NEBRASKA
DEPT. OF ENVIRONMENTAL QUALITY

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Cost and Effectiveness Analysis for Clean Water State Revolving Funds

Summary

With new changes to the Federal Water Pollution Control Act (FWPCA), all Clean Water State Revolving Fund (CWSRF) loan recipients must conduct a **Cost and Effectiveness Analysis** for applications submitted on or after October 1st, 2015. This requirement consists of preparing an engineering document evaluating the cost and effectiveness of the processes, materials, techniques, and technologies for carrying out the proposed project or activity, and selecting, to the extent practicable, a project or activity that maximizes the potential for efficient water use, reuse, recapture, and conservation, and energy conservation, taking into account the full lifecycle costs of the entire project, minimum performance requirements, constraints, goals, preferences, values, and other factors or considerations that impact effectiveness or add value.

A Cost and Effectiveness Analysis is an eligible cost for CWSRF assistance and it must be completed as a preliminary step before developing the final design for construction.

Introduction

On June 10, 2014, the Federal Water Pollution Control Act (FWPCA) was amended by adding Section 602(b)(13). See Interpretive Guidance WRRDA at the end of this document for EPA's interpretation on Cost and Effective Analysis that fits within the broader context of other FWPCA amendments.

EPA provided specific guidance on the Cost and Effectiveness Analysis. Please see links to the draft federal guidance Draft Supplemental Interpretive Guidance_602(b)(13) and Appendix III at the end of this document.

The Cost and Effective Analysis as written in the amendment is given below:

Section 602(b)(13)
As amended, the FWPCA now includes section 602(b)(13), which states:

> *(13) beginning in fiscal year 2016, the State will require as a condition of providing assistance to a municipality or intermunicipal, interstate, or State agency that the recipient of such assistance certify, in a manner determined by the Governor of the State, that the recipient—*
>
> > *(A) has studied and evaluated the cost and effectiveness of the processes, materials, techniques, and technologies for carrying out the proposed project or activity for which assistance is sought under this title; and*
> >
> > *(B) has selected, to the maximum extent practicable, a project or activity that maximizes the potential for efficient water use, reuse, recapture, and conservation, and energy conservation, taking into account—*
> >
> > > *(i) the cost of constructing the project or activity;*

(ii) the cost of operating and maintaining the project or activity over the life of the project or activity; and
(iii) the cost of replacing the project or activity;

Cost and Effectiveness Analysis

1. A professional engineer must certify they have studied and evaluated the processes, materials, techniques, and technologies to maximize the potential for efficient water use, reuse, recapture, and conservation, and energy conservation cost effectively for each feasible project alternative.

   1.1. If a CWSRF loan requires a Preliminary Engineering Report (PER), then the certification must be included in the Report. The PER must be sealed by a professional engineer. The seal fulfills the certification requirement.

   1.2. If a CWSRF loan does not require a PER, then certification must be submitted before the Finding of No Significant Impact (FONSI) or the Categorical Exclusion is issued. The certification must be signed by a professional engineer. The signature fulfills the certification requirement.

2. Identify the design criteria of the project that includes minimum performance requirements, project constraints, aid recipient's goals, preferences, and values.

3. Describe the technical feasible alternatives that satisfy the design criteria. A project may be broken into parts. Each part may consider several alternatives that address the needs for that part of the project such as different types of wastewater collection and conveyance, storage, treatment, land application, solids handling, etc. The alternatives for each part of the project are compared to find the most cost effective project part. Moreover, the project parts should integrate with the project as a whole to find the most overall cost effective project.

4. Consider the processes, materials, techniques, and technologies for carrying out the proposed project or activity that maximize the potential for efficient water use, reuse, recapture, and conservation, and energy conservation.

5. Calculate the lifecycle costs of each feasible alternative (see Lifecycle Cost Discussion at end of this document).

6. Compare feasible alternatives side by side showing lifecycle costs, effectiveness at meeting minimum performance requirements, and other factors or considerations that impact effectiveness or add value. Use numerical or qualitative ratings to show the advantages and disadvantages of each alternative. An engineer selects with aid recipients agreement the proposed project from the alternatives considered. Provide the recommendation in a narrative summary. If applicable, include in the discussion the factors or considerations that were decisive for choosing a higher lifecycle cost project.

7. Describe the outcomes of the project (project justification). Summarize the main outcomes of the proposed project and the secondary benefits. Describe the outcomes from each construction phase if the proposed project will be built in phases. Prioritize the outcomes as follows: 1) health, sanitation, and security, 2) regulatory compliance, 3) sustaining assets, i.e. restoring existing asset effectiveness, protecting existing assets, or reducing inflow and infiltration (I/I), 4) extending service to underserved areas or adding capacity, 5) other major outcomes/secondary benefits. In addition, describe needs that will not be addressed by the proposed project and discuss consequences or impacts if no project is undertaken.

Resources
Tools that may be used in conjunction with best judgment include rating the project with the ISI Envision rating tool found at http://www.sustainableinfrastructure.org/rating/* or HDR INC Sustainability Return on Investment tool: http://www.hdrinc.com/about-hdr/sustainability/sustainable-return-on-investment*. Similarly, other comprehensive rating systems or return on investment tools with robust environmental sustainability valuing system may be utilized as well.

EPA's Interpretive Guidance for Certain Amendments in the Water Resources Reform and Development Act

Draft Supplemental Interpretive Guidance 602(b)(13)

Draft Supplemental Interpretive Guidance Appendix III

Lifecycle Costs

Before discussing lifecycle costs, some definitions are in order such as design life, project alternatives, useful life of an asset, useful life of a project, salvage value, remaining depreciation, and return on investment.

Design Life
The design life of a project is the planned period of time that the project will meet the performance requirements of the intended purpose of the project. Capital project financing payment terms should not exceed the design life of the project or payments will continue after the planned project may become obsolete. Preliminary Engineering Reports (also called Facility Plans) generally plan for a 20-year design life, but may be any period determined reasonable by the engineer and concurred on by the state or federal agency

Project Alternatives
Preliminary Engineering Reports usually evaluate several **Alternatives** that meet the technical performance requirements. Feasible project Alternatives are considered to be "Alternatives". Infeasible design approaches are not considered to be "Alternatives"; however, infeasible design approaches should be listed with their major shortcomings as part of a complete discussion on project Alternatives.

Useful Life
Useful Life of an Asset. The useful life of an asset is the anticipated duration of time that the asset will provide enough performance value to keep the asset in operation. In many circumstances, the useful life of an asset is dependent on routine maintenance, rehabilitation, renewal, or replacement of component parts. See Table A and B on the following page for asset types with anticipated useful lives and examples of short lived assets (SLA) commonly found in wastewater treatment works.

Useful Life of a Project. The useful life of a project is the anticipated duration of time that the assets installed by the project will provide enough performance value to justify keeping the project assets in operation. Wastewater treatment works projects often consist of unit subsystems such as structures or equipment working together as part of a functional system. In many circumstances, the useful life of a project is dependent on routine maintenance, rehabilitation, renewal, and/or replacement of unit subsystems. Moreover, some projects consist of multiple functional systems where each functional system may have different useful life durations.

Examples of Useful Life of an Asset

1. Wastewater collection system:
   a. Force mains 60 years
   b. Interceptors and sewer mains 50 to 100 years
   c. Lift station equipment 20 years
2. Structures
   a. Buildings 60 Years
   b. Civil structures: concrete tanks or basins, lift station structures 75 years
   c. Outfall sewer lines 30 years
3. Process equipment and auxiliary equipment
   a. Pumps 8 to 40 Years
   b. Flow measurement 10 years
   c. Power generation systems 20 years
   d. Electrical 35 years
   e. SCADA components 5-10 years

Table A - Asset Type

Class	Asset Type	Useful Life Years
1	**Civil Infrastructure** (bridges, dams, large concrete infrastructure)	75
2	**Pressure Pipework**	60
3	**Sewers**	100
4	**Pumps**	40
5	**Valves**	30
6	**Motors**	35
7	**Electrical**	35
8	**Controls**	25
***8a**	**SCADA Programmable Logic Controllers** (as per SCADA International)	5-10
9	**Building Assets**	60
10	**Land**	300

Table is referenced from EPA Excel Spreadsheet Tool (XLS) Worksheet “A - Class and Condition” with a modification for line 8a to Table A-1 Effective Lives (Years). Contact NDEQ for a copy.

Table B - Common Short-Lived Assets (SLA) Wastewater Treatment Works

Treatment Related
Pumps motors and controls
Chemical feed pumps
Membrane, UV lamps
Valve actuators
SCADA, PLCS or Controllers
Aeration blowers, aeration diffusers, and nozzles
Field & Process instrumentation equipment: water sensors, pressure transducers, flow meters, etc.
Laboratory analyzers, centrifuges
Trickling filters, RBCs, etc.
Belt presses & driers
Sludge collecting and dewatering equipment
Chemical leak detection equipment
Hazardous atmosphere detectors
Digester cleanout, inspection and minor repairs
Collection System Related
Pumps and motors for lift stations
Lift station control system
Ventilations systems for lift stations
Televising (Condition assessment of sewers)
Treatment Works System Related
Generators, full load testing and generator servicing

Salvage Value

The salvage value as described in Clean Water SRF program is the net present value of the remaining straight line depreciation of an asset. The net present value of remaining depreciation of an asset must be included in a cost effectiveness analysis.

Salvage value as defined in an engineering economics text book may be omitted if it is not consequential towards the overall lifecycle cost of a project. In most cases, the actual salvage value of an asset is negative. It costs more money to remove and sell the asset at the end of its useful life than what it is worth. Moreover, the value of salvage, in most cases, is incidental compared to the initial capital cost, and operation and maintenance costs. For example, even newly installed sewer mains begin their useful life with zero or a negative salvage value as the costs to dig up and resell the mains would not return much cash.

An engineering text book definition: Salvage Value is the net cash value of an asset at the end of its useful life. The salvage value may be calculated by estimating the market value of selling the asset minus the estimated costs incurred to put the asset on the market, e.g. dismantling or handling costs. If the salvage value is significant, include the estimated net present salvage value as part of overall lifecycle costs.

Return on Investment (ROI) Calculations

The "profit" or ROI of a publically owned utility is essentially the value of safe drinking water that won't make you sick or the value of not living in your own sewer wastes. Therefore, a publically owned utility makes investment decisions not on how much dollar profit they expect to earn back from their investment but on installing assets cost effectively or cost efficiently as possible to achieve the desired outcome. A utility may also value other factors that add costs to a project such as adding measures to improve water conservation or protect water quality, energy efficiency, operation efficiency, operation effectiveness, or reduced risk such as fewer sewer sanitary sewer overflows and drinking water outages. In conclusion, a project should be chosen based on overall lifecycle costs, effectiveness at meeting minimum performance requirements, and other factors and consideration that impact effectiveness or add value.

Comparing Lifecycle Costs

Lifecycle costs are calculated from the cradle to grave, from initial capital costs and financing costs, operation and maintenance, renewal, and salvage costs. In order to compare the lifecycle costs of alternatives, plot the cumulative lifecycle costs of each alternative versus years. Consider plotting the costs over a time period equivalent to the useful life of the longest useful life alternative. The key for this type of comparisons is to renew the project assets to reach the useful life of the longest lived feasible alternative based on depreciation and or replacement of short lived assets (SLA). The plot lines will cross when comparing alternatives that have high initial capital costs and low operating costs versus low capital cost initial projects with high operation and maintenance costs. The crossover point projects the number of years the higher cost alternative will need to operate before it becomes the less expensive alternative. Of more importance than the crossover point especially if the plot lines do not cross, the differences between the plot lines provide the basis for comparing costs of one alternative to another over time.

When comparing lifecycle costs, it is best to compare cumulative lifecycle costs for each project on a single plot. Another way is to pick a time period to compare alternatives such as 20 year period. When the useful life of project assets exceed the time period, subtract the net present value of any remaining depreciation from the net present worth total of project costs. Lifecycle costs may be calculated with simple pay back that does not take into the time value of money or factoring in the time value of money considering the discount rate and the cost escalation rate. The discount rate also refers to the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows. Cost escalation is defined as changes in the cost or price of specific goods or services in a given economy over a period. The simple pay back is an easier calculation that provides a rough approximation that may be sufficient in many cases to compare project alternatives. Apply compounding factors such as discount rate with escalation rate to find more accurate lifecycle costs. Note that the farther out lifecycle cost calculations are projected for both simple payback and present worth payback, the more distorted and inaccurate the costs become.

The lifecycle costs calculations use 1) years of operation, 2) time value of money, 3) capital costs (construction and non-construction costs), 4) financing costs, 5) operation and maintenance costs (See Table C for examples of O&M costs), 6) rehabilitation, renewal and replacement costs, and 7) remaining depreciation. Note that the salvage value has been omitted as a calculation factor. Include it if it is significant. If the financing costs are included in an amortization schedule, use the amortization schedule in the lifecycle cost calculations. Otherwise, account for financing costs not included in an amortization schedule. In general, for drinking water project loans use an interest rate of 3.0% and for clean water loans use 2.5%. In general, use 20 year twice annual payments as the default terms of the amortization schedule. Lifecycle costs should be calculated at least as long as the amortization schedule terms, but no longer then the useful life of the longest useful alternative project. For the time value of money, use the discount rate and an escalation rate for specific goods and services. The discount rate is found in Appendix C of OMB circular A-94 and found at (https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c). The escalation rate is determined on a case by case basis depending on the asset. The discount rate and escalation rate may be used in combination to find the present worth of future dollars.

In order to operate a proposed project consisting of a functional system comprised of unit subsystems for as long as the design life or useful life of a project, each unit subsystems may require rehabilitation, renewal or replacement. For example, consider two alternatives: a trunk sewer main versus a four lift station sewer system. The trunk sewer main has a useful life of 100 years. Each lift station has a structure with a useful life of 60 years housing many component assets such as pump or motors with a component useful life of 35 years and other unit subsystems with 20 year useful life, and a control system with 10 years of life. Consider comparing the lifecycle costs for these two alternatives for 100 years of operation.

The lift station is scheduled for a major rehabilitation at 35 years, 60 years and 70 (2x35) years. Each time a lift station undergoes a major renovation the costs including financing costs if applicable are factored into the overall lifecycle costs. If the lift station structures are renovated at 60 years then at year 100 each of the four lift station structures will have 20 (60x2 – 120 = 20) years of life left. Similarly, if the pumps and motors are rehabilitated at 35 and 70 years, then the pumps and motors will have 5 years of remaining life left (35x3 – 100 = 5). The value of remaining useful life of the project may be omitted from lifecycle calculations if the lift station will be abandoned at year 100 or it may be factored into the lifecycle cost by using the net present value of remaining straight line depreciation if the lift station is likely to remain in use. In summary, compare the two project alternative lifecycle costs of the trunk sewer main with no major rehabilitation over 100 year useful life versus the four lift stations with all the renovations needed to achieve 100 years of operation.

A word of caution when calculating lifecycle cost out to 100 years, the actual true lifecycles cost may become greatly distorted. Even lifecycle costs over 20 years may introduce significant differences between actual and calculated lifecycle costs. However, the distortions introduced from lifecycle costs calculations tends to affect each alternative similarly, so the calculation still provides a useful comparison tool.

Remaining depreciation calculated from straight line depreciation is an artificial measure of remaining intrinsic dollar value of project assets; however, it is still a useful tool for lifecycle cost calculations. For example, the intrinsic dollar value of new purchases decreases faster at the beginning of their useful life than at the end. Moreover, the actual useful life an asset may be extended or reduced depending on the care and maintenance the asset receives. Similarly, although not easy to calculate, the intrinsic value of the as built project may change over time as the benefits from the services or deliverables generated from the project assets change. If a wastewater treatment works project reaches the end of its useful life, then any component assets with remaining useful life loses its remaining depreciation for lifecycle calculations. However, component assets may be still be recovered, if feasible, for another application as opposed to salvage as scrap, or abandoned in place.

Wastewater utilities may handle rehabilitation, renewal and replacement costs of component assets as ongoing operation and maintenance costs. These costs may be saved in advance with the use of sinking funds or a dedicated reserve. The funds transferred into the sinking fund or reserve each budget period is a cost for lifecycle calculations. Calculate the amount to transfer for each expensive component asset separately by dividing the original cost of the asset by the useful life of that asset (also called straight line depreciation). Then sum the calculated individual transfer amounts into a total lump sum to be placed in the sinking fund or reserve each budget period. Alternatively and more rigorously, the future cost of individual asset renovation and their remaining useful life may be used to calculate the present worth to be put into the sinking fund or reserve each budget period. Calculate the present worth of each asset separately and then sum each contribution to find the total to be transferred.

Instead of saving for a renovation by transferring funds into a dedicated reserve each budget period, a utility may pay for major renovations from their unrestricted reserves or with a loan. The costs of a major renovation include any associated financing costs if applicable. No matter how renovations are funded, include the costs in the lifecycle calculations.

Table C - Example of Operation and Maintenance (O&M) Cost Estimates

Operation and Maintenance Costs for Budget Period	**Costs**
Personnel (i.e. Salary, Benefits, Payroll Tax, Insurance, Training)	
Administrative Costs (e.g. office supplies, printing, etc.)	
Water Purchase or Waste Treatment Costs	
Insurance	
Energy Cost (Fuel and/or Electrical)	
Process Chemical	
Monitoring & Testing	
Professional Services	
Residuals Disposal	
Miscellaneous	
Transfer to reserve to replace short lived assets*	
Total $	

Note: An actual budget would also show transfers out of a budget to pay for shot lived asset replacements.

<u>Shortcuts for Alternative Lifecycle Cost Comparisons</u>

A lifecycle present worth cost analysis (an engineering economics technique to evaluate present and future costs for comparison of alternatives) should be completed to compare technically feasible alternatives. When a project encompasses two or more functional systems, each functional system should compare multiple technical feasible alternatives. For example, collection systems may compare replacement in kind versus cast in place pipe (CIPP) slip lining, open trenching versus bored in place, or mechanical treatment versus complete retention lagoons with or without land application. Each distinct functional system alternative should integrate with the whole project to obtain the most cost effective overall project. At least two alternatives should be evaluated per project or per functional system.

The lifecycle comparison shortcuts used in this section will not calculate actual lifecycle cost, but rather provide a simplified basis for comparing two or more alternatives lifecycle costs.

The design life or planning period to be used is recommended to be 20 years, but may be any period determined reasonable by the engineer and concurred on by the state or federal agency. State the actual number of years to be used to compare the lifecycle of alternatives.

If the loan amounts and the loan terms of two or more project alternatives are about the same, then lifecycle cost comparisons may omit financing costs such as payments toward principal interest or loan origination fees.

Sum annual O&M costs associated with new project assets. Convert O&M costs to present day dollars using a uniform series present worth (USPW) calculation. Include in the O&M annual costs for labor, material, energy, and byproduct/waste management costs/revenue, and annual transfer to dedicated replacement reserve.

Annual transfer to dedicated replacement reserve includes replacement costs of short lived assets (divide replacement cost by useful life for each SLA and sum the total to be transferred in the annual budget). Different features in the system may have varied lifecycles. Include in the short lived asset table, infrequent expensive O&M costs such as painting water storage tanks, water storage tank inspections, digester cleanout and inspections, generator full load tests, filter media replacement, UV bulb replacement, etc. Again divide infrequent large O&M costs by the interval period between the activity and sum the total to be transferred each budget period.

Use the capital cost (construction plus non-construction costs) for each feasible alternative.

The remaining depreciation (also called the salvage value in the Clean Water SRF program) of the constructed project should be estimated using the anticipated life expectancy of the constructed assets and straight line depreciation. Subtract the remaining depreciation after the planning period has elapsed from total project costs. Use a net present value calculation to find present worth of the remaining depreciation. Show discount rate, escalation rate, and combined rate if used in the calculation. For example if a lift station structure has a useful life of 60 years, determine the net present value of the remaining straight line depreciation for years 21 through 60.

Convert all costs to present day dollars. The discount rate to be used should be the "real" discount rate taken from Appendix C of OMB circular A-94 and found at (www.whitehouse.gov/omb/circulars/a094/a94_appxc.html). Use the discount rate and escalation rate to find the present value of uniform series and net present value.

i. Discount rate is the interest rate charged to commercial banks and other depository institutions for loans received from the Federal Reserve Bank's discount window. The discount rate also refers to the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows.

ii. Inflation is the rate at which the general level of prices for goods and services is rising and, consequently, the purchasing power of currency is falling.

iii. Cost escalation is defined as changes in the cost or price of specific goods or services in a given economy over a period.

The present worth of the remaining depreciation (also called the salvage value in the Clean Water SRF program) should be subtracted from the total present worth expenses. The net present value (NPV) is then calculated for each technically feasible alternative as the sum of the capital cost (C) plus the present worth of the uniform series of annual O&M (USPW (O&M)) costs minus the single payment present worth of the remaining depreciation (sometimes called the salvage value) (SPPW(S)):

NPV = C + USPW (O&M) – SPPW (S)

Show lifecycle calculations results and side by side comparison. A table showing the capital cost, annual O&M cost, remaining depreciation (sometimes called the salvage value), present worth of each of these values, and the NPV should be developed for state or federal agency review. All factors (major and minor components), discount rates, and planning periods used should be shown within the table.

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