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Energy Efficiency in Value Engineering: Barriers and Pathways

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ENERGY EFFICIENCY IN VALUE ENGINEERING: BARRIERS AND PATHWAYS

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ABSTRACT AND BENEFITS

Abstract:

Value engineering is a technique that wastewater treatment facilities (WWTFs) currently use, when required, to analyze cost reduction and performance optimization opportunities. The research explores the potential to address energy efficiency during value engineering analyses of WWTFs. The research identifies the Society of American Value Engineers (SAVE) International as the primary value engineering standards and certification organization and shows the six-step SAVE process for conducting value engineering analyses. A survey of WWTFs identifies four WWTFs that conduct value engineering analyses using the SAVE process. Then, the research reviews the analyses to determine their effectiveness in addressing process energy efficiency opportunities. While the SAVE value engineering process does not require identification of energy efficiency opportunities, the analyses conducted by the WWTFs do identify such opportunities. Based on survey results, WWTFs only conduct value engineering analyses when required, primarily because of the cost and time commitment. The research presents barriers to conducting value engineering analyses and discusses possible mitigation pathways. Pathways include 1) steps the State Revolving Fund can take, 2) development of a national value engineering standard that regulatory agencies can incorporate into wastewater system design requirements, and 3) development of WWTF-oriented energy efficiency training materials to add to SAVE's value engineer certification training.

Benefits:

- Documents WWTFs' current use of value engineering only when required by regulatory organizations and presents possible pathways to promote this practice for energy efficiency.
- Documents that WWTFs identify energy efficiency opportunities during value engineering analyses, though energy efficiency is not the focus of value engineering analysis.
- Presents a pathway through SAVE to add WWTF-oriented energy efficiency training materials to their value engineer certification training.
- Discusses a pathway to promote wastewater system value engineering through a national standard.

Keywords: SAVE International, wastewater treatment facility, national standard, energy efficiency.

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LIST OF ACRONYMS

ASTM	ASTM International – voluntary standards development organization; originally called American Society for Testing and Materials
AVS	Associate Value Specialist
CHP	Combined heat and power
CVS	Certified Value Specialist
DEC	New York State Department of Environmental Conservation
EFC	New York State Environmental Facilities Corporation
HRRSA	Harrisonburg-Rockingham Regional Sewer Authority
HRSD	Hampton Roads Sanitation District
MGD	Million gallons per day
MVF	Lawrence Delos Miles Value Foundation
MW	Megawatt
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NYC DEP	New York City Department of Environmental Protection
NYSERDA	New York State Energy Research and Development Authority
O&M	Operation and maintenance
SAIC	Science Applications International Corporation
SAVE	Society of American Value Engineers International
SRF	State Revolving Fund
10 States Standards	Wastewater treatment facility design standards prepared by the Wastewater Committee of the Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers
TR-16	*TR-16: Guides for the Design of Wastewater Treatment Works*, published by the New England Interstate Water Pollution Control Commission
U.S. EPA	United States Environmental Protection Agency
VA	Value Analysis
VE	Value Engineering
VMP	Value Methodology Practitioner
VPDES	Virginia Pollutant Discharge Elimination System
WEF	Water Environment Federation
WERF	Water Environment Research Foundation
WWTF	Wastewater Treatment Facility

EXECUTIVE SUMMARY

Lawrence D. Miles developed value engineering, also referred to as value analysis, while at General Electric in the early 1940s. A value engineering analysis is a defined process for improving the value of a project. Project value is improved when the amount of "resources" needed to perform a "function" is reduced. For instance, if a function is to "aerate water", then resources allocated to perform the function are capital, operation (including energy), and maintenance costs. A value engineering analysis identifies alternatives that reduce the resources (i.e., capital, operation [including energy], and maintenance costs) needed to perform aeration.

This value engineering practice study explores approaches to value engineering, identifying the six-step process developed by the Society of American Value Engineers (SAVE) International as the standard for evaluating value engineering analyses.

The study provides examples of the current use of value engineering in wastewater treatment facility (WWTF) projects. The study team identified municipalities that performed value engineering analyses as part of WWTF construction planning. The team found that municipalities tend to perform informal value engineering analyses that do not involve a SAVE Certified Value Specialist (CVS) and do not include the time and cost of the six-step SAVE value engineering process. While seven of the contacted municipalities performed value engineering analyses on past wastewater projects, only three followed the SAVE value engineering process. Projects that conducted a formal SAVE value engineering effort are generally larger in magnitude (i.e., $10 million or more) or are subject to a funding agency value engineering analysis requirement. For instance, the United States Environmental Protection Agency (EPA) requires value engineering analysis for WWTF projects greater than or equal to $10 million estimated construction cost (excluding sewers) receiving financial support in the form of EPA direct grants. EPA does not require that such analyses address energy efficiency.

The study analyzes the effectiveness of current value engineering studies in defining potential cost savings from implementing technology alternatives that increase treatment process energy efficiency. None of the municipalities contacted indicated specific value engineering activities focused on energy aspects. However, value engineering analyses conducted by the three municipalities that followed the SAVE value engineering process did identify energy-efficient alternatives (i.e., monitoring power, using premium efficiency motors, designing to use gravity feed versus pumping, implementing a biogas-fired boiler to reduce fuel costs, and designing two digester gas-fired engine-driven generators to match current loads rather than 20-year peak loads). Although VE does not specifically address energy efficiency in its approach, the VE assessment process often resulted in energy efficiency modifications to the planned design.

The study explores market transformation concepts, such as requirements for VE which apply to large projects receiving government funding, as a way to advance value engineering as a means to identify opportunities to increase wastewater treatment system energy efficiency. Secondarily, the study shows that value engineering analyses also identified cost savings opportunities for energy procurement (e.g., combined heat and power [CHP] and biogas production). Professional organizations, such as the Water Environment Federation (WEF), can

play a role in advancing value engineering with a focus on energy efficiency within the wastewater treatment community. Additionally, the study recommends incorporating value engineering into a national standard related to WWTF construction.

The study discusses the barriers to implementing value engineering analyses that focus on wastewater process energy reduction opportunities (e.g., cost of implementing the SAVE analysis, lack of a requirement to perform analysis, or no specific focus in value engineering on identifying energy reduction alternatives). Additionally, no national WWTF design guideline exists that could serve as a platform on which to incorporate value engineering with respect to wastewater process energy reduction. The study suggests a national design guideline as a pathway to implementing value engineering with a focus on energy reduction.

CHAPTER 1.0

INTRODUCTION

1.1 What Is Value Engineering Practice?

Value engineering is a technique in which the value of a system is increased by optimizing the mix of performance (function) and costs. In most applications, this practice identifies and removes unnecessary expenditures, thereby increasing the value of a product or structure.

While at General Electric in the early 1940s, Lawrence D. Miles developed value engineering, also referred to as value analysis, to manage production under material shortages faced during World War II.[1] Value engineering analysis is a process for improving the value of a project by reducing the amount of resources needed to perform a function.[2] For instance, if a function is to aerate water, then resources allocated to perform the function are capital, operation (including energy), and maintenance costs. A value engineering analysis identifies alternatives that reduce these resources needed to perform aeration.

1.1.1 How Does the Wastewater Sector Use Value Engineering?

SAVE International maintains that the use of value engineering improves the environment by providing a framework for infrastructure that provides environmental services, such as the domestic wastewater utility sector, to deliver safe, effective solutions that are also cost effective. Value engineering can achieve those objectives during the design of WWTFs. In fact, U.S. Office of Management and Budget Circular A-131 requires the use of value engineering for wastewater treatment projects that cost more than $10 million. SAVE claims that value engineering during project design produces the following results:

- Quick, creative, effective solutions
- Optimized environmental impact
- Maximized resources
- Optimized construction expenditures
- Lower life-cycle costs
- Alternative technology discoveries.

1.1.2 Overview of Energy Use by the Wastewater Utility Sector

Energy costs for wastewater system operations are a major portion of a utility's operating budget. Currently, facilities that manage domestic wastewater in centralized conveyance and treatment systems are an energy-demanding sector. Energy use accounts for about 35% of a WWTF's total cost to provide wastewater service, second only to labor costs. In certain municipalities, the wastewater treatment and collection system is the greatest user of electric energy of any local government service. The Electric Power Research Institute estimates that

[1] SAVE International, "Value Standard and Body of Knowledge," http://www.value-eng.org/pdf_docs/monographs/vmstd.pdf, June 2007, p. 7.
[2] ibid., p. 8.

domestic wastewater treatment and conveyance use 3% of the entire electrical energy produced in the United States.[3]

According to estimates published by U.S. EPA in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*,[4] the domestic wastewater sector is a significant greenhouse gas emitting sector, exceeded only by a few other activities, such as fossil fuel combustion, and by a few commercial industries, such as agriculture, iron and steel manufacturing, and the cement industry. The design of energy-efficient wastewater infrastructure is important to reducing the carbon footprint of wastewater treatment operations for any city or local government.

Wastewater managers have found that energy management can complement water quality objectives when facilities use efficient design and cost-effective products and processes. Wastewater utilities benefit from shorter payback periods, and, as public infrastructure, they have a financial commitment for long-term viability available through value engineering applied to new projects.

1.2 Energy Efficiency and Wastewater Facility Design

This value engineering practice study explores the potential to address energy efficiency in value engineering as applied during wastewater infrastructure projects, providing examples of current use of value engineering in WWTF projects. The study analyzes the effectiveness of current value engineering studies in identifying opportunities to increase treatment process energy efficiency. Secondarily, the study shows that value engineering analyses also identified cost savings opportunities for energy procurement (e.g., CHP and biogas production). It addresses barriers and pathways to implement value engineering and to achieve an associated reduction in wastewater process energy. The study explores market transformation concepts to advance value engineering as a means to identify opportunities to increase wastewater treatment system energy efficiency. The study presents a concept for incorporating value engineering into a national standard related to wastewater system construction. Also presented is a concept for professional organizations that promote standard practices, like the Water Environment Federation (WEF) to work with a national value engineering advocacy organization to play a role in advancing value engineering with a focus on energy efficiency within the wastewater community.

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[3] Electric Power Research Institute, *Quality Energy Efficient Retrofits for Wastewater Systems*, 1998. CR109081.
[4] U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Emissions and Sinks* (EPA 430-R-07-002), April 2007.

CHAPTER 2.0

OBJECTIVES AND APPROACH

Building on the professional practice of value analysis and the widely known benefits of value methodology, this study promotes the practice of value methodology in the domestic wastewater sector by demonstrating the benefit of energy reduction, and it seeks to improve the practice of value analysis in the area of energy management for wastewater utilities. In the United States, municipal WWTFs typically undergo major upgrades or expansions in a life cycle of approximately 30 years. As such, opportunities for incorporating energy-efficient systems into a plant's infrastructure best occur during the planning, design, and construction.

The overall objectives of this study are to: 1) develop WWTF-specific energy management information that can be incorporated into value engineering practice and 2) promote adoption among organizations specifying value engineering in WWTF design.

Supporting these objectives, this study: 1) identifies and evaluates professional organizations involved in promoting value engineering and in certifying value engineering practitioners and WWTF projects, 2) identifies WWTF value engineering projects and evaluates their effectiveness in relation to treatment process energy efficiency, 3) addresses market transformation concepts to facilitate use of value engineering within the WWTF community, and 4) evaluates the feasibility of establishing a national standard to promote WWTF value engineering, including implementation barriers and pathways.

CHAPTER 3.0

VALUE ENGINEERING INFORMATION SOURCES

Study participants collected information on value engineering practices from value engineering professional organizations, the U.S. EPA, and municipal wastewater treatment organizations that have used value engineering techniques. Then, they used these sources to define the elements of a value engineering analysis. The study team used the U.S. EPA source because the agency requires value engineering analysis for wastewater projects greater than $10 million that are funded with U.S. EPA direct grants.

3.1 Value Engineering Professional Organizations

The following paragraphs discuss the objectives and methodologies of two organizations that have promoted value engineering – SAVE International and Lawrence Delos Miles Value Foundation (MVF).

SAVE International – SAVE International, the primary value engineering standards and certification organization, offers a program to certify engineers as a Certified Value Specialist (CVS), Associate Value Specialist (AVS), or Value Methodology Practitioner (VMP). SAVE developed the following six-step value engineering process:[5]

Information Phase – Achieve a better understanding of the project goals and objectives. The team obtains and distributes project information to identify and prioritize issues of concern and to develop the study schedule. During this phase, the team defines project scope, schedule, budget, costs, risks, and non-monetary performance objectives and identifies high-level project functions and success parameters.

Function Analysis Phase – Develop a better understanding of what the project must do from a functional perspective. The team identifies project functions and develops function models that are dimensioned with cost drivers, performance attributes, and user attitudes to estimate function worth. This phase focuses the team on validating that the project satisfies the client's objectives. The team identifies value-mismatched functions on which to focus to improve the project.

Creative Phase – Brainstorm to identify better ways to meet project functions and generate ideas that may improve value.

Evaluation Phase – Select the best ideas from the Creative phase for further development. To initiate this process, the team categorizes ideas based on the way that they affect project cost and performance.

Development Phase – Develop the best ideas into value alternatives. Value alternatives consist of written information needed to convey the concept, including cost-benefit analyses, sketches, implementation steps, relative dates, and responsibilities.

[5] Documentation for the SAVE value engineering process appears in "Value Standard and Body of Knowledge", SAVE International, http://www.value-eng.org/pdf_docs/monographs/vmstd.pdf, June 2007.

Presentation Phase – Present and discuss value engineering recommendations. The team compares study conclusions to the success requirements established during the Information and Function Analysis phases, outlines an anticipated implementation plan, and prepares a formal report.

Lawrence Delos MVF – Founded by Lawrence Miles, considered to be the founder of value analysis (i.e., value engineering), MVF is a non-profit public foundation that promotes teaching of value methodology at the university level, promotes public awareness through publications and multimedia, and encourages research and development through scholarship and grant programs. With an academic and public awareness focus, MVF has marginal involvement with the professional world; however, MVF uses SAVE in various projects.

3.2 Information from Value Engineering Practitioners

The following information provides examples of federal and municipal authorities' practices in implementing value engineering analyses. In both cases, the SAVE value engineering process is the evaluation standard.

3.2.1 United States Environmental Protection Agency

The EPA requires value engineering analysis for wastewater projects greater than or equal to $10 million estimated construction cost (excluding sewers) that are receiving financial support in the form of EPA direct grants.[6] EPA does not require that such analyses address energy efficiency. Requirements for specific value engineering analysis content, such as addressing energy efficiency, must come from a state authority, such as the New York State Energy Research and Development Authority (NYSERDA).[7]

3.2.2 Municipalities

The study team identified 14 municipalities to identify which conduct value engineering analyses as part of wastewater system upgrade planning. The team selected municipalities for follow-up using the following criteria:

- Selection in New York and other states based on working relationships with the WWTF
- Identification of the WWTF by EPA as installing a CHP system (http://www.epa.gov/CHP/documents/chp_wwtf_opportunities.pdf).

Seven of the municipalities had performed value engineering analyses on past wastewater projects (Table 3-1). The team compared these analyses to the value engineering standard evaluation process defined by SAVE International (Table 3-2). Three of the seven municipalities followed the SAVE International six-phase value engineering process, including use of a SAVE CVS. One municipality used the SAVE six-phase value engineering process but did not use a SAVE CVS. The other three municipalities performed informal value engineering analyses.

Based on conversations with the municipalities, projects that employ value engineering analyses share the following characteristics:

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[6] EPA Construction Grant Regulations, Section 35.926 (Value Engineering), http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=ae66b29c76b73fd38ee9aa0f93fb5a3e&rgn=div8&view=text&node=40:1.0.1.2.32.4.142.63&idno=40, October 2009. The value engineering requirement under this section became mandatory in 1976.

[7] Telecommunication between Joe Cantwell (Science Applications International Corporation [SAIC]) and James Wheeler, P.E., DEE Associate Branch Chief, EPA Office of Wastewater Management, Municipal Technology Branch, October 2008.

- The majority of projects undertaken by the municipal utilities conduct informal value engineering that does not involve a SAVE CVS. Usually, the project design engineers are instructed to be cognizant of value engineering during the design phase.
- Projects that have conducted a formal value engineering effort are generally larger in magnitude (i.e., $10 million or more) or are subject to a funding agency value engineering analysis requirement.
- None of the municipalities indicated specific value engineering activities focused on energy aspects.

Following are comments on the degree to which certain municipal funding agencies require value engineering and require emphasis on energy efficiency in the value engineering analysis:

New York State Environmental Facilities Corporation (EFC) – EFC is the funding arm of the New York State Department of Environmental Conservation (DEC). The New York State governor's call for reducing energy demand has brought the New York State Department of Health, the DEC, and NYSERDA together to jointly promote the design, financing, and construction of energy-efficient and sustainable treatment facilities.[8] EFC is now considering a requirement for a comprehensive energy-efficiency measures evaluation for future major treatment facility upgrades. Application of value engineering practices, either formally or informally, likely would benefit these evaluations. Introduction of such requirements is in early stages of discussion at EFC.[9] Starting with current funding applications, however, consideration of energy efficiency will be expected in all facilities' plans or engineering reports. Future applications may require more formal documentation of energy-efficiency considerations in project planning.

Village of Essex Junction Wastewater Treatment Facility[10] – This project did not involve a formal value engineering effort because of the emerging and rapidly changing CHP technology and the way the project was bid. Bidders supplied performance data and recurring operation and maintenance (O&M) frequency and costs. Essex Junction entered all proposals into a model and evaluated life-cycle costs. The facility performed some value engineering through the various submittal stages; however, it did not use the SAVE value engineering methodology. Its approach was effective for the facility's needs. The facility's governing board required the project to have a simple payback of no more than seven years. To satisfy the payback period requirement, the facility reduced its funding obligation by obtaining funding from Efficiency Vermont, The Biomass Energy Resource Center, NativeEnergy, and the U.S. Department of Energy.

[8] New York State Environmental Facilities Corporation, "New York State Revolving Fund News", July 2008.
[9] O'Brien & Gere telecommunication with Jim Stearns EFC staff engineer, October 2008.
[10] O'Brien & Gere telecommunication with Jim Jutras, Water Quality Superintendent, Village of Essex Junction WWTF, August 2008.

Table 3-1. Survey to Identify Municipalities That Conduct Value Engineering Analyses as Part of Wastewater Treatment Facility Upgrade Planning.

State	Municipality/Agency	Contact/Title	VE Performed	Value Engineering Study Findings
VE Analysis Followed SAVE Process; SAVE-Certified Value Specialists Conducted the Analysis				
New York	Onondaga County/Department of Water Environment Protection	Randy Ott/ Commissioner	Yes	Wetzel Road Wastewater Treatment Plant and Sawmill Creek Pump Station performed VE to construct technically sound, cost-effective pumping and treatment facilities, while maximizing utilization of existing assets and minimizing impact on existing operations. VE efforts resulted in savings during the construction by reusing portions of the existing infrastructure (i.e., seven new buildings instead of the 11 buildings that were in the original design). The facility also experienced operational savings by using premium efficiency motors, power monitoring, and a boiler that burns biogas and by designing to allow for gravity flow, as opposed to pumping, where possible.
New York	New York City/ New York City Department of Environmental Protection (NYC DEP)	Harold Klinsky/ Deputy Assistant Director, Mayor's Office of Management & Budget	Yes	WWTF projects of more than $30 million must perform one VE study to receive funding from the NYC DEP[a]. NYC DEP can require any project to perform VE if it believes that it is necessary. NYC DEP requires projects of more than $80 million to perform two VE studies. SAVE CVSs perform all VE studies. New York City is developing guidelines for energy management but currently leaves energy management design practices to the discretion of the CVS during VE workshops.
Virginia	Mt. Crawford/ Harrisonburg-Rockingham Regional Sewer Authority (HRRSA)	Curtis Poe/ Executive Director	Yes	HRRSA value-engineered the 30% design for the expansion of the WWTF, which had been planned for increased flow and enhanced nutrient removal requirements. VE recommendations focused on downsizing the design to save cost, because the design incorporated future expanded flows that the facility would not realize for 20 additional years. HRRSA made additional structural recommendations that would reduce cost.
VE Analysis Followed SAVE Process; SAVE-Certified Value Specialists Did *Not* Conduct the Analysis				
Washington	King County Wastewater Treatment Division	Greg Bush/ Manager for Environmental and Community Services	Yes	King County value-engineered an engine generator installation design at its West Point Treatment Plant. The study concluded that a cogeneration system using available digester gas would cost the plant more over the life of the project because of its existing low electric rate, which reduces the economic benefit of self-generation. However, the study recommended that King County move forward with construction and installation of the previously purchased equipment for the following reasons that improve life-cycle economics: 1) the plant can use steam from the cogeneration system in its WWTF processes, 2) the system provides a hedge against higher future electric rates, and (3) value-engineered modifications to the original design would reduce costs.

Conducted Informal Analysis That Incorporated VE Elements; Did *Not* Use SAVE-Certified Value Specialists				
Massachusetts	Town of Dartmouth/ Department of Public Works, Water Pollution Control Division	Carlos Cardoso/ Water Pollution Control Manager	Yes	In 1992, a team performed a VE study for the construction of the Dartmouth WWTF; unfortunately, these documents are not available. Over the last several years, the facility has made improvements in energy efficiency, consisting of the installation of energy efficiency lighting and variable frequency motor drives. The Town works with the energy utility ENSTAR and takes advantage of incentive programs that help pay for upgrades. When performing upgrades, the Dartmouth considers payback periods of two - five years acceptable.
Pennsylvania	City of Lancaster/ Department of Public Works, Wastewater Bureau	Gary Bowers/ Plant Supervisor	Yes	The City of Lancaster currently works with Pennsylvania Power and Light to increase energy efficiency at the WWTF. When performing facility upgrades, the city bases its decisions on cost, performance, future scenarios, available finances, and energy efficiency. In deciding the type of process or technology to use, it often considers alternative technologies; however, the technology that will fit best with the existing facility weighs heavily in the decision-making process.
Vermont	Village of Essex/ Essex Junction WWTF	Jim Jutras/ Water Quality Superintendent	Yes	Essex Junction performed a CHP upgrade at the village WWTF[b]. It did not specifically value-engineer the CHP installation because the village had incorporated value into its bid selection process for the project. The village developed a bid specification that was part design/build and part performance. In the bid package, it provided existing conditions and performance requirements. Essex Junction asked bidders to respond with design/build solutions that would deliver the required heat and power. Bidders had to supply performance data and specify recurring O&M costs and O&M frequency. Essex Junction WWTF ran proposed costs and performance through its life-cycle cost model. Because the proposed CHP upgrade was a retrofit installation, the WWTF did some value engineering through the various submittal stages; however, the value engineering analysis was not complete.

Notes:

a Harold Klinsky, New York City Mayor's Office of Management & Budget, and O'Brien & Gere, conference call, September 17, 2008.

b Based on e-mail from Jim Jutras, Water Quality Superintendent, Village of Essex/Essex Junction WWTF, Vermont, August 29, 2008.

c VE stands for value engineering.

Table 3-2. Value Engineering in Wastewater Treatment Facility Projects.

State	Municipality/Agency	SAVE International Six-Phase Process: Information	Function Analysis	Creative	Evaluation	Development	Presentation
VE Analysis Followed SAVE Process; SAVE-Certified Value Specialists Conducted the Analysis							
New York	Onondaga County/ Department of Water Environment Protection	●	●	●	●	●	●
New York	New York City/ NYC DEP	●	●	●	●	●	●
Virginia	Mt. Crawford/ HRRSA	●	●	●	●	●	●
VE Analysis Followed SAVE Process; SAVE-Certified Value Specialists Did *Not* Conduct the Analysis							
Washington	Seattle/King County Wastewater Treatment Division	●	●	●	●	●	●
Conducted Informal Analysis That Incorporated VE Elements; Did *Not* Use SAVE-Certified Value Specialists							
Massachusetts	Town of Dartmouth/ Department of Public Works, Water Pollution Control Division	●		●		●	
Pennsylvania	City of Lancaster/ Department of Public Works, Wastewater Bureau	●		●		●	
Vermont	Essex Junction WWTF				●	●	

Note: VE stands for value engineering.

CHAPTER 4.0

WASTEWATER TREATMENT FACILITY PROJECTS EMPLOYING VALUE ENGINEERING

In Section 3.2.2, this study identifies four recent major WWTF projects that followed the SAVE value engineering process as part of the municipal WWTF projects survey. CVSs conducted three of these value engineering analyses following all steps in the SAVE process. The value engineering analysis conducted in King County followed the SAVE process, but a CVS did not conduct the analysis. This section discusses the objectives and findings of the SAVE analyses performed at three of these sites. Value engineering analysis information is not available for the NYC DEP project.

4.1 New York – Onondaga County/Department of Water Environment Protection

When this project began, the 3.5 MGD Wetzel Road Wastewater Treatment Plant and the Sawmill Creek Pump Station had been in operation more than 30 years and were rapidly approaching the end of their useful lives. The plant operated at or above its design capacity during periods of wet weather. Significant features of this project included:

- Replaced the existing Sawmill Creek Pumping Station.
- Upgraded the existing Wetzel Road Wastewater Treatment Plant (doubling the treatment capacity, while complying with new and more stringent effluent requirements).
- Maximized utilization of existing treatment plant assets.
- Designed technically sound, cost-effective pumping and treatment facilities.
- Participated in the value engineering process to maximize the county's return on investment, while achieving goals and objectives.
- Designed new and upgraded facilities to fit within the existing tight site and to protect the surrounding wooded wetlands.
- Maintained treatment operations and effluent water quality during construction.

Project Objectives – The county's goal for this project was to construct technically sound, life-cycle cost-effective pumping and treatment facilities, while maximizing utilization of existing assets and minimizing the impact on existing operations (i.e., preserve water quality).

Value Engineering Findings Summary – The value engineering efforts resulted in savings during construction by reusing portions of the existing infrastructure (i.e., seven new buildings instead of the 11 buildings that were in the original design). The project also experienced operational savings by using premium efficiency motors, power monitoring, and a boiler that burns biogas and by designing to allow for gravity flow, where possible, as opposed to pumping.

4.2 Virginia – Mt. Crawford/HRRSA

HRRSA value-engineered the 30% design for the expansion of the WWTF, which had been planned for increased flow and enhanced nutrient removal requirements. The team used the six-phase value engineering job plan to guide its deliberations.

Project Objectives – HRRSA engaged in the value engineering study with the goal of identifying alternatives that would allow it to meet its Virginia Pollutant Discharge Elimination System (VPDES) permit requirements more cost-effectively.

Value Engineering Findings Summary – The study presented several alternatives to save project costs. Value engineering recommendations focused on downsizing the design to save cost because the design incorporated future expanded flows that the facility would not realize for 20 additional years. HRRSA made additional structural recommendations that would reduce cost.

4.3 Seattle/King County, Washington

King County value-engineered an engine generator installation design at its West Point Treatment Facility. The value engineering began after King County had already entered into a purchase agreement for two engine generators and related equipment and had a natural gas line installed to serve as a backup fuel source for the engine generators.

Project Objectives – The county conducted value engineering because bids for the construction and installation of two 2.3 MW Caterpillar Model 3612 engine-driven generators came in significantly higher than the original engineer's estimate of probable costs.

Value Engineering Findings Summary – The county completed work on this project through a series of steps that deviated from SAVE International's six-phase process. However, its approach comprehensively included the same methodology. Initially, the project team defined seven alternatives to be developed and considered in the study. Next, a project team conducted a survey to develop and prioritize evaluation criteria. Subsequently, the team applied the criteria to eliminate five of the seven alternatives. The team then developed the two remaining alternatives to a conceptual design level and quantified full life-cycle costs to enable a cost comparison and a final recommendation.

The study identified several areas of the original design that the county could modify to reduce project costs. Initially, the study concluded that a cogeneration system using available digester gas would add cost to the treatment facility over the life of the project, in part because the low King County electricity rate reduced the economic benefit of self-generation. However, the study recommended that King County move forward with construction and installation of the previously purchased equipment for the following reasons that improve life-cycle economics: 1) the facility can use steam from the cogeneration system in WWTF processes, 2) the system provides a hedge against higher future electric rates, and 3) value-engineered modifications to the original design would reduce costs.

CHAPTER 5.0

VALUE ENGINEERING'S EFFECTIVENESS IN ADDRESSING PROCESS ENERGY EFFICIENCY IN WASTEWATER TREATMENT FACILITY PROJECTS

The following paragraphs evaluate the effectiveness of the three value engineering projects discussed in Chapter 4.0 in relation to treatment process energy efficiency.

5.1 New York – Onondaga County/Department of Water Environment Protection

Value engineering identified the following projects to improve energy efficiency at the WWTF site: power monitoring, premium efficiency motors, and designing to use gravity feed versus pumping. Additionally, the biogas-fired boiler exemplifies fuel-switching to reduce fuel costs.

5.2 Virginia – Mt. Crawford/HRRSA

This value engineering study recommended downsizing the design to match current loads, rather than 20-year peak loads. The implication is that the facility would scale up WWTF systems in the future, as merited by load growth. This design approach results in near-term energy savings.

5.3 King County, Washington

The West Point Treatment Facility value engineering study was effective in reducing the costs associated with construction and installation of two engine-driven generators for beneficial use of digester gas. The team addressed energy efficiency throughout the project. The project team identified the following criteria, including energy efficiency and digester gas, to evaluate utilization technology opportunities. The percentages, indicating criterion priority, represent the percentage of the survey audience that felt a specific criterion was important:

Proven and reliable system	100%
Beneficial use of digester gas	90%
Schedule impact	90%
Net revenue versus O&M costs	79%
Energy efficiency	65%
Impact on emissions	63%.

CHAPTER 6.0

BARRIERS AND PATHWAYS TO IMPLEMENTING VALUE ENGINEERING WITH ENERGY REDUCTION FOCUS

6.1 Barriers

Following are barriers in the wastewater sector to implementing value engineering with a focus on energy reduction:

Constrained Budget Barrier. Municipal budgets are constrained and cannot handle the cost of a formal value engineering analysis.

Requirement Barrier. Value engineering analyses are performed usually when required but not otherwise. As stated in Section 3.2.2, the study observed that value engineering analysis using the six-phase SAVE process usually were required to do so by a funding agency. In particular, funding agencies were found to require SAVE value engineering analyses for large projects (i.e., more than a $10 million capital investment); value engineering analyses for large projects are likely to identify cost savings opportunities that are high enough to increase return on investment and to justify the cost of the analysis.

National Standard Barrier. No nationally recognized wastewater system design guidance is uniformly accepted, making it difficult to implement a national standard that would make energy reduction and energy recovery a focal point. Several states use the 10 States Standards as guidance; other states use TR-16. Some states have their own unique set of guidance documents.

Value Engineering Lacks Energy Reduction Focus Barrier. The formal value engineering process is general in nature and does not state that energy reduction should be a focal point.

6.2 Pathways

Following are possible pathways to mitigate barriers to implementing value engineering with a focus on energy reduction:

Constrained Budget Barrier. Principal forgiveness or low interest loans offered by the loan agency (i.e., the State Revolving Fund [SRF]) offer creative solutions that could enable municipalities to pay for a value engineering analysis out of loan payment savings. Also, value engineering is usually performed on large projects (i.e., projects that fall under the EPA rule for grants greater than or equal to $10 million), which are most likely to realize the highest savings as a result of value engineering recommendations. Principal forgiveness and low interest loans generate cost savings for all ranges of project size, making it more likely that smaller projects could pay for value engineering analyses.

Requirement Barrier. Facilities can reduce the requirement barrier as they develop pathways to address other barriers. For example, because of cost and time commitment, a facility usually performs a formal SAVE value engineering analysis only when required. If a municipality adopts pathways that mitigate the constrained budget barrier, then a value engineering analysis will be more affordable to the municipality. Currently, value engineering analyses do not have an energy reduction focus unless it is a municipal requirement. Pathways that enhance the energy reduction focus (e.g., SAVE's addressing energy reduction as a focal point in its certification training and governing agencies' implementing a national value engineering standard) should help municipal wastewater systems justify value engineering analysis based on financial benefits rather than as a requirement.

National Standard Barrier. Governing agencies should develop and implement a national standard that would be available for all states to adopt. Municipalities would be able to include these standards in their procurement documentation with little to no incurred cost to them. An appropriate venue for disseminating this national standard would be through a nationally recognized wastewater organization such as WEF.

A national standard could include guidance that would identify typical major energy-intensive processes or equipment at WWTFs (e.g., aeration systems, pumps, mixers, solids handling facilities, boilers, and lighting) and suggest the performance of a life-cycle analysis of these operations. It could also establish procedures for identifying and evaluating areas where system efficiency improvement measures and renewable energy alternatives would be most applicable. Examples of these measures include solids stabilization, aeration, CHP, use of timers, motion sensor lighting, and alternative fuels for vehicles.

Value Engineering Lacks Energy Reduction Focus Barrier. Section 6.4 presents the pathway through SAVE to develop energy reduction as a value engineering focal point.

6.3 Feasibility of National Standard for Value Engineering of Wastewater Systems

The majority of the projects reviewed in Section 3.2.2 had an informal value engineering effort that did not involve a SAVE CVS. Usually, the owner or funding/regulatory agency instructed the design engineers to be cognizant of value engineering during the design phase. A national standard for wastewater system value engineering would provide wording that municipalities and funding/regulatory agencies could adopt and incorporate into procurement documents to ensure that value engineering is part of the wastewater system design development process and that the value engineering analysis addresses energy-intensive functions in the wastewater. The national standard could provide examples of energy-intensive wastewater system functions and energy-efficient solutions in a supplement to its wording. *ASTM E1699-00(2005) Standard Practice for Performing Value Analysis (VA) of Buildings and Building Systems* is an example of a national standard that applies value engineering to a specific application (i.e., buildings).

6.4 Pathways through the SAVE Foundation to Promote Value Engineering in Wastewater Treatment Projects

The following recommendations address ways in which WWTFs that already perform value engineering analyses for their projects can elevate the focus on energy efficiency and energy management within these analyses. Analysis using the six-step SAVE process has been established as the standard for value engineering (see Chapter 3.0). Examples in Chapter 5 explore how facilities can address energy efficiency and energy management considerations under all phases of the six-step SAVE value engineering process. The following recommendations grow out of these observations and discussions with SAVE:[11]

Explore a collaborative agreement between wastewater sector professional organizations such as WEF and SAVE. This vehicle would be a memorandum of understanding that enables cross-promotion of interests. The agreement would enable a wastewater sector professional organization and SAVE to reach into the value engineering specialists community to elevate energy efficiency and energy management as a value engineering focus. For instance, jointly, SAVE and a wastewater sector professional organization could develop communications (e.g., through SAVE conferences and publications, including the monthly SAVE newsletter, *Interactions*, and the SAVE journal, *Value World*) that address energy efficiency and energy management as a value engineering focus for a WWTF project.

Develop SAVE CVS certification training material that addresses WWTF energy efficiency and energy management opportunities as a value engineering focus. Stakeholders could develop training modules for the two modules in the SAVE certification training sequence. CVS is the highest of SAVE's three certification levels. A SAVE CVS must pass both modules for certification. Module 1 covers the six-step SAVE value engineering process, including basic cost analysis; it provides a basic foundation for understanding value engineering, enabling the CVS to participate in value engineering studies. Module 2 extends training such that those completing it successfully are certified as experts (CVS) who can lead value engineering studies.[12] Because development and revision of SAVE training material for Modules 1 and 2 are on a four-year cycle, the society could take near-term intermediate steps to address energy efficiency and energy management as a value engineering focus for a WWTF project. For instance, the development of a model approach to a wastewater project could be incorporated into the modules as an example. Although being a CVS is not necessarily a requirement for a successful path forward, it would serve to give more exposure to a value engineering focus on energy efficiency and energy management.

Work with municipalities and regulatory agencies to promote value engineering for energy management. This recommendation would include reaching out to those engaged in the wastewater treatment field to obtain consensus on reasonable means (e.g., policy and procedures) to foster energy management's consideration during value engineering analyses. Continued dialogue with these groups could help in determining ways to incorporate findings into guidelines and standards of practice. The objective would be to increase use of energy efficiency and energy management best practices in future value engineering projects. Research indicates that regional groups responsible for standards such as 10 States and TR-16 should not be part of this effort. These organizations are not proactive in promoting new standards; they adopt standards that are already common practice among their member states.

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[11] Teleconference with David C. Wilson, P.E., CVS, President, SAVE International, and SAIC and O'Brien & Gere, October 16, 2008.

[12] A discussion of training contents for each module appears at the following web site: http://www.value-eng.org/education_seminarmanual.php, November, 2008.

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