180	124	14	27	15	0.689	0.078	0.150	0.083	0.0659	596.5	402569	301927
Naogaon	2,391,355	290	240	49	1	0	0.828	0.169	0.003	0.000	0.0432	722.4	412303	8246
Narail	698,447	106	54	23	18	11	0.509	0.217	0.170	0.104	0.1111	543.1	342634	191085
Narayanganj	2,173,948	104	80	8	9	7	0.769	0.077	0.087	0.067	0.0539	820.3	501680	334454
Narsingdi	1,895,984	172	122	25	16	9	0.709	0.145	0.093	0.052	0.0657	872.5	551158	275579
Natore	1,521,336	170	166	3	1	0	0.976	0.018	0.006	0.000	0.0050	52.9	35796	8949
Nawabganj	1,425,322	160	119	22	14	5	0.744	0.138	0.088	0.031	0.0548	546.4	365239	169257
Netrokona	1,988,188	284	98	98	67	221	0.345	0.345	0.236	0.778	0.4220	5873.2	2702256	2016191
Nilphamari	1,571,690	182	143	39	0	0	0.786	0.214	0.000	0.000	0.0544	598.2	336791	0
Noakhali	2,577,244	260	110	47	56	47	0.423	0.181	0.215	0.181	0.1368	2468.3	1486872	1020985
Pabna	2,176,270	249	188	39	13	9	0.755	0.157	0.052	0.036	0.0587	894.0	533142	192281
Panchagarh	836,196	134	117	17	0	0	0.873	0.127	0.000	0.000	0.0322	188.4	106085	0
Patuakhali	1,460,781	185	154	31	0	0	0.832	0.168	0.000	0.000	0.0425	434.8	244780	0
Pirojpur	1,111,068	210	146	59	4	1	0.695	0.281	0.019	0.005	0.0748	581.7	338611	26454
Rajbari	951,906	126	89	25	9	3	0.706	0.198	0.071	0.024	0.0659	439.0	279528	90658
Rajshahi	2,286,874	308	267	28	11	2	0.867	0.091	0.036	0.006	0.0286	458.5	304422	96524
Rangamati	508,182	281	254	27	0	0	0.904	0.096	0.000	0.000	0.0244	86.7	48829	0
Rangpur	2,542,441	206	172	32	2	0	0.835	0.155	0.010	0.000	0.0402	715.7	419626	24684
Satkhira	1,864,704	195	79	63	28	25	0.405	0.323	0.144	0.128	0.1457	1902.1	1109260	506817
Sherpur	1,279,542	159	118	35	4	2	0.742	0.220	0.025	0.013	0.0630	564.5	329945	48285
Shoriatpur	1,082,300	179	119	41	15	4	0.665	0.229	0.084	0.022	0.0741	561.2	362782	114881
Sirajganj	2,693,814	232	145	73	13	1	0.625	0.315	0.056	0.004	0.0862	1625.6	1010180	162558
Sunamganj	2,013,738	293	45	110	128	10	0.154	0.375	0.437	0.034	0.1451	2046.0	1704461	948450
Sylhet	2,555,566	373	258	56	50	9	0.692	0.150	0.134	0.024	0.0589	1054.2	787909	404232
Tangail	3,290,696	332	245	76	9	2	0.738	0.229	0.027	0.006	0.0628	1445.7	862321	109029
Thakurgaon	1,214,376	151	147	4	0	0	0.974	0.026	0.000	0.000	0.0067	57.1	32169	0
Total	124,272,764	13,839										68,628	41,146,973	17,927,273

Table A2. Arsenic Exposure and Attributable Mortality for Comilla District

Upazila	Population in 2009	MICS Samples	Frequency				Population Proportion				PAF	As Attrib. Deaths/ Year	Pop >10 ppb	Pop >50 ppb
			0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb	0-10 ppb	10.1-50 ppb	50.1-150 ppb	>150.1 ppb				
Barura	386,426	28	10	2	8	8	0.357	0.071	0.286	0.286	0.1574	425.7	248417	220815
Brahman Para	198,389	23	6	4	7	6	0.261	0.174	0.304	0.261	0.1748	242.8	146635	112133
Burichang	283,427	25	19	1	2	3	0.760	0.040	0.080	0.120	0.0653	129.6	68022	56685
Chandina	294,056	25	0	0	7	18	0.000	0.000	0.280	0.720	0.3145	647.5	294056	294056
Chauddagram	417,285	27	19	4	2	2	0.704	0.148	0.074	0.074	0.0737	215.2	123640	61820
Comilla	516,319	26	25	1	0	0	0.962	0.038	0.000	0.000	0.0098	35.3	19858	0
Adarsa Sadar														
Daudkandi	336,728	28	9	2	5	12	0.321	0.071	0.179	0.429	0.2063	486.4	228494	204442
Debidwar	415,535	26	3	2	5	16	0.115	0.077	0.192	0.615	0.2845	827.5	367589	335624
Homna	209,289	27	13	1	3	10	0.481	0.037	0.111	0.370	0.1685	246.8	108520	100769
Laksam	265,039	27	2	4	6	15	0.074	0.148	0.222	0.556	0.2808	521.0	245406	206141
Meghna	106,006	26	14	3	7	2	0.538	0.115	0.269	0.077	0.0826	61.3	48926	36694
Monoharganj	230,457	27	7	1	4	15	0.259	0.037	0.148	0.556	0.2465	397.6	170709	162173
Muradnagar	513,002	27	5	2	5	15	0.185	0.074	0.185	0.556	0.2590	929.9	418002	380001
Nangalkot	349,523	27	10	4	10	3	0.370	0.148	0.370	0.111	0.1131	276.8	220070	168289
Sadar Dakshin	485,247	27	23	2	1	1	0.852	0.074	0.037	0.037	0.0368	125.1	71888	35944
Titas	187,137	25	13	4	6	2	0.520	0.160	0.240	0.080	0.0928	121.6	89826	59884
	5,193,865	421										5690	2,870,059	2,435,472

Table A3. Union-wise Arsenic Mitigation Technology Scenarios for Comilla District

Upazila	Union	Situation Analysis 2009 JICA/DPHE																
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Barura	Galimpur	44,187	95	15	16.02	37,108	27	3	8	58	21	0	0				742
Barura	Uttar Jalam	20,657	98	5	14.98	17,563	12	22	1	12	1	0	0				351
Barura	Dakshin Jalam	24,144	96.68	1	14	20,764	11	17	4	20	0	0	0				415
Barura	Uttar Payalgachha	23,660	95	13	16.91	19,659	15	10	0	31	9	0	0				393
Barura	Adda	25,257	99	5	24.96	18,953	10	30	3	54	0	0	0				379
Barura	Adra	24,001	98	19	29.33	16,962	7	4	2	91	7	0	0				339
Barura	Deora	11,887	83	3	36.21	7,583	37	0	14	14	2	0	0				152
Barura	Uttar Khosbas	30,712	81	1	22.86	23,691	53	19	12	24	0	0	0				474
Barura	Dakshin Khosbas	20,348	83	2	25.95	15,068	39	4	17	20	2	0	0				301
Barura	Dakshin Payalgachha	23,980	97	33	22.37	18,616	159	0	0	65	9	0	0				372
Barura	Paurashabha	44,094	51	3	26.28	32,506	108	1	36	29	7	0	0				650
Barura	Dakshin Shilmuri	26,776	28	2	42.78	15,321	140	0	20	15	2	0	0				306
Barura	Uttar Shilmuri	18,989	26	0	65.93	6,470	159	0	0	33	1	0	0				129
Barura	Uttar Bhabanipur	23,879	17	0	53.35	11,140	179	0	11	7	0	0	0				223
Barura	Dakshin Bhabanipur	23,855	11	0	53.41	11,114	167	0	14	15	0	0	0				222
Brahman Para	Dulalpur	23,035	73.87	9	24.83	17,315	66	0	0	22	0	0	0				346
Brahman Para	Chandla	20,428	77.7	5	22.59	15,813	48	0	0	23	0	0	0				316
Brahman Para	Sidlai	25,232	69.39	12	25.76	18,732	79	0	0	21	0	0	0				375
Brahman Para	Madhabpur	30,826	75.41	2	20.66	24,457	65	0	0	33	0	0	0				489
Brahman Para	Malapara	16,809	73.56	3	21.66	13,168	44	0	0	12	0	0	0				263
Brahman Para	Shahebabad	21,623	77.14	10	24.35	16,358	49	0	0	35	0	0	0				327
Brahman Para	Brahaman Para	22,441	77.33	5	48.37	11,586	59	0	0	108	0	0	0				232
Brahman Para	Shashidel	37,995	38.22	9	36.44	24,150	174	0	0	41	0	0	0				483
Burichang	Bharella	45,498	21.14	10	48.72	23,331	277	0	58	6	0	0	0				467
Burichang	Mokam	46,581	21.81	2	49.96	23,309	276	0	77	5	0	0	0				466
Burichang	Mainamati	37,757	28.48	0	61.8	14,423	202	0	145	12	0	0	0				288
Burichang	Rajapur	30,605	20.16	0	77.1	7,009	191	0	143	29	0	0	0				140
Burichang	Pir Jatrapur	22,315	25.38	0	98.16	411	198	0	133	6	0	0	0				8
Burichang	Baksimail	30,233	15.9	1	97.18	853	208	0	211	33	0	0	0				17
Burichang	Burichang	35,883	24.76	2	135.66	-	280	0	352	40	0	0	0			1	0
Burichang	Sholanal	34,555	11.57	0	125.28	-	246	0	361	59	0	0	0				0

Upazila	Union	Situation Analysis 2009 JICA/DPHE															
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Chandina	Karankhal	15,488	94	48	17.63	12,757	9	0	23	10	0	0	0				255
Chandina	Joyag	23,160	95	41	17.4	19,130	8	0	44	10	0	0	0				383
Chandina	Barkait	23,885	93	43	12.79	20,830	12	0	25	10	0	0	0				417
Chandina	Madhia	25,499	93	44	14.79	21,728	11	0	41	6	0	0	0				435
Chandina	Maijkhara	46,004	89	27	15.54	38,855	34	0	58	18	0	0	0				777
Chandina	Barera	18,077	95	35	22.65	13,983	8	0	40	15	0	0	0				280
Chandina	Delahi Nababpur	22,450	95	14	32.72	15,104	9	1	70	33	0	0	0				302
Chandina	Mahichal	20,667	86	56	23.9	15,728	19	1	39	17	0	0	0				315
Chandina	Shuhilpur	18,442	94	11	31.72	12,592	11	0	55	24	0	0	0				252
Chandina	Etbarpur	7,539	89	27	53.46	3,509	30	0	27	5	0	0	0				70
Chandina	Batakashi	18,470	95	38	43.07	10,515	18	0	73	38	0	0	0				210
Chandina	Gallai	32,260	92	25	65.08	11,265	212	0	73	38	0	0	0				225
Chandina	Bara Karai	22,115	75	20	23.51	16,916	48	0	26	6	0	0	0				338
Chauddagram	Kankapait	26,592	43.45	1	58.18	11,121	212	25	0	1	0	0	0				222
Chauddagram	Mushirhat	31,354	46.81	2	58.46	13,024	254	28	0	0	0	0	0				260
Chauddagram	Alkara	34,766	23.53	1	48.42	17,932	241	16	0	2	0	0	0				359
Chauddagram	Batisha	29,950	22.13	0	56.43	13,049	227	18	11	4	0	0	0				261
Chauddagram	Jagannath Dighi	26,342	29.59	1	54.78	11,912	187	26	5	4	0	0	0				238
Chauddagram	Sreepur	29,495	20.46	1	58.62	12,205	220	21	25	0	0	0	0				244
Chauddagram	Cheora	30,336	19.7	0	59.78	12,201	254	25	0	0	0	0	0				244
Chauddagram	Gunabati	36,717	16.33	0	44.08	20,532	236	13	0	0	0	0	0				411
Chauddagram	Kashinagar	32,057	2.44	0	58.6	13,272	241	18	22	8	0	0	0				265
Chauddagram	Shubhapur	42,794	16.93	0	46.63	22,839	286	21	0	0	0	0	0				457
Chauddagram	Gholpasha	24,974	6.09	0	72.62	6,838	187	28	55	7	0	0	0				137
Chauddagram	Chauddagram	26,090	8.96	0	84.71	3,989	209	69	48	14	0	0	0				80
Chauddagram	Ujirpur	27,830	4.17	0	92.25	2,157	190	4	161	40	0	0	0				43
Chauddagram	Kalikapur	17,988	0.28	0	121.41	-	125	4	130	77	0	0	0				0
Daudkandi	Maruka	35,895	86.56	7	24.81	26,989	112	25	0	0	0	0	0				540
Daudkandi	Padua	21,782	74.1	17	7.16	20,222	0	24	0	0	0	0	0				404
Daudkandi	Gauripur	24,204	82.8	14	55.59	10,749	174	33	0	0	0	0	0				215
Daudkandi	Biteshwar	24,884	81.61	12	47.02	13,184	155	25	0	0	0	0	0				264

Upazila	Union	Situation Analysis 2009 JICA/DPHE															
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Daudkandi	Paschim Mohammadpur	21,957	95.28	4	50.62	10,842	150	21	0	0	0	0	0				217
Daudkandi	Purba Panchgachhi	19,084	81.5	27	49.39	9,658	128	17	0	0	0	0	0				193
Daudkandi	Uttar Elitganj	19,405	84.22	14	65.99	6,600	170	27	0	0	0	0	0				132
Daudkandi	Dakshin Elitganj	16,847	84.7	75	65.2	5,863	143	26	0	0	0	0	0				117
Daudkandi	Purba Mohammadpur	19,865	90.72	4	61.19	7,710	160	27	0	0	0	0	0				154
Daudkandi	Barpara	19,320	84.61	5	61.9	7,361	155	29	0	0	0	0	0				147
Daudkandi	Daulatpur	27,025	76.8	16	34.39	17,731	116	27	0	0	0	0	0				355
Daudkandi	Goalmari	34,733	74.1	31	44.35	19,329	201	36	0	0	0	0	0				387
Daudkandi	Sundalpur	20,600	77.46	10	61.84	7,861	148	48	0	0	0	0	0				157
Daudkandi	Jingaltali	15,448	89.11	6	80.79	2,968	161	31	0	0	0	0	0				59
Daudkandi	Uttar Daudkandi	15,679	76.12	79	84.57	2,419	150	54	0	0	0	0	0				48
Debidwar	Debidwar	48,884	83.06	12	16.49	40,823	55	33	0	36	0	0	0				816
Debidwar	Dhamti	22,234	93.24	6	12.57	19,439	13	8	0	22	0	0	0				389
Debidwar	Sultanpur (DD)	24,821	96.59	40	11.78	21,897	7	13	0	25	0	0	0				438
Debidwar	Uttar Gunaighar	21,224	90.12	6	15.62	17,909	19	12	0	20	0	0	0				358
Debidwar	Dakshin Gunaighar	21,646	92.56	28	12.61	18,916	15	12	0	15	0	0	0				378
Debidwar	Uttar Rajamehar	25,794	90.35	3	11.84	22,740	19	5	0	23	0	0	0				455
Debidwar	Bhani	25,269	96.2	6	9.52	22,863	8	11	0	18	0	0	0				457
Debidwar	Yusufpur	18,135	78.9	0	19.35	14,626	38	13	0	3	0	0	0				293
Debidwar	Mohanpur	26,263	74.4	1	17.82	21,583	48	10	0	14	0	0	0				432
Debidwar	Borkamta	27,957	79.45	6	16.27	23,408	42	19	0	9	0	0	0				468
Debidwar	Rasulpur	20,409	73.38	0	19.75	16,378	52	6	0	4	0	0	0				328
Debidwar	Bara Shaghar	18,360	76.35	1	23.72	14,005	42	19	0	6	0	0	0				280
Debidwar	Jaforganj	26,125	65.36	3	26.62	19,171	65	25	0	17	0	0	0				383
Debidwar	Subil	21,054	79.13	4	21.47	16,534	40	13	0	3	22	0	0				331
Debidwar	Fatehabad	39,874	55.33	9	28.53	28,498	136	32	0	7	0	0	0				570
Debidwar	Elahabad	27,486	42.19	3	32.63	18,517	120	15	0	3	0	0	0				370
Homna	Bhasania	20,850	81	25	17.77	17,145	0	45	0	12	0	0	0				343
Homna	Chander Char	26,244	91	6	12.38	22,995	0	50	0	0	0	0	0				460
Homna	Dulalpur	21,347	82	39	14.31	18,292	0	47	0	0	0	0	0				366
Homna	Asadpur	23,627	74	22	4.95	22,457	0	14	0	4	0	0	0				449

Upazila	Union	Situation Analysis 2009 JICA/DPHE															
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Homna	Homna	23,448	74	37	14.14	20,132	0	51	0	0	0	0	0				403
Homna	Gharmura	15,554	61	30	4.6	14,839	0	11	0	0	0	0	0				297
Homna	Goypur	13,307	61	10	55.19	5,963	0	109	0	4	0	0	0				119
Homna	Ghagutia	23,347	44	27	10.86	20,812	0	39	0	0	0	0	0				416
Homna	Mathavanga	17,879	59	29	10.18	16,059	0	28	0	0	0	0	0				321
Homna	Nilakhi	23,686	51	29	15.64	19,982	0	57	0	0	0	0	0				400
Laksam	Paurashabha	59,161	88.59	360	13.62	51,103	117	0	0	7	0	0	0				1,022
Laksam	Bakai	38,221	87.1	28	21.26	30,095	80	30	0	15	0	0	0				602
Laksam	Modafar Gong	37,644	97.82	708	22.27	29,261	55	42	0	32	0	0	0				585
Laksam	Kandirpur	34,712	97.96	896	37.83	21,580	110	57	0	35	0	0	0				432
Laksam	Ajgara	25,319	94.4	256	34.4	16,609	100	19	0	15	0	0	0				332
Laksam	Uttardah	23,254	95.58	688	31.59	15,908	75	7	0	31	0	0	0				318
Laksam	Gobindapur	25,345	98.72	519	44.62	14,036	105	48	0	21	0	0	0				281
Laksam	Laksam Purbo	21,383	88.59	108	51.07	10,463	120	19	0	29	0	0	0				209
Meghna	Luterchar	12,070	69.06	2	33.93	7,975	38	25	0	0	0	0	0				159
Meghna	Radhanagar	14,337	69.37	18	33.1	9,591	29	44	0	0	0	0	0				192
Meghna	Barakanda	22,326	58.11	12	26.49	16,412	66	25	0	0	0	0	0				328
Meghna	Chalibhanga	13,341	40.19	5	45.31	7,296	81	12	0	0	0	0	0				146
Meghna	Gobindapur	19,908	50.15	13	44.73	11,003	81	56	0	0	0	0	0				220
Meghna	Chandanpur	11,278	35.24	10	82.99	1,918	129	15	0	0	0	0	0				38
Meghna	Manikerchar	12,746	39.36	7	85.68	1,825	128	40	0	0	0	0	0				37
Monoharganj	Baishgaon	23,297	98.8	564	19.81	18,682	20	47	0	4	0	0	0				374
Monoharganj	Hasnabad	18,603	99.41	393	15.72	15,679	7	34	0	4	0	0	0				314
Monoharganj	Maisatua	22,172	99.13	187	12.9	19,312	9	29	0	6	0	0	0				386
Monoharganj	Dakshin Jhalam	21,670	99.43	850	18	17,769	9	41	0	10	0	0	0				355
Monoharganj	Lakshmanpur	17,018	98.68	149	19.1	13,768	17	25	0	8	0	0	0				275
Monoharganj	Nather Petua	19,601	99.35	537	8.29	17,976	10	12	0	3	0	0	0				360
Monoharganj	Sorospur	22,565	99.09	222	11.23	20,031	12	22	0	5	0	0	0				401
Monoharganj	Khila	20,972	99.15	173	11.16	18,632	11	20	0	5	0	0	0				373
Monoharganj	Uttar Hawla	23,036	98.5	125	11.85	20,306	20	17	0	5	0	0	0				406
Monoharganj	Uttar Jhalam	22,026	98.52	874	20.36	17,542	22	41	0	6	0	0	0				351

Upazila	Union	Situation Analysis 2009 JICA/DPHE															
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Monoharganj	Bipulashar	19,497	96.88	98	22	15,208	41	21	0	4	0	0	0				304
Muradnagar	Purba Bangara	18,438	97.86	30	17.55	15,202	25	21	0	2	0	23	0				304
Muradnagar	Paschim Bangara	19,559	98.75	23	10.97	17,413	14	9	0	10	0	0	0				348
Muradnagar	Chapitala	14,056	98.83	28	17.18	11,641	10	7	0	20	0	2	0				233
Muradnagar	Jatrapur	19,146	98.67	78	7.13	17,781	15	1	0	5	0	0	0				356
Muradnagar	Kamalla	18,478	97.76	134	11.39	16,373	22	2	0	8	0	5	0				327
Muradnagar	Purba Nabipur	23,391	99.21	81	11.95	20,596	15	14	0	14	0	0	0				412
Muradnagar	Paschim Nabipur	23,801	97.89	41	17.44	19,650	40	10	0	11	0	11	2				393
Muradnagar	Dakshin Ramchandrapur	17,434	97.01	39	15.86	14,669	22	1	0	19	0	7	0				293
Muradnagar	Tonki	17,572	97.98	22	12.21	15,426	21	4	0	8	0	0	0				309
Muradnagar	Darora (Purba)	18,715	93.94	43	23.72	14,276	53	5	0	10	0	4	0				286
Muradnagar	Dhamghar	39,483	93.47	98	27.1	28,783	152	5	0	6	0	8	1				576
Muradnagar	Muradnagar	33,819	93.53	100	28.64	24,133	128	10	0	10	0	13	0				483
Muradnagar	Paharpur	20,831	98.83	47	23.88	15,857	12	32	0	32	0	7	0				317
Muradnagar	Babutiparha	24,093	98.38	85	30.09	16,843	20	25	0	66	0	7	0				337
Muradnagar	Paschim Purbadhair	18,233	95.83	39	25.42	13,598	36	5	0	30	0	4	0				272
Muradnagar	Uttar Ramchandrapur	17,304	96.63	41	21.41	13,599	41	2	0	14	0	0	0				272
Muradnagar	Sreekail	37,432	98.27	70	24.9	28,111	35	50	0	57	0	18	0				562
Muradnagar	Akubpur	36,102	96.33	18	47.01	19,130	85	77	0	99	0	1	0				383
Muradnagar	Chhaliakandi	19,328	96.59	54	46.59	10,323	32	28	0	78	0	7	0				206
Muradnagar	Jahapur	28,395	86.35	49	62.09	10,765	256	2	0	12	0	16	0				215
Muradnagar	Andikot	31,814	72.88	29	116.21	-	510	31	0	27	0	10	0				0
Muradnagar	Purba Purbadhair	15,578	49.76	16	178.17	-	421	3	0	3	0	0	0				0
Nangalkot	Adra	41,120	83.56	233	8.38	37,674	39	4	0	10	0	0	0				753
Nangalkot	Jodda	38,183	72.58	94	18.9	30,966	77	0	0	34	0	0	0				619
Nangalkot	Daulkhar	39,094	55.06	12	19.95	31,295	105	0	0	15	0	0	0				626
Nangalkot	Nangalkot	49,706	44.68	35	27.85	35,863	188	0	0	25	0	0	0				717
Nangalkot	Bakshaganj	21,905	34.01	8	30.86	15,145	98	2	0	4	0	0	0				303
Nangalkot	Dhalua	30,132	29.25	26	33.65	19,993	154	2	0	0	0	0	0				400
Nangalkot	Mokara	35,818	24.09	22	36.66	22,687	188	1	0	13	0	0	0				454
Nangalkot	Peria	25,491	31.12	13	32.89	17,107	116	4	0	9	0	0	0				342

Upazila	Union	Situation Analysis 2009 JICA/DPHE															
		Population 2009	Arsenic Contamination Ratio %	Number of Arsenic Patients	SWD Coverage Ratio %	Population in need of Safe Water Options	Active STW	Active DTW	Active STW-T	Active DTW-T	Active DW	Active RWH	Active AIRP	Active VSST/SST	Active PSF	Active PWSS	Water Points Needed
Nangalkot	Roykot	37,539	26.42	26	33.65	24,907	201	2	0	8	0	0	0				498
Nangalkot	Bangodda	21,878	23.58	21	40.11	13,103	129	0	0	6	0	0	0				262
Nangalkot	Satbaria	8,657	23.09	10	64.57	3,067	80	0	0	6	0	0	0				61
Sadar Dakshin	Perul South	38,918	40.03	84	1.34	38,396	0	6	0	2	0	0	0				768
Sadar Dakshin	Belghar	43,380	40.17	251	38.06	26,870	243	6	0	5	0	0	0				537
Sadar Dakshin	Perul North	38,918	40.03	83	49.27	19,743	283	10	0	2	0	0	0				395
Sadar Dakshin	Paurashabha	21,523	35	0	0.91	21,327	0	3	0	0	0	0	0				427
Sadar Dakshin	Bholain South	37,500	33.21	69	1.73	36,851	0	10	0	0	0	0	0				737
Sadar Dakshin	Barapara	42,581	35	65	56.18	18,659	231	15	0	122	0	0	0				373
Sadar Dakshin	Bijoypur	63,693	35	136	59.59	25,738	284	14	0	209	0	0	0			2	515
Sadar Dakshin	Baghmara	41,590	37.2	129	41.57	24,301	254	8	0	4	0	0	0				486
Sadar Dakshin	Bholain North	37,500	33.21	68	47.32	19,755	242	29	0	2	0	0	0				395
Sadar Dakshin	Choura	41,375	35	97	63.94	14,920	210	26	0	171	0	0	0				298
Sadar Dakshin	Galiara	34,280	35	66	72.62	9,386	184	24	0	175	0	0	0				188
Sadar Dakshin	Purba Jorekanon	21,523	35	140	96.34	788	130	17	0	172	0	0	0				16
Sadar Dakshin	Paschim Jorekanon	22,466	35	170	83.61	3,682	120	9	0	160	0	0	0				74
Titas	Bhitkandi	25,606	84.75	4	56.1	11,241	287	34	0	0	0	0	0				225
Titas	Majidpur	32,608	83.05	10	49.04	16,617	209	37	0	0	0	0	0				332
Titas	Satani	17,008	84.65	4	68.79	5,308	139	41	0	0	0	0	0				106
Titas	Balarampur	22,975	72.83	2	50.93	11,274	153	27	0	0	0	0	0				225
Titas	Jiarkandi	17,811	70.75	9	59.85	7,151	113	51	0	0	0	0	0				143
Titas	Narandia	18,853	74.93	7	52.75	8,908	113	40	0	0	0	0	0				178
Titas	Kala Kandi	12,378	79.05	1	65.11	4,319	103	21	0	0	0	0	0				86
Titas	Kari Kandi	19,066	73.24	8	73.3	5,091	163	52	0	0	0	0	0				102
Titas	Jagatpur	20,832	70	14	65.21	7,247	170	39	0	0	0	0	0				145
		4,677,546			12,194	2,916,415	18,388	3,201	2,673	3,545	83						58,328

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Barura	Galimpur	3.7%	70.7%	25.6%	0.0%	27	525	190	-		27	525	190	0	0
Barura	Uttar Jalam	62.9%	34.3%	2.9%	0.0%	221	120	10	-		221	120	10	0	0
Barura	Dakshin Jalam	45.9%	54.1%	0.0%	0.0%	191	224	0	-		191	224	0	0	0
Barura	Uttar Payalgachha	20.0%	62.0%	18.0%	0.0%	79	244	71	-		79	244	71	0	0
Barura	Adda	35.7%	64.3%	0.0%	0.0%	135	244	0	-		135	244	0	0	0
Barura	Adra	3.9%	89.2%	6.9%	0.0%	13	303	23	-		13	303	23	0	0
Barura	Deora	0.0%	87.5%	12.5%	0.0%	0	133	19	-		0	133	19	0	0
Barura	Uttar Khosbas	44.2%	55.8%	0.0%	0.0%	209	264	0	-		209	264	0	0	0
Barura	Dakshin Khosbas	15.4%	76.9%	7.7%	0.0%	46	232	23	-		46	232	23	0	0
Barura	Dakshin Payalgachha	0.0%	87.8%	12.2%	0.0%	0	327	45	-		0	327	45	0	0
Barura	Paurashabha	2.7%	78.4%	18.9%	0.0%	18	510	123	-		18	510	123	0	0
Barura	Dakshin Shilmuri	0.0%	88.2%	11.8%	0.0%	0	270	36	-		0	270	36	0	0
Barura	Uttar Shilmuri	0.0%	97.1%	2.9%	0.0%	0	126	4	-		0	126	4	0	0
Barura	Uttar Bhabanipur	0.0%	100.0%	0.0%	0.0%	0	223	0	-		0	223	0	0	0
Barura	Dakshin Bhabanipur	0.0%	100.0%	0.0%	0.0%	0	222	0	-		0	222	0	0	0
Brahman Para	Dulalpur	0.0%	100.0%	0.0%	0.0%	0	346	0	-		0	346	0	0	0
Brahman Para	Chandla	0.0%	100.0%	0.0%	0.0%	0	316	0	-		0	316	0	0	0
Brahman Para	Sidlai	0.0%	100.0%	0.0%	0.0%	0	375	0	-		0	375	0	0	0
Brahman Para	Madhabpur	0.0%	100.0%	0.0%	0.0%	0	489	0	-		0	489	0	0	0
Brahman Para	Malapara	0.0%	100.0%	0.0%	0.0%	0	263	0	-		0	263	0	0	0
Brahman Para	Shahebabad	0.0%	100.0%	0.0%	0.0%	0	327	0	-		0	327	0	0	0
Brahman Para	Brahaman Para	0.0%	100.0%	0.0%	0.0%	0	232	0	-		0	232	0	0	0
Brahman Para	Shashidel	0.0%	100.0%	0.0%	0.0%	0	483	0	-		0	483	0	0	0
Burichang	Bharella	0.0%	100.0%	0.0%	0.0%	0	467	0	-		0	467	0	0	0
Burichang	Mokam	0.0%	100.0%	0.0%	0.0%	0	466	0	-		0	466	0	0	0
Burichang	Mainamati	0.0%	100.0%	0.0%	0.0%	0	288	0	-		0	288	0	0	0
Burichang	Rajapur	0.0%	100.0%	0.0%	0.0%	0	140	0	-		0	140	0	0	0
Burichang	Pir Jatrapur	0.0%	100.0%	0.0%	0.0%	0	8	0	-		0	8	0	0	0
Burichang	Baksimail	0.0%	100.0%	0.0%	0.0%	0	17	0	-		0	17	0	0	0
Burichang	Burichang	0.0%	100.0%	0.0%	0.0%	0	0	0	-		0	0	0	0	0
Burichang	Sholanal	0.0%	100.0%	0.0%	0.0%	0	0	0	-		0	0	0	0	0

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Chandina	Karankhal	0.0%	100.0%	0.0%	0.0%	0	255	0	-	DW/VSST	0	0	255	0	0
Chandina	Joyag	0.0%	100.0%	0.0%	0.0%	0	383	0	-	DW/VSST	0	0	383	0	0
Chandina	Barkait	0.0%	100.0%	0.0%	0.0%	0	417	0	-	DW/VSST	0	0	417	0	0
Chandina	Madhia	0.0%	100.0%	0.0%	0.0%	0	435	0	-	DW/VSST	0	0	435	0	0
Chandina	Maijkhara	0.0%	100.0%	0.0%	0.0%	0	777	0	-	DW/VSST	0	0	777	0	0
Chandina	Barera	0.0%	100.0%	0.0%	0.0%	0	280	0	-	DW/VSST	0	0	280	0	0
Chandina	Delahi Nababpur	2.9%	97.1%	0.0%	0.0%	9	293	0	-	DW/VSST	0	0	302	0	0
Chandina	Mahichal	5.6%	94.4%	0.0%	0.0%	17	297	0	-		17	297	0	0	0
Chandina	Shuhilpur	0.0%	100.0%	0.0%	0.0%	0	252	0	-	DW/VSST	0	0	252	0	0
Chandina	Etbarpur	0.0%	100.0%	0.0%	0.0%	0	70	0	-	DW/VSST	0	0	70	0	0
Chandina	Batakashi	0.0%	100.0%	0.0%	0.0%	0	210	0	-	DW/VSST	0	0	210	0	0
Chandina	Gallai	0.0%	100.0%	0.0%	0.0%	0	225	0	-	DW/VSST	0	0	225	0	0
Chandina	Bara Karai	0.0%	100.0%	0.0%	0.0%	0	338	0	-	DW/VSST	0	0	338	0	0
Chauddagram	Kankapait	96.2%	3.8%	0.0%	0.0%	214	9	0	-		214	9	0	0	0
Chauddagram	Mushirhat	100.0%	0.0%	0.0%	0.0%	260	0	0	-		260	0	0	0	0
Chauddagram	Alkara	88.9%	11.1%	0.0%	0.0%	319	40	0	-		319	40	0	0	0
Chauddagram	Batisha	81.8%	18.2%	0.0%	0.0%	214	47	0	-		214	47	0	0	0
Chauddagram	Jagannath Dighi	86.7%	13.3%	0.0%	0.0%	206	32	0	-		206	32	0	0	0
Chauddagram	Sreepur	100.0%	0.0%	0.0%	0.0%	244	0	0	-		244	0	0	0	0
Chauddagram	Cheora	100.0%	0.0%	0.0%	0.0%	244	0	0	-		244	0	0	0	0
Chauddagram	Gunabati	100.0%	0.0%	0.0%	0.0%	411	0	0	-		411	0	0	0	0
Chauddagram	Kashinagar	69.2%	30.8%	0.0%	0.0%	184	82	0	-		184	82	0	0	0
Chauddagram	Shubhapur	100.0%	0.0%	0.0%	0.0%	457	0	0	-		457	0	0	0	0
Chauddagram	Gholpasha	80.0%	20.0%	0.0%	0.0%	109	27	0	-		109	27	0	0	0
Chauddagram	Chauddagram	83.1%	16.9%	0.0%	0.0%	66	13	0	-		66	13	0	0	0
Chauddagram	Ujirpur	9.1%	90.9%	0.0%	0.0%	4	39	0	-		4	39	0	0	0
Chauddagram	Kalikapur	4.9%	95.1%	0.0%	0.0%	0	0	0	-		0	0	0	0	0
Daudkandi	Maruka	100.0%	0.0%	0.0%	0.0%	540	0	0	-	DTW-SU	540	0	0	0	0
Daudkandi	Padua	100.0%	0.0%	0.0%	0.0%	404	0	0	-	DTW-SU	404	0	0	0	0
Daudkandi	Gauripur	100.0%	0.0%	0.0%	0.0%	215	0	0	-	DTW-SU	215	0	0	0	0
Daudkandi	Biteshwar	100.0%	0.0%	0.0%	0.0%	264	0	0	-	DTW-SU	264	0	0	0	0

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Daudkandi	Paschim Mohammadpur	100.0%	0.0%	0.0%	0.0%	217	0	0	-	DTW-Tdev	0	217	0	0	0
Daudkandi	Purba Panchgachhi	100.0%	0.0%	0.0%	0.0%	193	0	0	-		193	0	0	0	0
Daudkandi	Uttar Elitganj	100.0%	0.0%	0.0%	0.0%	132	0	0	-	DTW-SU	132	0	0	0	0
Daudkandi	Dakshin Elitganj	100.0%	0.0%	0.0%	0.0%	117	0	0	-	DTW-Tdev	0	117	0	0	0
Daudkandi	Purba Mohammadpur	100.0%	0.0%	0.0%	0.0%	154	0	0	-	DTW-Tdev	0	154	0	0	0
Daudkandi	Barpara	100.0%	0.0%	0.0%	0.0%	147	0	0	-	DTW-SU	147	0	0	0	0
Daudkandi	Daulatpur	100.0%	0.0%	0.0%	0.0%	355	0	0	-	DTW-SU	355	0	0	0	0
Daudkandi	Goalmari	100.0%	0.0%	0.0%	0.0%	387	0	0	-	DTW-SU	387	0	0	0	0
Daudkandi	Sundalpur	100.0%	0.0%	0.0%	0.0%	157	0	0	-	DTW-SU	157	0	0	0	0
Daudkandi	Jingaltali	100.0%	0.0%	0.0%	0.0%	59	0	0	-	DTW-SU	59	0	0	0	0
Daudkandi	Uttar Daudkandi	100.0%	0.0%	0.0%	0.0%	48	0	0	-	DTW-SU	48	0	0	0	0
Debidwar	Debidwar	47.8%	52.2%	0.0%	0.0%	390	426	0	-	DW/VSST	0	0	816	0	0
Debidwar	Dhamti	26.7%	73.3%	0.0%	0.0%	104	285	0	-	DW/VSST	0	0	389	0	0
Debidwar	Sultanpur (DD)	34.2%	65.8%	0.0%	0.0%	150	288	0	-	DW/VSST	0	0	438	0	0
Debidwar	Uttar Gunaighar	37.5%	62.5%	0.0%	0.0%	134	224	0	-	DW/VSST	0	0	358	0	0
Debidwar	Dakshin Gunaighar	44.4%	55.6%	0.0%	0.0%	168	210	0	-	DW/VSST	0	0	378	0	0
Debidwar	Uttar Rajamehar	17.9%	82.1%	0.0%	0.0%	81	374	0	-	DW/VSST	0	0	455	0	0
Debidwar	Bhani	37.9%	62.1%	0.0%	0.0%	173	284	0	-	DW/VSST	0	0	457	0	0
Debidwar	Yusufpur	81.3%	18.8%	0.0%	0.0%	238	55	0	-		238	55	0	0	0
Debidwar	Mohanpur	41.7%	58.3%	0.0%	0.0%	180	252	0	-	DW/VSST	0	0	432	0	0
Debidwar	Borkamta	67.9%	32.1%	0.0%	0.0%	318	150	0	-	DW/VSST	0	0	468	0	0
Debidwar	Rasulpur	60.0%	40.0%	0.0%	0.0%	197	131	0	-	DW/VSST	0	0	328	0	0
Debidwar	Bara Shaghar	76.0%	24.0%	0.0%	0.0%	213	67	0	-	DW/VSST	0	0	280	0	0
Debidwar	Jaforganj	59.5%	40.5%	0.0%	0.0%	228	155	0	-		228	155	0	0	0
Debidwar	Subil	34.2%	7.9%	57.9%	0.0%	113	26	191	-	DW/VSST	0	0	331	0	0
Debidwar	Fatehabad	82.1%	17.9%	0.0%	0.0%	468	102	0	-	DW/VSST	0	0	570	0	0
Debidwar	Elahabad	83.3%	16.7%	0.0%	0.0%	309	62	0	-	DW/VSST	0	0	370	0	0
Homna	Bhasania	78.9%	21.1%	0.0%	0.0%	271	72	0	-	DW/VSST	0	0	343	0	0
Homna	Chander Char	100.0%	0.0%	0.0%	0.0%	460	0	0	-	DW/VSST	0	0	460	0	0
Homna	Dulalpur	100.0%	0.0%	0.0%	0.0%	366	0	0	-	DW/VSST	0	0	366	0	0
Homna	Asadpur	77.8%	22.2%	0.0%	0.0%	349	100	0	-	DW/VSST	0	0	449	0	0

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Homna	Homna	100.0%	0.0%	0.0%	0.0%	403	0	0	-	DW/VSST	0	0	403	0	0
Homna	Gharmura	100.0%	0.0%	0.0%	0.0%	297	0	0	-	DW/VSST	0	0	297	0	0
Homna	Goypur	96.5%	3.5%	0.0%	0.0%	115	4	0	-	DW/VSST	0	0	119	0	0
Homna	Ghagutia	100.0%	0.0%	0.0%	0.0%	416	0	0	-	DW/VSST	0	0	416	0	0
Homna	Mathavanga	100.0%	0.0%	0.0%	0.0%	321	0	0	-	DW/VSST	0	0	321	0	0
Homna	Nilakhi	100.0%	0.0%	0.0%	0.0%	400	0	0	-	DW/VSST	0	0	400	0	0
Laksam	Paurashabha	0.0%	100.0%	0.0%	0.0%	0	1022	0	-	DW/VSST	0	0	1022	0	0
Laksam	Bakai	66.7%	33.3%	0.0%	0.0%	401	201	0	-	DW/VSST	0	0	602	0	0
Laksam	Modafar Gong	56.8%	43.2%	0.0%	0.0%	332	253	0	-	DW/VSST	0	0	585	0	0
Laksam	Kandirpur	62.0%	38.0%	0.0%	0.0%	267	164	0	-		267	164	0	0	0
Laksam	Ajgara	55.9%	44.1%	0.0%	0.0%	186	147	0	-	DW/VSST	0	0	332	0	0
Laksam	Uttardah	18.4%	81.6%	0.0%	0.0%	59	260	0	-	DW/VSST	0	0	318	0	0
Laksam	Gobindapur	69.6%	30.4%	0.0%	0.0%	195	85	0	-	DW/VSST	0	0	281	0	0
Laksam	Laksam Purbo	39.6%	60.4%	0.0%	0.0%	83	126	0	-	DW/VSST	0	0	209	0	0
Meghna	Luterchar	100.0%	0.0%	0.0%	0.0%	159	0	0	-		159	0	0	0	0
Meghna	Radhanagar	100.0%	0.0%	0.0%	0.0%	192	0	0	-		192	0	0	0	0
Meghna	Barakanda	100.0%	0.0%	0.0%	0.0%	328	0	0	-		328	0	0	0	0
Meghna	Chalibhanga	100.0%	0.0%	0.0%	0.0%	146	0	0	-		146	0	0	0	0
Meghna	Gobindapur	100.0%	0.0%	0.0%	0.0%	220	0	0	-		220	0	0	0	0
Meghna	Chandanpur	100.0%	0.0%	0.0%	0.0%	38	0	0	-		38	0	0	0	0
Meghna	Manikerchar	100.0%	0.0%	0.0%	0.0%	37	0	0	-		37	0	0	0	0
Monoharganj	Baishgaon	92.2%	7.8%	0.0%	0.0%	344	29	0	-		344	29	0	0	0
Monoharganj	Hasnabad	89.5%	10.5%	0.0%	0.0%	281	33	0	-		281	33	0	0	0
Monoharganj	Maisatua	82.9%	17.1%	0.0%	0.0%	320	66	0	-		320	66	0	0	0
Monoharganj	Dakshin Jhalam	80.4%	19.6%	0.0%	0.0%	286	70	0	-		286	70	0	0	0
Monoharganj	Lakshmanpur	75.8%	24.2%	0.0%	0.0%	209	67	0	-		209	67	0	0	0
Monoharganj	Nather Petua	80.0%	20.0%	0.0%	0.0%	288	72	0	-		288	72	0	0	0
Monoharganj	Sorospur	81.5%	18.5%	0.0%	0.0%	326	74	0	-		326	74	0	0	0
Monoharganj	Khila	80.0%	20.0%	0.0%	0.0%	298	75	0	-		298	75	0	0	0
Monoharganj	Uttar Hawla	77.3%	22.7%	0.0%	0.0%	314	92	0	-		314	92	0	0	0
Monoharganj	Uttar Jhalam	87.2%	12.8%	0.0%	0.0%	306	45	0	-		306	45	0	0	0

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Monoharganj	Bipulashar	84.0%	16.0%	0.0%	0.0%	255	49	0	-		255	49	0	0	0
Muradnagar	Purba Bangara	45.7%	4.3%	0.0%	50.0%	139	13	0	152	PSF	0	0	0	0	304
Muradnagar	Paschim Bangara	47.4%	52.6%	0.0%	0.0%	165	183	0	-	PSF	0	0	0	0	348
Muradnagar	Chapitala	24.1%	69.0%	0.0%	6.9%	56	161	0	16	PSF	0	0	0	0	233
Muradnagar	Jatrapur	16.7%	83.3%	0.0%	0.0%	59	296	0	-	PSF	0	0	0	0	356
Muradnagar	Kamalla	13.3%	53.3%	0.0%	33.3%	44	175	0	109		44	175	0	109	0
Muradnagar	Purba Nabipur	50.0%	50.0%	0.0%	0.0%	206	206	0	-	PSF	0	0	0	0	412
Muradnagar	Paschim Nabipur	31.3%	34.4%	0.0%	34.4%	123	135	0	135	PSF	0	0	0	0	393
Muradnagar	Dakshin Ramchandrapur	3.7%	70.4%	0.0%	25.9%	11	206	0	76	PSF	0	0	0	0	293
Muradnagar	Tonki	33.3%	66.7%	0.0%	0.0%	103	206	0	-		103	206	0	0	0
Muradnagar	Darora (Purba)	26.3%	52.6%	0.0%	21.1%	75	150	0	60	PSF	0	0	0	0	286
Muradnagar	Dhamghar	26.3%	31.6%	0.0%	42.1%	151	182	0	242	PSF	0	0	0	0	576
Muradnagar	Muradnagar	30.3%	30.3%	0.0%	39.4%	146	146	0	190	DW/VSST	0	0	483	0	0
Muradnagar	Paharpur	45.1%	45.1%	0.0%	9.9%	143	143	0	31	DW/VSST	0	0	317	0	0
Muradnagar	Babutiparha	25.5%	67.3%	0.0%	7.1%	86	227	0	24		86	227	0	24	0
Muradnagar	Paschim Purbadhair	12.8%	76.9%	0.0%	10.3%	35	209	0	28	PSF	0	0	0	0	272
Muradnagar	Uttar Ramchandrapur	12.5%	87.5%	0.0%	0.0%	34	238	0	-	PSF	0	0	0	0	272
Muradnagar	Sreekail	40.0%	45.6%	0.0%	14.4%	225	256	0	81	PSF	0	0	0	0	562
Muradnagar	Akubpur	43.5%	55.9%	0.0%	0.6%	166	214	0	2	PSF	0	0	0	0	383
Muradnagar	Chhaliakandi	24.8%	69.0%	0.0%	6.2%	51	143	0	13	PSF	0	0	0	0	206
Muradnagar	Jahapur	6.7%	40.0%	0.0%	53.3%	14	86	0	115	DW/VSST	0	0	215	0	0
Muradnagar	Andikot	45.6%	39.7%	0.0%	14.7%	0	0	0	-	PSF	0	0	0	0	0
Muradnagar	Purba Purbadhair	50.0%	50.0%	0.0%	0.0%	0	0	0	-	PSF	0	0	0	0	0
Nangalkot	Adra	28.6%	71.4%	0.0%	0.0%	215	538	0	-		215	538	0	0	0
Nangalkot	Jodda	0.0%	100.0%	0.0%	0.0%	0	619	0	-		0	619	0	0	0
Nangalkot	Daulkhar	0.0%	100.0%	0.0%	0.0%	0	626	0	-		0	626	0	0	0
Nangalkot	Nangalkot	0.0%	100.0%	0.0%	0.0%	0	717	0	-		0	717	0	0	0
Nangalkot	Bakshaganj	33.3%	66.7%	0.0%	0.0%	101	202	0	-		101	202	0	0	0
Nangalkot	Dhalua	100.0%	0.0%	0.0%	0.0%	400	0	0	-		400	0	0	0	0
Nangalkot	Mokara	7.1%	92.9%	0.0%	0.0%	32	421	0	-		32	421	0	0	0
Nangalkot	Peria	30.8%	69.2%	0.0%	0.0%	105	237	0	-		105	237	0	0	0

Upazila	Union	Scenario 1: Scale-up existing								Scenario 2: 1st Tech Priorities					
		DTW % of non-STW	DTW-T % of non-STW	DW % of non-STW	RWH% of non-STW	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	1st Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF
Nangalkot	Roykot	20.0%	80.0%	0.0%	0.0%	100	399	0	-		100	399	0	0	0
Nangalkot	Bangodda	0.0%	100.0%	0.0%	0.0%	0	262	0	-		0	262	0	0	0
Nangalkot	Satbaria	0.0%	100.0%	0.0%	0.0%	0	61	0	-		0	61	0	0	0
Sadar Dakshin	Perul South	75.0%	25.0%	0.0%	0.0%	576	192	0	-		576	192	0	0	0
Sadar Dakshin	Belghar	54.5%	45.5%	0.0%	0.0%	293	244	0	-		293	244	0	0	0
Sadar Dakshin	Perul North	83.3%	16.7%	0.0%	0.0%	329	66	0	-		329	66	0	0	0
Sadar Dakshin	Paurashabha	100.0%	0.0%	0.0%	0.0%	427	0	0	-		427	0	0	0	0
Sadar Dakshin	Bholain South	100.0%	0.0%	0.0%	0.0%	737	0	0	-		737	0	0	0	0
Sadar Dakshin	Barapara	10.9%	89.1%	0.0%	0.0%	41	332	0	-		41	332	0	0	0
Sadar Dakshin	Bijoypur	6.3%	93.7%	0.0%	0.0%	32	482	0	-		32	482	0	0	0
Sadar Dakshin	Baghmara	66.7%	33.3%	0.0%	0.0%	324	162	0	-		324	162	0	0	0
Sadar Dakshin	Bholain North	93.5%	6.5%	0.0%	0.0%	370	25	0	-		370	25	0	0	0
Sadar Dakshin	Choura	13.2%	86.8%	0.0%	0.0%	39	259	0	-		39	259	0	0	0
Sadar Dakshin	Galiara	12.1%	87.9%	0.0%	0.0%	23	165	0	-		23	165	0	0	0
Sadar Dakshin	Purba Jorekanon	9.0%	91.0%	0.0%	0.0%	1	14	0	-		1	14	0	0	0
Sadar Dakshin	Paschim Jorekanon	5.3%	94.7%	0.0%	0.0%	4	70	0	-		4	70	0	0	0
Titas	Bhitkandi	100.0%	0.0%	0.0%	0.0%	225	0	0	-		225	0	0	0	0
Titas	Majidpur	100.0%	0.0%	0.0%	0.0%	332	0	0	-		332	0	0	0	0
Titas	Satani	100.0%	0.0%	0.0%	0.0%	106	0	0	-		106	0	0	0	0
Titas	Balarampur	100.0%	0.0%	0.0%	0.0%	225	0	0	-		225	0	0	0	0
Titas	Jiarkandi	100.0%	0.0%	0.0%	0.0%	143	0	0	-		143	0	0	0	0
Titas	Narandia	100.0%	0.0%	0.0%	0.0%	178	0	0	-		178	0	0	0	0
Titas	Kala Kandi	100.0%	0.0%	0.0%	0.0%	86	0	0	-		86	0	0	0	0
Titas	Kari Kandi	100.0%	0.0%	0.0%	0.0%	102	0	0	-		102	0	0	0	0
Titas	Jagatpur	100.0%	0.0%	0.0%	0.0%	145	0	0	-		145	0	0	0	0
						27,744	28,574	736	1,275		17,796	17,008	18,496	133	4,895
			Total Capital Costs				$47,836,183		Total Capital Costs				$45,579,931		
			Total PV 20 years at 5%				$57,417,762		Total PV 20 years at 5%				$74,128,509		
			Total PV 20 years at 10%				$54,381,842		Total PV 20 years at 10%				$65,082,903		
			Total PV 20 years at 15%				$52,648,674		Total PV 20 years at 15%				$59,918,881		

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Barura	Galimpur		27	525	190	0	0	2	19	525	190	0
Barura	Uttar Jalam		221	120	10	0	0	17	155	120	10	0
Barura	Dakshin Jalam		191	224	0	0	0	14	134	224	0	0
Barura	Uttar Payalgachha		79	244	71	0	0	6	55	244	71	0
Barura	Adda		135	244	0	0	0	10	95	244	0	0
Barura	Adra		13	303	23	0	0	1	9	303	23	0
Barura	Deora		0	133	19	0	0	0	0	133	19	0
Barura	Uttar Khosbas		209	264	0	0	0	16	147	264	0	0
Barura	Dakshin Khosbas		46	232	23	0	0	3	32	232	23	0
Barura	Dakshin Payalgachha		0	327	45	0	0	0	0	327	45	0
Barura	Paurashabha		18	510	123	0	0	1	12	510	123	0
Barura	Dakshin Shilmuri		0	270	36	0	0	0	0	270	36	0
Barura	Uttar Shilmuri		0	126	4	0	0	0	0	126	4	0
Barura	Uttar Bhabanipur		0	223	0	0	0	0	0	223	0	0
Barura	Dakshin Bhabanipur		0	222	0	0	0	0	0	222	0	0
Brahman Para	Dulalpur		0	346	0	0	0	0	0	346	0	0
Brahman Para	Chandla		0	316	0	0	0	0	0	316	0	0
Brahman Para	Sidlai		0	375	0	0	0	0	0	375	0	0
Brahman Para	Madhabpur		0	489	0	0	0	0	0	489	0	0
Brahman Para	Malapara		0	263	0	0	0	0	0	263	0	0
Brahman Para	Shahebabad		0	327	0	0	0	0	0	327	0	0
Brahman Para	Brahaman Para		0	232	0	0	0	0	0	232	0	0
Brahman Para	Shashidel		0	483	0	0	0	0	0	483	0	0
Burichang	Bharella		0	467	0	0	0	0	0	467	0	0
Burichang	Mokam		0	466	0	0	0	0	0	466	0	0
Burichang	Mainamati		0	288	0	0	0	0	0	288	0	0
Burichang	Rajapur		0	140	0	0	0	0	0	140	0	0
Burichang	Pir Jatrapur		0	8	0	0	0	0	0	8	0	0
Burichang	Baksimail		0	17	0	0	0	0	0	17	0	0
Burichang	Burichang		0	0	0	0	0	0	0	0	0	0
Burichang	Sholanal		0	0	0	0	0	0	0	0	0	0

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Chandina	Karankhal	PSF	0	0	0	0	255	0	0	255	0	0
Chandina	Joyag	PSF	0	0	0	0	383	0	0	383	0	0
Chandina	Barkait	PSF	0	0	0	0	417	0	0	417	0	0
Chandina	Madhia	PSF	0	0	0	0	435	0	0	435	0	0
Chandina	Maijkhara	PSF	0	0	0	0	777	0	0	777	0	0
Chandina	Barera	PSF	0	0	0	0	280	0	0	280	0	0
Chandina	Delahi Nababpur	PSF	0	0	0	0	302	1	6	293	0	0
Chandina	Mahichal		17	297	0	0	0	1	12	297	0	0
Chandina	Shuhilpur	PSF	0	0	0	0	252	0	0	252	0	0
Chandina	Etbarpur	PSF	0	0	0	0	70	0	0	70	0	0
Chandina	Batakashi	PSF	0	0	0	0	210	0	0	210	0	0
Chandina	Gallai	PSF	0	0	0	0	225	0	0	225	0	0
Chandina	Bara Karai	PSF	0	0	0	0	338	0	0	338	0	0
Chauddagram	Kankapait		214	9	0	0	0	16	150	9	0	0
Chauddagram	Mushirhat		260	0	0	0	0	20	182	0	0	0
Chauddagram	Alkara		319	40	0	0	0	24	223	40	0	0
Chauddagram	Batisha		214	47	0	0	0	16	149	47	0	0
Chauddagram	Jagannath Dighi		206	32	0	0	0	15	145	32	0	0
Chauddagram	Sreepur		244	0	0	0	0	18	171	0	0	0
Chauddagram	Cheora		244	0	0	0	0	18	171	0	0	0
Chauddagram	Gunabati		411	0	0	0	0	31	287	0	0	0
Chauddagram	Kashinagar		184	82	0	0	0	14	129	82	0	0
Chauddagram	Shubhapur		457	0	0	0	0	34	320	0	0	0
Chauddagram	Gholpasha		109	27	0	0	0	8	77	27	0	0
Chauddagram	Chauddagram		66	13	0	0	0	5	46	13	0	0
Chauddagram	Ujirpur		4	39	0	0	0	0	3	39	0	0
Chauddagram	Kalikapur		0	0	0	0	0	0	0	0	0	0
Daudkandi	Maruka	PSF	0	0	0	0	540	40	378	0	0	0
Daudkandi	Padua	PSF	0	0	0	0	404	30	283	0	0	0
Daudkandi	Gauripur	PSF	0	0	0	0	215	16	150	0	0	0
Daudkandi	Biteshwar	PSF	0	0	0	0	264	20	185	0	0	0

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Daudkandi	Paschim Mohammadpur	PSF	0	0	0	0	217	16	152	0	0	0
Daudkandi	Purba Panchgachhi		193	0	0	0	0	14	135	0	0	0
Daudkandi	Uttar Elitganj	PSF	0	0	0	0	132	10	92	0	0	0
Daudkandi	Dakshin Elitganj	PSF	0	0	0	0	117	9	82	0	0	0
Daudkandi	Purba Mohammadpur	PSF	0	0	0	0	154	12	108	0	0	0
Daudkandi	Barpara	PSF	0	0	0	0	147	11	103	0	0	0
Daudkandi	Daulatpur	PSF	0	0	0	0	355	27	248	0	0	0
Daudkandi	Goalmari	PSF	0	0	0	0	387	29	271	0	0	0
Daudkandi	Sundalpur	PSF	0	0	0	0	157	12	110	0	0	0
Daudkandi	Jingaltali	PSF	0	0	0	0	59	4	42	0	0	0
Daudkandi	Uttar Daudkandi	PSF	0	0	0	0	48	4	34	0	0	0
Debidwar	Debidwar	DTW-Tdev	0	816	0	0	0	29	273	426	0	0
Debidwar	Dhamti	DTW-Tdev	0	389	0	0	0	8	73	285	0	0
Debidwar	Sultanpur (DD)	DTW-Tdev	0	438	0	0	0	11	105	288	0	0
Debidwar	Uttar Gunaighar	DTW-Tdev	0	358	0	0	0	10	94	224	0	0
Debidwar	Dakshin Gunaighar	DTW-Tdev	0	378	0	0	0	13	118	210	0	0
Debidwar	Uttar Rajamehar	DTW-Tdev	0	455	0	0	0	6	57	374	0	0
Debidwar	Bhani	DTW-Tdev	0	457	0	0	0	13	121	284	0	0
Debidwar	Yusufpur		238	55	0	0	0	18	166	55	0	0
Debidwar	Mohanpur	DTW-Tdev	0	432	0	0	0	13	126	252	0	0
Debidwar	Borkamta	DTW-Tdev	0	468	0	0	0	24	222	150	0	0
Debidwar	Rasulpur	DTW-Tdev	0	328	0	0	0	15	138	131	0	0
Debidwar	Bara Shaghar	DTW-Tdev	0	280	0	0	0	16	149	67	0	0
Debidwar	Jaforganj		228	155	0	0	0	17	160	155	0	0
Debidwar	Subil	DTW-Tdev	0	331	0	0	0	8	79	26	191	0
Debidwar	Fatehabad	DTW-Tdev	0	570	0	0	0	35	327	102	0	0
Debidwar	Elahabad	DTW-Tdev	0	370	0	0	0	23	216	62	0	0
Homna	Bhasania	DTW-SU	343	0	0	0	0	20	189	72	0	0
Homna	Chander Char	DTW-SU	460	0	0	0	0	34	322	0	0	0
Homna	Dulalpur	DTW-SU	366	0	0	0	0	27	256	0	0	0
Homna	Asadpur	DTW-SU	449	0	0	0	0	26	245	100	0	0

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Homna	Homna	DTW-SU	403	0	0	0	0	30	282	0	0	0
Homna	Gharmura	DTW-SU	297	0	0	0	0	22	208	0	0	0
Homna	Goypur	PSF	0	0	0	0	119	9	81	4	0	0
Homna	Ghagutia	DTW-SU	416	0	0	0	0	31	291	0	0	0
Homna	Mathavanga	DTW-SU	321	0	0	0	0	24	225	0	0	0
Homna	Nilakhi	PSF	0	0	0	0	400	30	280	0	0	0
Laksam	Paurashabha	PSF	0	0	0	0	1022	0	0	1022	0	0
Laksam	Bakai	PSF	0	0	0	0	602	30	281	201	0	0
Laksam	Modafar Gong	PSF	0	0	0	0	585	25	233	253	0	0
Laksam	Kandirpur		267	164	0	0	0	20	187	164	0	0
Laksam	Ajgara	PSF	0	0	0	0	332	14	130	147	0	0
Laksam	Uttardah	PSF	0	0	0	0	318	4	41	260	0	0
Laksam	Gobindapur	PSF	0	0	0	0	281	15	137	85	0	0
Laksam	Laksam Purbo	PSF	0	0	0	0	209	6	58	126	0	0
Meghna	Luterchar		159	0	0	0	0	12	112	0	0	0
Meghna	Radhanagar		192	0	0	0	0	14	134	0	0	0
Meghna	Barakanda		328	0	0	0	0	25	230	0	0	0
Meghna	Chalibhanga		146	0	0	0	0	11	102	0	0	0
Meghna	Gobindapur		220	0	0	0	0	17	154	0	0	0
Meghna	Chandanpur		38	0	0	0	0	3	27	0	0	0
Meghna	Manikerchar		37	0	0	0	0	3	26	0	0	0
Monoharganj	Baishgaon		344	29	0	0	0	26	241	29	0	0
Monoharganj	Hasnabad		281	33	0	0	0	21	196	33	0	0
Monoharganj	Maisatua		320	66	0	0	0	24	224	66	0	0
Monoharganj	Dakshin Jhalam		286	70	0	0	0	21	200	70	0	0
Monoharganj	Lakshmanpur		209	67	0	0	0	16	146	67	0	0
Monoharganj	Nather Petua		288	72	0	0	0	22	201	72	0	0
Monoharganj	Sorospur		326	74	0	0	0	24	229	74	0	0
Monoharganj	Khila		298	75	0	0	0	22	209	75	0	0
Monoharganj	Uttar Hawla		314	92	0	0	0	24	220	92	0	0
Monoharganj	Uttar Jhalam		306	45	0	0	0	23	214	45	0	0

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Monoharganj	Bipulashar		255	49	0	0	0	19	179	49	0	0
Muradnagar	Purba Bangara	DTW-Tdev	0	304	0	0	0	10	97	13	0	152
Muradnagar	Paschim Bangara	DTW-Tdev	0	348	0	0	0	12	115	183	0	0
Muradnagar	Chapitala	DTW-Tdev	0	233	0	0	0	4	39	161	0	16
Muradnagar	Jatrapur	DTW-Tdev	0	356	0	0	0	4	41	296	0	0
Muradnagar	Kamalla		44	175	0	109	0	3	31	175	0	109
Muradnagar	Purba Nabipur	DTW-Tdev	0	133	0	0	0	15	144	206	0	0
Muradnagar	Paschim Nabipur	DTW-Tdev	0	133	0	0	0	9	86	135	0	135
Muradnagar	Dakshin Ramchandrapur	DTW-Tdev	0	133	0	0	0	1	8	206	0	76
Muradnagar	Tonki		103	206	0	0	0	8	72	206	0	0
Muradnagar	Darora (Purba)	DTW-Tdev	0	137	0	0	0	6	53	150	0	60
Muradnagar	Dhamghar	DTW-Tdev	0	137	0	0	0	11	106	182	0	242
Muradnagar	Muradnagar	PSF	0	0	0	0	483	11	102	146	0	190
Muradnagar	Paharpur	PSF	0	0	0	0	317	11	100	143	0	31
Muradnagar	Babutiparha		86	227	0	24	0	6	60	227	0	24
Muradnagar	Paschim Purbadhair	DTW-Tdev	0	272	0	0	0	3	24	209	0	28
Muradnagar	Uttar Ramchandrapur	DTW-Tdev	0	272	0	0	0	3	24	238	0	0
Muradnagar	Sreekail	DTW-Tdev	0	562	0	0	0	17	157	256	0	81
Muradnagar	Akubpur	DTW-Tdev	0	383	0	0	0	12	117	214	0	2
Muradnagar	Chhaliakandi	DTW-Tdev	0	206	0	0	0	4	36	143	0	13
Muradnagar	Jahapur	PSF	0	0	0	0	215	1	10	86	0	115
Muradnagar	Andikot	DTW-Tdev	0	0	0	0	0	0	0	0	0	0
Muradnagar	Purba Purbadhair	DTW-Tdev	0	0	0	0	0	0	0	0	0	0
Nangalkot	Adra		215	538	0	0	0	16	151	538	0	0
Nangalkot	Jodda		0	619	0	0	0	0	0	619	0	0
Nangalkot	Daulkhar		0	626	0	0	0	0	0	626	0	0
Nangalkot	Nangalkot		0	717	0	0	0	0	0	717	0	0
Nangalkot	Bakshaganj		101	202	0	0	0	8	71	202	0	0
Nangalkot	Dhalua		400	0	0	0	0	30	280	0	0	0
Nangalkot	Mokara		32	421	0	0	0	2	23	421	0	0
Nangalkot	Peria		105	237	0	0	0	8	74	237	0	0

Upazila	Union	Scenario 2: 2nd Tech Priorities						Scenario 3: 30% DTW now Multiple Connection				
		2nd Priority Tech	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed PSF	Proposed DTW-MC	New Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Nangalkot	Roykot		100	399	0	0	0	7	70	399	0	0
Nangalkot	Bangodda		0	262	0	0	0	0	0	262	0	0
Nangalkot	Satbaria		0	61	0	0	0	0	0	61	0	0
Sadar Dakshin	Perul South		576	192	0	0	0	43	403	192	0	0
Sadar Dakshin	Belghar		293	244	0	0	0	22	205	244	0	0
Sadar Dakshin	Perul North		329	66	0	0	0	25	230	66	0	0
Sadar Dakshin	Paurashabha		427	0	0	0	0	32	299	0	0	0
Sadar Dakshin	Bholain South		737	0	0	0	0	55	516	0	0	0
Sadar Dakshin	Barapara		41	332	0	0	0	3	29	332	0	0
Sadar Dakshin	Bijoypur		32	482	0	0	0	2	23	482	0	0
Sadar Dakshin	Baghmara		324	162	0	0	0	24	227	162	0	0
Sadar Dakshin	Bholain North		370	25	0	0	0	28	259	25	0	0
Sadar Dakshin	Choura		39	259	0	0	0	3	28	259	0	0
Sadar Dakshin	Galiara		23	165	0	0	0	2	16	165	0	0
Sadar Dakshin	Purba Jorekanon		1	14	0	0	0	0	1	14	0	0
Sadar Dakshin	Paschim Jorekanon		4	70	0	0	0	0	3	70	0	0
Titas	Bhitkandi		225	0	0	0	0	17	157	0	0	0
Titas	Majidpur		332	0	0	0	0	25	233	0	0	0
Titas	Satani		106	0	0	0	0	8	74	0	0	0
Titas	Balarampur		225	0	0	0	0	17	158	0	0	0
Titas	Jiarkandi		143	0	0	0	0	11	100	0	0	0
Titas	Narandia		178	0	0	0	0	13	125	0	0	0
Titas	Kala Kandi		86	0	0	0	0	6	60	0	0	0
Titas	Kari Kandi		102	0	0	0	0	8	71	0	0	0
Titas	Jagatpur		145	0	0	0	0	11	101	0	0	0
			18,142	26,198	544	133	12,024	2081	19421	28574	736	1275
			Total Capital Costs			$44,159,792		Total Capital Costs			$44,434,936	
			Total PV 20 years at 5%			$63,564,034		Total PV 20 years at 5%			$54,016,515	
			Total PV 20 years at 10%			$57,415,807		Total PV 20 years at 10%			$50,980,596	
			Total PV 20 years at 15%			$53,905,863		Total PV 20 years at 15%			$49,247,428	

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Barura	Galimpur	22	19	367	133	-	3	22	420	152	-
Barura	Uttar Jalam	11	155	84	7	-	1	177	96	8	-
Barura	Dakshin Jalam	12	134	157	0	-	2	153	180	0	-
Barura	Uttar Payalgachha	12	55	171	50	-	2	63	195	57	-
Barura	Adda	11	95	171	0	-	2	108	195	0	-
Barura	Adra	10	9	212	16	-	1	11	242	19	-
Barura	Deora	5	0	93	13	-	1	0	106	15	-
Barura	Uttar Khosbas	14	147	185	0	-	2	167	212	0	-
Barura	Dakshin Khosbas	9	32	162	16	-	1	37	185	19	-
Barura	Dakshin Payalgachha	11	0	229	32	-	1	0	262	36	-
Barura	Paurashabha	20	12	357	86	-	3	14	408	98	-
Barura	Dakshin Shilmuri	9	0	189	25	-	1	0	216	29	-
Barura	Uttar Shilmuri	4	0	88	3	-	1	0	100	3	-
Barura	Uttar Bhabanipur	7	0	156	0	-	1	0	178	0	-
Barura	Dakshin Bhabanipur	7	0	156	0	-	1	0	178	0	-
Brahman Para	Dulalpur	10	0	242	0	-	1	0	277	0	-
Brahman Para	Chandla	9	0	221	0	-	1	0	253	0	-
Brahman Para	Sidlai	11	0	262	0	-	1	0	300	0	-
Brahman Para	Madhabpur	15	0	342	0	-	2	0	391	0	-
Brahman Para	Malapara	8	0	184	0	-	1	0	211	0	-
Brahman Para	Shahebabad	10	0	229	0	-	1	0	262	0	-
Brahman Para	Brahaman Para	7	0	162	0	-	1	0	185	0	-
Brahman Para	Shashidel	14	0	338	0	-	2	0	386	0	-
Burichang	Bharella	14	0	327	0	-	2	0	373	0	-
Burichang	Mokam	14	0	326	0	-	2	0	373	0	-
Burichang	Mainamati	9	0	202	0	-	1	0	231	0	-
Burichang	Rajapur	4	0	98	0	-	1	0	112	0	-
Burichang	Pir Jatrapur	0	0	6	0	-	0	0	7	0	-
Burichang	Baksimail	1	0	12	0	-	0	0	14	0	-
Burichang	Burichang	-	0	0	0	-	-	0	0	0	-
Burichang	Sholanal	-	0	0	0	-	-	0	0	0	-

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Chandina	Karankhal	8	0	179	0	-	1	0	204	0	-
Chandina	Joyag	11	0	268	0	-	2	0	306	0	-
Chandina	Barkait	12	0	292	0	-	2	0	333	0	-
Chandina	Madhia	13	0	304	0	-	2	0	348	0	-
Chandina	Maijkhara	23	0	544	0	-	3	0	622	0	-
Chandina	Barera	8	0	196	0	-	1	0	224	0	-
Chandina	Delahi Nababpur	9	6	205	0	-	1	7	235	0	-
Chandina	Mahichal	9	12	208	0	-	1	14	238	0	-
Chandina	Shuhilpur	8	0	176	0	-	1	0	201	0	-
Chandina	Etbarpur	2	0	49	0	-	0	0	56	0	-
Chandina	Batakashi	6	0	147	0	-	1	0	168	0	-
Chandina	Gallai	7	0	158	0	-	1	0	180	0	-
Chandina	Bara Karai	10	0	237	0	-	1	0	271	0	-
Chauddagram	Kankapait	7	150	6	0	-	1	171	7	0	-
Chauddagram	Mushirhat	8	182	0	0	-	1	208	0	0	-
Chauddagram	Alkara	11	223	28	0	-	1	255	32	0	-
Chauddagram	Batisha	8	149	33	0	-	1	171	38	0	-
Chauddagram	Jagannath Dighi	7	145	22	0	-	1	165	25	0	-
Chauddagram	Sreepur	7	171	0	0	-	1	195	0	0	-
Chauddagram	Cheora	7	171	0	0	-	1	195	0	0	-
Chauddagram	Gunabati	12	287	0	0	-	2	329	0	0	-
Chauddagram	Kashinagar	8	129	57	0	-	1	147	65	0	-
Chauddagram	Shubhapur	14	320	0	0	-	2	365	0	0	-
Chauddagram	Gholpasha	4	77	19	0	-	1	88	22	0	-
Chauddagram	Chauddagram	2	46	9	0	-	0	53	11	0	-
Chauddagram	Ujirpur	1	3	27	0	-	0	3	31	0	-
Chauddagram	Kalikapur	-	0	0	0	-	-	0	0	0	-
Daudkandi	Maruka	16	378	0	0	-	2	432	0	0	-
Daudkandi	Padua	12	283	0	0	-	2	324	0	0	-
Daudkandi	Gauripur	6	150	0	0	-	1	172	0	0	-
Daudkandi	Biteshwar	8	185	0	0	-	1	211	0	0	-

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Daudkandi	Paschim Mohammadpur	7	152	0	0	-	1	173	0	0	-
Daudkandi	Purba Panchgachhi	6	135	0	0	-	1	155	0	0	-
Daudkandi	Uttar Elitganj	4	92	0	0	-	1	106	0	0	-
Daudkandi	Dakshin Elitganj	4	82	0	0	-	0	94	0	0	-
Daudkandi	Purba Mohammadpur	5	108	0	0	-	1	123	0	0	-
Daudkandi	Barpara	4	103	0	0	-	1	118	0	0	-
Daudkandi	Daulatpur	11	248	0	0	-	1	284	0	0	-
Daudkandi	Goalmari	12	271	0	0	-	2	309	0	0	-
Daudkandi	Sundalpur	5	110	0	0	-	1	126	0	0	-
Daudkandi	Jingaltali	2	42	0	0	-	0	47	0	0	-
Daudkandi	Uttar Daudkandi	1	34	0	0	-	0	39	0	0	-
Debidwar	Debidwar	24	273	298	0	-	3	312	341	0	-
Debidwar	Dhamti	12	73	200	0	-	2	83	228	0	-
Debidwar	Sultanpur (DD)	13	105	202	0	-	2	120	230	0	-
Debidwar	Uttar Gunaighar	11	94	157	0	-	1	107	179	0	-
Debidwar	Dakshin Gunaighar	11	118	147	0	-	2	135	168	0	-
Debidwar	Uttar Rajamehar	14	57	262	0	-	2	65	299	0	-
Debidwar	Bhani	14	121	199	0	-	2	139	227	0	-
Debidwar	Yusufpur	9	166	38	0	-	1	190	44	0	-
Debidwar	Mohanpur	13	126	176	0	-	2	144	201	0	-
Debidwar	Borkamta	14	222	105	0	-	2	254	120	0	-
Debidwar	Rasulpur	10	138	92	0	-	1	157	105	0	-
Debidwar	Bara Shaghar	8	149	47	0	-	1	170	54	0	-
Debidwar	Jaforganj	12	160	109	0	-	2	183	124	0	-
Debidwar	Subil	10	79	18	134	-	1	91	21	153	-
Debidwar	Fatehabad	17	327	72	0	-	2	374	82	0	-
Debidwar	Elahabad	11	216	43	0	-	1	247	49	0	-
Homna	Bhasania	10	189	51	0	-	1	217	58	0	-
Homna	Chander Char	14	322	0	0	-	2	368	0	0	-
Homna	Dulalpur	11	256	0	0	-	1	293	0	0	-
Homna	Asadpur	13	245	70	0	-	2	279	80	0	-

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Homna	Homna	12	282	0	0	-	2	322	0	0	-
Homna	Gharmura	9	208	0	0	-	1	237	0	0	-
Homna	Goypur	4	81	3	0	-	0	92	3	0	-
Homna	Ghagutia	12	291	0	0	-	2	333	0	0	-
Homna	Mathavanga	10	225	0	0	-	1	257	0	0	-
Homna	Nilakhi	12	280	0	0	-	2	320	0	0	-
Laksam	Paurashabha	31	0	715	0	-	4	0	818	0	-
Laksam	Bakai	18	281	140	0	-	2	321	161	0	-
Laksam	Modafar Gong	18	233	177	0	-	2	266	202	0	-
Laksam	Kandirpur	13	187	115	0	-	2	214	131	0	-
Laksam	Ajgara	10	130	103	0	-	1	149	117	0	-
Laksam	Uttardah	10	41	182	0	-	1	47	208	0	-
Laksam	Gobindapur	8	137	60	0	-	1	156	68	0	-
Laksam	Laksam Purbo	6	58	88	0	-	1	66	101	0	-
Meghna	Luterchar	5	112	0	0	-	1	128	0	0	-
Meghna	Radhanagar	6	134	0	0	-	1	153	0	0	-
Meghna	Barakanda	10	230	0	0	-	1	263	0	0	-
Meghna	Chalibhanga	4	102	0	0	-	1	117	0	0	-
Meghna	Gobindapur	7	154	0	0	-	1	176	0	0	-
Meghna	Chandanpur	1	27	0	0	-	0	31	0	0	-
Meghna	Manikerchar	1	26	0	0	-	0	29	0	0	-
Monoharganj	Baishgaon	11	241	21	0	-	1	275	23	0	-
Monoharganj	Hasnabad	9	196	23	0	-	1	224	26	0	-
Monoharganj	Maisatua	12	224	46	0	-	2	256	53	0	-
Monoharganj	Dakshin Jhalam	11	200	49	0	-	1	229	56	0	-
Monoharganj	Lakshmanpur	8	146	47	0	-	1	167	53	0	-
Monoharganj	Nather Petua	11	201	50	0	-	1	230	58	0	-
Monoharganj	Sorospur	12	229	52	0	-	2	261	59	0	-
Monoharganj	Khila	11	209	52	0	-	1	238	60	0	-
Monoharganj	Uttar Hawla	12	220	65	0	-	2	251	74	0	-
Monoharganj	Uttar Jhalam	11	214	31	0	-	1	245	36	0	-

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Monoharganj	Bipulashar	9	179	34	0	-	1	204	39	0	-
Muradnagar	Purba Bangara	9	97	9	0	106.4	1	111	11	0	122
Muradnagar	Paschim Bangara	10	115	128	0	-	1	132	147	0	-
Muradnagar	Chapitala	7	39	112	0	11.2	1	45	128	0	13
Muradnagar	Jatrapur	11	41	207	0	-	1	47	237	0	-
Muradnagar	Kamalla	10	31	122	0	76.4	1	35	140	0	87
Muradnagar	Purba Nabipur	12	144	144	0	-	2	165	165	0	-
Muradnagar	Paschim Nabipur	12	86	95	0	94.6	2	98	108	0	108
Muradnagar	Dak. Ramchandrapur	9	8	145	0	53.2	1	9	165	0	61
Muradnagar	Tonki	9	72	144	0	-	1	82	165	0	-
Muradnagar	Darora (Purba)	9	53	105	0	42.1	1	60	120	0	48
Muradnagar	Dhamghar	17	106	127	0	169.7	2	121	145	0	194
Muradnagar	Muradnagar	14	102	102	0	133.1	2	117	117	0	152
Muradnagar	Paharpur	10	100	100	0	21.9	1	114	114	0	25
Muradnagar	Babutiparha	10	60	159	0	16.8	1	69	181	0	19
Muradnagar	Paschim Purbadhair	8	24	146	0	19.5	1	28	167	0	22
Muradnagar	Uttar Ramchandrapur	8	24	167	0	-	1	27	190	0	-
Muradnagar	Sreekail	17	157	179	0	56.7	2	180	205	0	65
Muradnagar	Akubpur	11	117	150	0	1.5	2	133	171	0	2
Muradnagar	Chhaliakandi	6	36	100	0	9.0	1	41	114	0	10
Muradnagar	Jahapur	6	10	60	0	80.4	1	11	69	0	92
Muradnagar	Andikot	-	0	0	0	-	-	0	0	0	-
Muradnagar	Purba Purbadhair	-	0	0	0	-	-	0	0	0	-
Nangalkot	Adra	23	151	377	0	-	3	172	431	0	-
Nangalkot	Jodda	19	0	434	0	-	2	0	495	0	-
Nangalkot	Daulkhar	19	0	438	0	-	3	0	501	0	-
Nangalkot	Nangalkot	22	0	502	0	-	3	0	574	0	-
Nangalkot	Bakshaganj	9	71	141	0	-	1	81	162	0	-
Nangalkot	Dhalua	12	280	0	0	-	2	320	0	0	-
Nangalkot	Mokara	14	23	295	0	-	2	26	337	0	-
Nangalkot	Peria	10	74	166	0	-	1	84	189	0	-

Upazila	Union	Scenario 4: 30% Mini-Piped Systems					Scenario 4: 20% Village-Piped Systems				
		Proposed Mini-Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH	Proposed Pipe	Proposed DTW	Proposed DTW-T	Proposed DW	Proposed RWH
Nangalkot	Roykot	15	70	279	0	-	2	80	319	0	-
Nangalkot	Bangodda	8	0	183	0	-	1	0	210	0	-
Nangalkot	Satbaria	2	0	43	0	-	0	0	49	0	-
Sadar Dakshin	Perul South	23	403	134	0	-	3	461	154	0	-
Sadar Dakshin	Belghar	16	205	171	0	-	2	234	195	0	-
Sadar Dakshin	Perul North	12	230	46	0	-	2	263	53	0	-
Sadar Dakshin	Paurashabha	13	299	0	0	-	2	341	0	0	-
Sadar Dakshin	Bholain South	22	516	0	0	-	3	590	0	0	-
Sadar Dakshin	Barapara	11	29	233	0	-	1	33	266	0	-
Sadar Dakshin	Bijoypur	15	23	338	0	-	2	26	386	0	-
Sadar Dakshin	Baghmara	15	227	113	0	-	2	259	130	0	-
Sadar Dakshin	Bholain North	12	259	18	0	-	2	296	20	0	-
Sadar Dakshin	Choura	9	28	181	0	-	1	32	207	0	-
Sadar Dakshin	Galiara	6	16	116	0	-	1	18	132	0	-
Sadar Dakshin	Purba Jorekanon	0	1	10	0	-	0	1	11	0	-
Sadar Dakshin	Paschim Jorekanon	2	3	49	0	-	0	3	56	0	-
Titas	Bhitkandi	7	157	0	0	-	1	180	0	0	-
Titas	Majidpur	10	233	0	0	-	1	266	0	0	-
Titas	Satani	3	74	0	0	-	0	85	0	0	-
Titas	Balarampur	7	158	0	0	-	1	180	0	0	-
Titas	Jiarkandi	4	100	0	0	-	1	114	0	0	-
Titas	Narandia	5	125	0	0	-	1	143	0	0	-
Titas	Kala Kandi	3	60	0	0	-	0	69	0	0	-
Titas	Kari Kandi	3	71	0	0	-	0	81	0	0	-
Titas	Jagatpur	4	101	0	0	-	1	116	0	0	-
		1,750	19,421	20,002	515	892	233	22,195	22,859	589	1,020
		Total Capital Costs			$49,233,967		Total Capital Costs			$48,367,907	
		Total PV 20 years at 5%			$85,380,500		Total PV 20 years at 5%			$75,746,683	
		Total PV 20 years at 10%			$73,927,485		Total PV 20 years at 10%			$67,071,728	
		Total PV 20 years at 15%			$67,389,104		Total PV 20 years at 15%			$62,119,307	

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