Drinking Water State Revolving Fund
Green Project Reserve

Business Case Examples

A business case may have many formats. EPA does not require any specific format. Regardless of the format used, the business case should include all pertinent information needed to evaluate the project benefits.

These hypothetical examples follow the essential components of EPA's April 21, 2010 guidance for GPR business cases.

Project level data for business cases may include annotated engineering reports, water or energy audit information, and/or results of water system tests that may exist in project files and be summarized and referenced in the business cases.

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Pipe Replacement

Water Efficiency

Summary

- Replacement of 24,000 feet of pre-1930s lead-jointed cast iron (CI) distribution pipe with new 8-inch to 16-inch ductile iron (DI) pipe to eliminate the loss of 115 million gallons of water per year (MGY), equal to 10% of total production and 52% of total system water loss.
- SRF loan amount = $2,500,000
- Water saving (green) portion of loan = 100%
- Annual water savings = 115 million gallons (MG)

Background

- The water distribution system has approximately 80 miles of CI and DI distribution pipe ranging from 6 to 16 inches in diameter. The water system is 100% metered and includes a master meter (or production meter) at the source water supply (after treatment).
- As part of a water loss management plan,[1] the water utility calibrates all water meters every 5 years and conducts a leak detection survey every 2 years. Over the past 5 years the utility performed a physical condition assessment of 1% of the distribution pipes. The pipes were selected for assessment based on historic leak detection survey data.
    - Based on the assessment of 1% of the pipe, the utility concluded that the pre-1930s distribution pipe is in the poorest condition, has incurred the most leaks, and is most critical to replace.
- Pre-1930s pipe accounts for 17% (13.6 miles) of the 80 miles of distribution pipe. This project will replace 24,000 feet of pipe (4.5 miles or approximately 33% of the pre-1930s pipe) with 8-inch to 16-inch DI pipe.
    - The remaining 83% of the distribution system includes DI pipe installed between 1950 and 2000. Because this pipe has been found to be in better condition, there is no alternative pipe replacement project that would yield the same (or better) water efficiency gains.
- In 2010, the water treatment plant processed an average of 3 million gallons per day (MGD) or 1,095 MGY. Based on the water balance, the system had an authorized water consumption of 875 MGY. The total system water loss of 220 MGY is the difference between the water produced and the authorized consumption.
- The system water loss is comprised of the following:
    - Apparent losses of 0.05% based on water meter accuracy = 5.48 MGY (assume no losses due to unauthorized consumption or theft)
    - Real losses = 214.52 MGY
        - Transmission and distribution main leaks = 210 MGY
        - Storage tanks/overflows = 2.52 MGY
        - Service connection leaks = 2 MGY[2]
- The real losses correlate to 74.78 gallons/connection/day.[3]

Results

- 175 pipeline repairs were made during the last year. The highest frequency of repairs was in the pre-1930s pipes and equally distributed among all sizes.[4] In addition to the leak repair records, the leak detection survey, and condition assessment assisted with determining which sections of distribution mains are most prone to leaks and are the highest priority for replacement.[5]
- The utility concluded there is minimal water loss in pipes installed after the 1930s and estimates the 210 MGY of water loss through the distribution pipe is primarily from the pre-1930s pipe.

1 Water Loss Management Plan for the Hypothetical Drinking Water System. February 2011.
2 Leak Detection and Condition Assessment for the Hypothetical Drinking Water System. Updated August 2010.
3 The system has 7,859 connections.
4 Water Loss Management Plan for the Hypothetical Drinking Water System. February 2011.
5 Leak Detection and Condition Assessment for the Hypothetical Drinking Water System. Updated August 2010.

Pipe Replacement, continued

- Based on the condition assessment, the 24,000 linear feet of pipe selected for replacement is estimated to account for approximately 115 MGY of lost water.[6]
- The estimated 115 MGY of water loss from the pre-1930s pipe is 52% of the overall water loss of the system: 115 / 220 = 52%.

Conclusions

- By replacing the 24,000 feet of pipe, the utility anticipates conserving 115 MGY (52% of overall water loss); therefore, reducing the volume of water withdrawn, treated, and pumped from the reservoir.
- The cost to pump and treat water is $1.53 per 1,000 gallons. Cost savings from reduced leaks are estimated at $175,950 (115,000 * $1.53). The simple payback period of the loan is 14.2 years.
- Additional benefits include reductions in unnecessary pumping and operation and maintenance expenditures, and eliminating potential health hazards associated with waterborne pathogens entering the water distribution system.
- The energy savings of avoiding pumping the 115 MGY in water lost from the reservoir to the service connection, an elevation difference of 200 feet, is 103,600 kilowatt-hours (kWh) per year. The carbon emissions avoided from reducing this electricity consumption are equivalent to 74.4 metric tons of carbon dioxide.[7] (Note that the energy savings and carbon reduction calculations are not required for water efficiency business cases.)

6 Leak Detection and Condition Assessment for the Hypothetical Drinking Water System. Updated August 2010.
7 USEPA Greenhouse Gas Equivalencies Calculator, retrieved January 2011: http://www.epa.gov/cleanenergy/energy-resources/calculator.html.

Existing Water Meter Replacement

Water Efficiency

Summary

- Replacement of 288,000 broken, malfunctioning, and old water meters is estimated to eliminate the apparent loss of 514 million gallons of water per year (MGY) and reduce the system's non-revenue water.
- SRF loan amount = $750,000
- Water saving (green) portion of loan = 100%
- Annual water savings = 514 million gallons (MG)

Background

- The water distribution system serves 800,000 people and has approximately 320,000 residential connections. Total system water production is 51,388 MGY or 141 million gallons per day (MGD).
- Water meters for approximately 240,000 residential connections were installed in 1984. The remaining 80,000 meters were added with growth of the system. Of the 320,000 residential meters approximately 10% (or 32,000) are less than 10 years old.
- Based on industry standards, water meter replacement is recommended at least every 15 years.[1]
- The water utility recently implemented a water conservation and water loss mitigation policy. The replacement of the water meters is the first of several water loss optimization projects with a goal to reduce non-revenue water (including apparent and real water losses as well as unbilled authorized consumption).
- Additionally, the manufacturer's statement indicates a 25-year-old water meter is estimated to be 99% accurate (down from 99.9% at installation), and a 30-year old water meter is estimated to be 82% accurate.[2] Therefore, the option of continuing to use the existing water meters without replacement will likely lead to further reductions in water efficiency.

Results

- Based on a meter assessment, 288,000 meters were broken, malfunctioning or old. The majority of the positive displacement water meters installed in 1984 are malfunctioning (inaccurate readings), deteriorated, or broken; therefore, it was assumed that all water meters installed in1984 were in this same condition. In addition, 60% of the remaining meters (or 48,000 meters) installed since 1984 are in the same poor condition. Based on this assessment, each residential connection uses an average of 91,244 gallons of water per year.
- The annual apparent water loss attributed to the 288,000 broken, malfunctioning, and old meters is estimated to average 1,784 gallons per connection per year or 514 MGY (1% of annual system production).[3]

Conclusions

- The estimated 514 MGY of apparent loss is being consumed, but the water usage is not recorded; thus the value of the water loss is associated with the retail cost of the water. The associated cost of the apparent water loss is $3.80 per 1,000 gallons or $1,953,200 per year.
- By replacing meters and reducing apparent loss, the water utility will recover revenue that is currently being lost. However, some customers are expected to conserve water once they pay the full cost of their water use. The utility, therefore, estimates that after the water meters are replaced, it will recover $1,562,400 per year of additional revenue, which is 80% of the potential annual revenue ($1,953,200).
- Reducing the apparent losses increases the financial stability of the water utility, provides for a better understanding of actual water consumption, and aids in identifying real water losses.
- Accurate metering of water consumption is an important conservation measure because inaccurate metering misleads customers in regard to water consumption. Providing more accurate water bills will send a stronger price signal to customers and will result in more efficient water consumption.
- Water leakage and inaccuracy increases with water meter age; therefore, an investment in water meters today will generate increasing benefits in the coming years. Also, the water savings from the water meter replacement will extend the life of the water supply and delay the need for capital expansion projects.

1 AWWA M6, Water Meters – Selection, Installation, Testing and Maintenance, 1999.
2 User's Manual for Hypothetical Brand Residential Meters. January 1984.
3 Residential Meter Assessment for the Hypothetical Drinking Water System. July 2010.

Storage Tank Replacement

Water Efficiency

Summary

- Replacement of water storage Tank A will improve water efficiency of the distribution system by eliminating 1.8 million gallons per year (MGY) of water loss and providing additional water storage capacity.
- SRF loan amount = $410,000
- Water savings (green) portion of loan = 100%
- Annual water savings = 1.8 million gallons (MG)

Background

- Total system water production is 170 MGY or 465,753 gallons per day, and the water distribution system has 2 booster pump stations and 2 storage tanks with a capacity of 150,000 gallons (Tank A) and 750,000 gallons (Tank B).
- With the current system configuration, Tank A is 150 feet below Tank B. This configuration prevents water from flowing out of Tank A when Tank B is at normal operating levels (pressure difference of 65 pounds per square inch).
- As a result, the water in Tank A stagnates and loses its residual chlorine. The tank must be emptied and refilled periodically to ensure that potable water is available.
- Approximately 1.8 MG of water (3.4% of current use) is drained annually from the 150,000-gallon Tank A.

Results

- After performing a system evaluation, the water utility determined that replacing Tank A with a larger storage tank (340,000 gallon capacity) at the same elevation as Tank B will enable both tanks to drop and fill at similar levels, thus reducing the 1.8 MG of stagnant water that must be discarded annually from Tank A.
- Energy consumption was considered when evaluating the different alternatives for this project. An added benefit of the new tank configuration is that it will eliminate the pump station required to fill Tank A.
    - The other alternative considered was installing a booster pump to inject water from Tank A into the system. However, a new booster pump will increase energy use and costs as compared to a new storage tank located at the same elevation as the existing Tank B.

Conclusions

- Construction of a new water storage tank is the most cost-effective and sustainable solution.[1] The new storage tank will save 1.8 MG of water each year and reduce the utility's treatment costs.
- With a capacity of 340,000 gallons, the new tank will eliminate wasted water, reduce chemical use, improve service pressure, and increase the reliability of the utility's infrastructure.
- The annual water savings was calculated at $30,000,[2] and the simple payback period on this investment is less than 15 years.[3]
- Implementing the project will delay the need for plant expansions and will reduce the amount of water taken from the source water body, which is important for maintaining the quality of its habitat, especially during droughts.

1 Preliminary Engineering Report for the Hypothetical Storage Tank Replacement Project. March 2010.
2 Cost Benefit Analysis for Hypothetical Storage Tank Replacement Project. June 2010.
3 Preliminary Engineering Report for the Hypothetical Storage Tank Replacement Project. March 2010.

Treatment Process Selection

Water Efficiency

Summary

- Two alternatives were evaluated to reduce disinfection byproduct (DBP) concentrations: Granulated Activated Carbon (GAC) and ground water blending.
- Because the GAC backwashing operation uses 1.70 million gallons per day (MGD) of water, the innovative approach of blending ground water with treated surface water will be used to conserve water resources, reduce system costs, reduce DBP concentrations, and address non-compliance issues.
- SRF loan amount = $4,200,000
- Water savings (green) portion of loan = 100%
- Annual water savings (compared to a more conventional GAC system) = 620 million gallons (MG)

Background

- 19.1 billion gallons per year (BGY) is withdrawn from the only surface water source in the area: a river that contains significant levels of organic matter. Total organic carbon (TOC) in the surface water is 10 parts per million (ppm).
- DBPs are created as a result of chlorine disinfection of the treated water. The drinking water utility must modify its treatment and/or disinfection process to reduce the resultant annual average DBP concentration to a level below EPA's new regulatory standards.[1]
- Drinking water utility has rights to ground water that contains less than 0.1 ppm TOC.

Alternatives Evaluated

- An engineering feasibility study identified two potential treatment options to reduce DBP concentrations: GAC and ground water blending.[2]
- The GAC system was the first treatment option evaluated.[3]
  - o This treatment option included adding a GAC filter to the end of the treatment process where treated water would be filtered prior to pumping to the storage tank. The concrete GAC filter basin would be four feet high with an 8,100 square feet surface area.
  - o The initial cost (including installation) of the GAC system would be $8.5 million. The annual operation and maintenance cost includes $560,000[4] for replacement of the filter media.
  - o The filter requires daily backwashing, which would result in an additional 1.70 MGD of water used for treatment (620 MG of water per year).[5] The increased water consumption would result in an estimated $108,500 in additional annual electric costs.[6]
  - o Additionally, the average pressure of the water passing through the GAC would drop, thus resulting in increased pumping costs.
- Ground water blending was the second treatment option evaluated.[7]
  - o This treatment option consisted of diluting the treated surface water at the finished water storage tank with ground water (23% ground water to 77% treated water blend) to lower DBP concentrations in the finished water.
  - o Total project cost of $4.2 million is for the installation of the two miles of 36-inch pipe and ancillary equipment (e.g., fittings and valves) from the existing well field to the finished water storage tank. The average annual operating and maintenance cost (not including pumping costs) of the blending system is $100,000 per year.
  - o Based on modeling, during a peak demand day, 37 MG of treated surface water would be mixed with 11 MG of ground water withdrawn from the aquifer to provide 48 MG of water that meets all water quality standards.

1 1st and 2nd Qtr 2010 Water Quality Data for Hypothetical Water System.
2 Feasibility Study for Disinfection Byproduct (DBPs) Treatment Options. December 2010.
3 Feasibility Study for Disinfection Byproduct (DBPs) Treatment Options. December 2010.
4 Roy, 2010, AWWA Journal.
5 Backwash requires flushing with finished water for 15 minutes at 14 gallons per minute per square foot.
6 Calculations based on electricity bills and submeter electric data for 2010.
7 Feasibility Study for Disinfection Byproduct (DBPs) Treatment Options. December 2010.

Treatment Process Selection, continued

- o Prior to blending, 23% of the treated surface water in the storage tank will be diverted to injection wells to recharge other aquifers and replace the ground water withdrawn.
- o Ground water wells will be located at least 3,500 feet from the injection wells to maintain steady-state aquifer level change of about 17 feet from the high point where the treated surface water is injected to the low point where it is recovered. Because the aquifer is normally at a saturated depth of 130 feet, the injections and withdrawals should not significantly disturb the aquifer.
- o Because the upper portion or vadose zone of the aquifer is a desirable mixture of sand and unconsolidated clay, it will naturally filter out much of the TOC and DBPs as the treated surface (recharge) water infiltrates and recharges the water table.

Results

- With limited water resources and the need to conserve the water supply, the water utility selected the ground water blending option since it will not increase overall water consumption.
- In addition, the ground water blending technique was chosen over a GAC filter because the GAC system was determined to not be feasible due to backwash water waste, additional energy consumption, the life-cycle costs of the system, and the size of the filter required.

Conclusions

- The total life cycle costs of installation and operation and maintenance for the selected blending treatment option are $5.4 million; one-third of the total life cycle costs of $16.8 million for the GAC treatment system.[8]
- Blending ground water instead of using a conventional GAC system will avoid the withdrawal of 620 MG of water each year from the surface source, save $108,500 in energy costs, and will help maintain the riparian habitat of endangered wildlife. It will also avoid the purchase of GAC equipment and its associated operation and maintenance costs.

8 Life Cycle Cost Analysis for DBP treatment options. December 2010.

Pump and Motor Replacement

Energy Efficiency

Summary

- Replacing two large pumps and motors in a high-service pump station with new high efficiency pumps and motors will reduce the pump station's energy demand. The pump station building, located on the premises of the water treatment plant facility, was also upgraded with new pipe, valves and other equipment.
- SRF loan amount = $100,000
  - o $35,000 pump and motor replacement
- Energy efficiency (green) portion of loan = 35%
  - o The remaining 65% of the loan was used for a new single bay vehicle service garage and emergency generator.
- Annual energy savings = 49,736 kilowatt-hours (kWh) ($4,964 per year)

Background

- Results of an energy efficiency audit show that replacing the two large pumps and motors in the high-service pump station with energy efficient units will yield energy savings.
- The existing high-service pump station equipment is about 30 years old. The existing pumps are rated at 600 gallons per minute (gpm) at 154 feet with a manufacturer-rated efficiency of 77%. Existing motors were rated at 85%. Currently the actual operating efficiency for both the pumps and motors is probably lower because of the age of the pump system.

Results

- The proposed new pumps will have a rated efficiency of 89%.[1]
- The proposed new motors will have a rated efficiency of 93.5%.[2]

Calculated Energy Efficiency Improvements

- The efficiency (wire-to-water) of the existing pumps and motors = 77% * 85% = 65.5% (pump efficiency times motor efficiency) (Please see table below for details).
- The efficiency of proposed pumps and motors = 89% * 93.5% = 83.2% (Please see table below for details).
- The power required for each pump to operate can be calculated based on the pump capacity of 600 gpm and the Total Dynamic Head (TDH) of 154 feet.[3] The power required for an existing pump is 27 kilowatts (kW). The power required for a proposed pump is 21 kW.
- The annual power consumption for the existing or the proposed system can be calculated from the number of hours each pump operates. For the existing pumps the estimated annual power consumption is 232,975 kWh.[4] For the proposed pumps the estimated annual power consumption is 183,239 kWh.

1 Hypothetical Manufacturer Pump Specifications. Fall 2010.

2 Hypothetical Manufacturer Motor Specifications. Spring 2010.

3 The power consumption can be estimated for each case, if existing information is not available. Using the wire-to-water efficiency, the pump flow rate, Q (in gpm), and the total dynamic head, TDH (in feet), of the pumping system, the power consumption (in kW) = Q * TDH * 0.746 / (3960 * wire-to-water efficiency). In this case, the power = 600 gpm * 154 feet * 0.746 / (3960 * wire-to-water efficiency).

4 Assuming the new/modified pumping system will operate the equivalent number of hours per year as the existing system, then the annual electric power consumption for the existing and proposed pumping system (kWh/year) = power consumption (in kW) * the number of hours the pump-motor operates (from the pumping system's run time meters) in a single year.

Pump and Motor Replacement, continued

- As shown in the table below, the energy difference = (232,975 kWh - 183,239 kWh) = 49,736 kWh.

Energy Efficiency Calculations for Existing Pumps and Motors

Description	No. of Units	Capacity (gpm)	TDH (feet)	Power (Hp)[a]	Power (kW)[b]	Pump Eff [c]	Motor Eff [c]	Wire-to-Water[d]	Runtime (hr)[e]	Annual Consumption (kWh)[f]
Existing System	2	600	154	23.3	17.4	77%	85%	65.5%	4380	232,975
Proposed System	2	600	154	23.3	17.4	89%	93.5%	83.2%	4380	183,239
Total Energy Savings										49,736

Table Notes:
a. Power (Hp) = flow rate (Q) * TDH / 3960
b. Power (kW) = Q * TDH * 0.746 / 3960
c. Minimum efficiency at rated design point
d. Wire-to-water efficiency = pump efficiency * motor efficiency
e. Runtime assumes 365 days per year, 12 hours per day
f. Annual consumption (kWh) = No. of Units * runtime * Q * TDH * 0.746 / (3960 * wire-to-water efficiency)

Conclusions

- By replacing the pumps and motors in the high-service pump station, the utility will reduce energy use by 49,740 kWh annually.
- At 10 cents per kWh, energy reductions from the new pumps and motors will save up to $4,974 per year.
- Assuming the cost to purchase the new pumps and motors is $35,000, then the simple payback = $35,000 / $4,974/year = 7 years.
- Typically a payback period of less than 5-7 years is considered reasonable for a pumping system.

SCADA System for Pump Operation

Water & Energy Efficiency

Summary

- The installation of a supervisory control and data acquisition (SCADA) system to monitor the water level in a 2.5 million gallon storage tank will: (1) reduce storage tank overflows, (2) reduce energy consumption by enabling the remote start and stop of the finished water pump station, and (3) monitor pressure within the system and remotely start and stop booster pumps within the system.
- SRF loan amount = $185,000
- Water and energy saving (green) portion of loan = 100%
- Annual energy savings = 295,686 kilowatt-hours (kWh) (31.5% savings)
- Annual water savings = 600,000 gallons per year

Background

- The utility's annual production averages 365 million gallons per year (MGY). The peak daily demand is 1.5 million gallons per day (MGD). The distribution system includes one storage tank, two finished water pumps, and two booster pumps.
- 2.5 million gallon (MG) Storage Tank:
    - o The storage tank is located on a hillside that is inaccessible by vehicle; therefore, water utility staff must walk to the tank and manually read the tank level through a pressure gauge located at the tank. Utility staff complete this task on a daily basis.
- Finished Water and Booster Pumps:
    - o The characteristics of the finished water and booster pumps are summarized in the table below:

Description	Number	Horsepower (Hp)	Total Dynamic Head (TDH) (ft)	Gallons Per Minute (gpm)	Run Time (hours)
Finished Water Pumps	2	80	450	700	12
Booster Pumps	2	20	150	500	16

    - o The finished water pumps are turned on or off based on the water level of the storage tank and the booster pumps are operated manually based on pressure monitors located at strategic points within the distribution the system.
    - o During an energy efficiency audit, it was noted that the booster pumps were not operated efficiently because they appeared to be overdesigned (i.e. designed for the peak demand rather than for the average demand).[1]
    - o Due to the manual operation of the finished water pumps, the storage tank overflowed 5 times in the past year (consistent with the number of overflow events in previous years).[2] As noted in the table below, these overflows result in water losses totaling 600,000 gallons per year.

Number of Overflows	Estimated Duration (hours)	Flow Rate (gpm)	Gallons of Overflow Per Occurrence (gal)	Total Annual Overflow (gal)
5	10	200	120,000	600,000

Results

- Based on its evaluation of audit results, the utility installed a SCADA system to provide automated operation of the finished water pumps and booster pumps. SCADA remote terminal units (RTUs) will transmit signals of high and low water levels in the storage tank to the finished water pumps. Similarly, RTUs at the distribution system pressure sensors will transmit signals to the booster pumps.
- The automated operation of the pumps via the proposed SCADA system will reduce the run-time of the pumps. It is anticipated that the finished water pumps will operate an average of 8 hours a day and the booster pumps will operate an average of 12 hours a day after installation of the SCADA system.

1 Energy Audit for Hypothetical Drinking Water System, January 2011.
2 Preliminary Engineering Report for Hypothetical Drinking Water System, May 2010.

SCADA System for Pump Operation, continued

- Calculations:
  - o Power (kW) = flow rate (Q) * TDH * 0.746 / (3960 * wire-to-water efficiency[3])
  - o Power (kW) * hours operation * number of pumps = kWh annually[4]
  - o Finished water pumps have a wire-to-water efficiency of 72.98%
    - — Energy savings estimated at 240,363 kWh per year (33% savings) = $24,036.30[5]
  - o Booster pumps have a wire-to-water efficiency of 79.17%
    - — Energy savings estimated at 55,324 kWh per year (25% savings) = $5,532.40[6]

Conclusions

- The automation of the finished water and booster pump operation via the proposed SCADA system is estimated to provide an annual energy savings of 295,686 kWh or $29,569.
- Additionally, the automated operation of the finished water pumps will eliminate the 600,000 gallons per year of water lost from tank overflows that currently occur with manual pump operation. Because less treated water will be lost, this will correlate with a small savings in treatment and pumping costs as well.
- The simple payback of the proposed SCADA system is 6 years ($185,000 / $29,569/year).
- The proposed SCADA system will reduce the time spent by the operator to manually monitor the tank level and manually operate the pumps. In addition, this SCADA system will allow the operators to view the level of the tank, see its trending at any time, and be able to realize secondary energy cost benefits like off-peak pumping. The cost associated with manual tank monitoring and pump operation is estimated at $15,000.[7]
- Furthermore, the proposed SCADA system will provide a valuable means for tracking and optimizing the energy efficiency of the pumping system over the long term.[8]

3 The power consumption is estimated using the wire-to-water efficiency, the pump flow rate, Q (in gpm), and the total dynamic head, TDH (in feet), of the pumping system.
4 The annual electric power consumption for the pumping system (kWh/year) = power consumption (in kW) * the number of hours the pump-motor operates (from the pumping system's run time meters) in a single year.
5 Energy savings are the difference between the power consumption (kWh) calculated for the finished water pumps at 12 hours per day and at 8 hours per day.
6 Energy savings are the difference between the power consumption (kWh) calculated for the booster pumps at 16 hours per day and at 12 hours per day.
7 Two hours to read tank for 365 days a year, at a rate of $20/hour.
8 System Evaluation for Hypothetical Drinking Water System, January 2011.