Strategies for Sustainable Construction Using a Unique Rating System: A Case Study

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The Envision™ sustainable infrastructure rating system is administered through the Institute for Sustainable Infrastructure (ISI) and designed to help users identify ways in which sustainable approaches can be used to plan, design, construct, and operate infrastructure projects. Applying this rating system to utility infrastructure, such as a water resource reclamation facility (WRRF), can provide owners, planners, managers, designers, and contractors with a practical, numerical measure of sustainability. Hillsborough County (County) is currently expanding its South County Advanced Wastewater Treatment Facility (AWTF) from 4.5 to 10 mil gal per day (mgd), a construction project that totals over $68 million.

Although the project was not submitted to ISI for official verification and award, the rating system was applied to the construction phase in order to assess sustainability measures carried out during this particular phase of the project. The County retained three onsite resident observers, one of whom is credentialed by ISI as an Envision Sustainability Professional (ENV SP). The perspective from which this article was written is unique—18 months of full-time construction experience as a resident engineer on the job site, coupled with being an ENV SP and having knowledge of applying the rating system to other projects. This allows for the perfect marriage of construction knowledge and the rating system, with the benefit of identifying specific strategies that can be done to improve the sustainability of the project. This perspective leads to the ability to align the rating-system aspects with the dual nature of sustainability during construction.

This article presents examples of how the rating system can be used during utility construction projects to improve sustainability performance. For example, effective coordination through the use of meetings and written plans reduces the chance of issues arising during scheduled plant shut-downs and helps resume reliable plant operations and service for customers. The rating system provides a practical measure of sustainability, making it easier to assess, manage, and improve the conditions of civil infrastructure and contribute to overall utility sustainability. This rating system has become increasingly recognized by project owners, planners, managers, and designers as an appropriate water infrastructure rating tool since its introduction in 2012.

A description of, and the need for, this rating system are presented from various perspectives, and numerous strategies for sustainable construction through the case study example at the AWTF are described.

Sustainable Construction Defined

In their book, *Design for Sustainability*, Ji and Plainiotis define sustainable construction as "a process that is environmentally responsible and resource-efficient throughout a building's life cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages." Even though they state that the process is through a *building's* life cycle, this definition can also be applied to the life cycle of facilities and infrastructure, such as WRRFs, pipelines, and pump stations. Furthermore, this definition highlights the importance of cooperation among all parties involved with the project at all stages.

Need for a Sustainable Infrastructure Rating System

The American Society of Civil Engineers (ASCE) assessed the conditions of 15 categories of civil infrastructure. To communicate the results of its study, ASCE produced a report card that states that the current condition of America's infrastructure should receive a grade of D (poor condition). For the drinking water and wastewater categories, leaking pipelines and pump failures are examples contributing to this low grade. The ASCE estimates that a five-year investment of $2.2 trillion would bring America's infrastructure grade to a B (good condition). It would be beneficial to have a rating system that covers these categories so that money for infrastructure projects is well spent.

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Water professionals familiar with the Leadership in Energy and Environmental Design (LEED™) rating system recognize that it focuses on buildings and facilities. What LEED does not provide is a comprehensive system to evaluate the sustainability of civil infrastructure projects. Therefore, the Envision infrastructure sustainability rating system was developed by ISI in partnership with the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design. No other United States rating system covers all aspects of civil infrastructure, so Envision was developed, in part, to fill this gap.

The Envision Rating System

This rating system has several components, including a self-assessment checklist, the rating tool, a credential program for individuals, a project evaluation and verification program, and a recognition program. The system is structured around five categories: quality of life, leadership, resource allocation, natural world, and climate and risk. The rating system's guidance manual contains a table of point values, which shows the five categories and numerous credits (each row in the table is a credit). For the case study included here, specific strategies will be presented that show how these Envision sustainability goals, or credits, can be achieved during construction.

Levels of achievement indicate how well a credit meets the criteria described in the guidance manual, and are arranged in increasing order from less sustainable to more sustainable. There are five levels of achievement, as displayed on the right in the table of point values: improved (encouraging), enhanced (on the right track), superior (remarkable performance), conserving (zero negative impacts), and restorative (restoration of resources and ecological systems, economic, and social sys-

Continued on page 10

Continued from page 8

tems). The higher the level of achievement on a project, the more points that are achieved for a particular credit. Once the project is scored on the degree to which credits are met, the project is eligible to receive an award. The ENV SP on the project team may submit the scoring and supporting documentation to ISI. The ISI assigns an ENV SV ("Verifier") to review and confirm the points achieved as submitted by the ENV SP. The Verifier will then make a recommendation for an award based on the percentage of possible points achieved: Platinum (50 percent and greater), Gold (40 percent), Silver (30 percent), and Bronze (20 percent). With such a variety of ways to be sustainable, it is nearly impossible to incorporate them all into one project to earn all of the possible points.

Benefits of using the system include market recognition for high levels of achievement in sustainability; demonstration of social, economic, and environmental stewardship; ability to evaluate trade-offs and meet sustainability goals; and increased potential to receive grant funding. The rating system includes a credential program for individuals, through which they can become certified (ENV SPs and ENV SVs) to work on, submit, or verify projects for awards.

The system's "self-assessment checklist" is an Excel-based questionnaire used to guide the initial stages of planning for a project to be sustainable. Questions are arranged by the five rating system categories, and the user completes the checklist by answering the questions as they relate to the project. The available responses are "yes," "no," or "not applicable." The checklist is more or less a preliminary assessment to see where the project stands on its sustainable aspects, and it is used for internal purposes only (not submitted to ISI). The checklist is recommended to be completed prior to the project undergoing full evaluation and scoring. The guidance manual published by ISI assists ENV SPs with the scoring process and helps structure the information for verification. This manual includes detailed descriptions of all of the credits and the criteria that must be met within each level of achievement in order to receive points for that credit.

Perspectives

The benefits of the rating system can be viewed from various perspectives as follows:

Owner

- Projects are to set or meet sustainability goals
- Opportunity to be a "green city"
- Good public relations from Envision awards

Engineering/Design Team

- ENV SPs provide services to increase sustainability on projects
- Team looks beyond purely technical aspects of the project
- Uses guidelines to meet the owner's sustainability goals

Contractor

- Save money using this system and more efficient methods of construction execution
- Possibility to obtain more work through specialty certifications
- Recognition for awards

Public

- Care about the environment that citizens breathe, see, live in, and use
- Would want to ensure the sustainable investment of tax dollars
- Community priorities are addressed in civil infrastructure projects

Regulatory

- Sustainability aligns with the mission of regulatory agencies
- In many cases, using sustainable methods ensures permit compliance

Construction Phase Focus

The rating system looks at the degree of sustainability during the whole project or phase. It supports the idea that project sustainability is cumulative and each phase contributes to the overall sustainability of the project. The construction phase is the link between the design phase and the operations and maintenance (O&M) phase. During the design phase, the team strategizes for sustainability and may write sustainability features into specifications or include sustainable aspects on the drawing sheets. Construction is where the design is implemented, and O&M is the actual use of the asset. It is recognized that operating the facility over the long term has the most impact on the sustainability of the project; however, the focus here is on the construction phase. In other words, the construction phase is short in relation to the useful lifetime of an asset (e.g., three years versus 20 years), but strategies can still be implemented during this phase.

Case Study Site Description

As previously stated, Hillsborough County is currently expanding its AWTF from 4.5 to 10 mgd. This is the largest construction project the County has ever undertaken and the expansion doubles the footprint of the existing plant site. The facility is located in Ruskin (southeast of Tampa) and borders residential, agricultural, commercial, and transportation types of land

Table 1. South County Advanced Wastewater Treatment Facility Existing and Expanded Plant Data

Structure(s)	Existing	Expansion
Headworks	One bar screen, one pista grit, odor control system	Three new bar screens, two pista grits, two mixers, two classifiers, odor control system
Bioreactor	1.2 mil gal (MG) anaerobic selector (fermentation zone); two oxidation ditches (1.96 MG each) using brush rotor process	Five-stage activated sludge biological nutrient removal process (16-MG capacity), recycle pumps, 20 mixers, odor control, diffused air system
Air Blowers	Two for filters, two for biosolids holding tank	Six new blowers
Clarification	Two clarifiers, each 0.56 MG	Two additional clarifiers, each 0.64 MG
Filtration	Four (rehab) filters	Three additional filters
Disinfection	Chlorine	Ultraviolet
Reclaimed Storage	Two tanks, each 6 MG	No new
Reject Storage	Temporary modutank during construction (0.6 MG)	6-MG new reject storage tank
Pump Stations	Two plant lift stations, one reclaimed water PS with five pumps	Four plant drain PS, one intermediate PS, one effluent PS, two new reclaimed pumps
Administration Building	900 sq ft	6,600 sq ft
Electrical Buildings	Three	Three new
Chemical Storage and Feed Systems	Methanol, alum, chlorine	Alum, external carbon feed, sodium hypochlorite
Solids Handling	Two centrifuges	One additional centrifuge

use. South of the facility is a County potable water repump station, and an office building neighbors the plant site to the west. Another adjacent property west of the plant site is a cattle field, and further west of that is an Amazon.com distribution center. One benefit of the project location is that there are no residential zones immediately bordering the site. The site is unique because it is over a mile long, in a linear arrangement, and overlaps with the existing plant, making it subject to exacerbated short-term hazards. Table 1 lists the components of the existing and expanded plant.

With so many new structures and equipment, there are countless opportunities for sustainable construction to be practiced in the field at this point in the project's life cycle.

Strategies for Sustainable Construction

The concept of the dual nature of sustainability during construction involves two major components: the sustainable features of the design, and the sustainability during construction activities. It is important that sustainable features of the design are carried out during construction (e.g., conformance to drawings, specifications, etc.) and built as designed. Sustainability during construction activities includes proper sequencing for maintenance of plant operations (MOPOs), saving water and energy using efficient methods, and appropriate field decisions made by the contractor and other field staff. The examples that follow illustrate both types of sustainability during construction.

Leadership Leads to Sustainability

Leadership is one of the five categories in the rating system. During plant shutdowns for pipeline tie-ins, sustainable strategies would include effective coordination and communication among involved parties, organized meetings, and written plans. For change orders, the sustainable strategy would be that the owner saves money with the reduction of change orders, therefore reducing the amount of work that is not competitively bid. For scheduling and phasing of work, the MOPOs need to be carefully coordinated for the portion of the existing plant within the construction zone. Testing and maintenance should be logged and well-documented. One example of this is how the general contractor performs regular maintenance on pumps and other stored equipment as stated in the specific warranty paperwork.

For the Envision credit leadership category 3.3, a project will undoubtedly be more sustainable if the useful life of assets can be extended. Sustainable engineering designs can find a new use for existing unneeded plant components after demolition rather than disposing of them. For example, the AWTF expansion design calls for salvaging both existing oxidation ditches to serve as additional reject water storage in the future. Once the new bioreactor becomes operational, the existing oxidation tanks can be decommissioned, but not demolished. New equipment, such as the bioreactor mixers and motors, are logged in the County's asset management system. The serial number, speed, horsepower, date put into service, photographs, etc., of each individual asset is entered into the asset management system, as well as any old asset that is being taken out of service. This method assists the County not only with knowing which assets it owns and where, but in the future to know which ones may be reaching the end of their useful life and may need to be replaced. Long-term planning for asset management is essential for forecasting budget, time, and workforce constraints and needs to be incorporated into the County's capital improvement plan.

Construction projects have many parties involved—owner, consulting engineering firms, general contractor, subcontractors, construction manager, project managers, plant manager, soils testing firms, resident observers, and field engineers—and the AWTF expansion is no different. A transparent dedication to teamwork and a genuine commitment to the project's success will earn points for "collaboration" in the system's leadership category. Interpretation of the drawings, specifications, requests for information, submittals, and change proposal requests require daily communication among field personnel and office managers. Care must be taken to use the proper channels of communication so that work is authorized by the appropriate person in charge.

All parties involved want to feel that they are being kept informed on project status updates. Managers meet weekly at the AWTF general contractor's trailer to discuss project progress, schedule, and potential challenges, including how to avoid and resolve them. From those meetings, leaders manage their staff in accordance with the agreed-upon items of the meeting. It is the managers' responsibility to communicate information to their staff, and it is the responsibility of field personnel to inform their managers of any issues or questions from the field work. This includes clear and effective verbal and written communication. In short, an open line of communication among office and field staff is crucial to the success and sustainability of the project.

Materials Recycling and Control Contribute to Effective Resource Allocation

As previously stated, resource allocation is one of the five rating system categories. Credits within this category encourage the efficient use and allocation of materials, energy, and water. Prior to the creation of Envision, this category summarized the typical idea of what sustainability meant: to use recycled materials, divert waste from landfills, buy local, and reduce energy and water use. However, as shown in the other strategies presented here, sustainable infrastructure covers much more than just these goals.

For the typical construction practice of designating a concrete spoils pile (scraps, washout, leftovers from pours, demolished concrete, etc.), sustainable strategies would include transporting the concrete to a recycling facility, or using it as road base. Both strategies avoid it being taken to a landfill. The AWTF has a designated stockpile area at the north end of the site for excavated soils. The sustainable practice is to reuse this soil for backfill. The site contains several large bins to collect metal waste, which avoids it being sent to landfills and also allows the contractor to receive a rebate check ($/lb value) from the recycling facility. Another materials recycling sustainable strategy was the reuse of wooden forms for concrete pours instead of new pieces of wood each time. A rumble strip was placed at the main site entrance/exit that allows soils to be vibrated off the tires of vehicles and not leave the site.

Restorative or innovative credits could be awarded for the energy subcategory if the following idea can be developed: since this is an expansion of an existing plant, devise a way to capture methane gas from the current treatment process and use it for energy during construction, such as for temporary power of construction equipment. Using renewable energy in this manner would allow the plant to be "energy neutral" by the reuse of methane gas for an in-house power plant "generator."

Construction activities at a WRRF should be planned for daylight as much as possible for three main reasons:

1. Daylight is safer for the workers and observers because visibility is not limited due to lack of natural light.
2. Organisms are not disturbed by artificial light used during nighttime construction.
3. The energy requirement to power lights for nighttime work can be avoided.

Continued on page 12

Continued from page 11

Effective Water Management Earns Points

A well-managed water use program during construction demonstrates a leader's commitment to sustainability. When possible, it is best to use reclaimed water instead of potable water. Potable water quality is not necessary for operations such as hydroblasting concrete, dust control, and machine washdown, so using reclaimed water saves money. For the typical practice of refueling machinery (cranes, track hoes, forklifts, etc.), it is best to use double-wall fuel tanks and have kits nearby for quick cleanup of spills, so as to not contaminate groundwater. For the washout area for trucks, concrete scraps pile, and when cutting into pipelines, plastic liner systems should be in place to prevent groundwater contamination. When dealing with excessive rain, and during dewatering activities, silt fences and GeoHay bales can be used and eroded slopes can be restored. These strategies align with rating system credits RA3.1, RA3.2, RA3.3, and NW2.3.

The AWTF expansion construction site is set up where pipes of reclaimed water from the existing plant provide service water for construction activities. This benefit is twofold: potable water use is avoided, and the percentage of plant reclaimed water use is increased (instead of that water being discharged directly into the receiving water body). A project may score high in the subcategory of resource allocation for water if a way can be devised for the reclaimed water to be reused multiple times within the construction process. For example, if a tank structure can be filled with reclaimed water for a 24-hour leak test and two days later a 30-in. pipeline needs to be pressure-tested, perhaps that same water can be used for both tests and gravity flow (preferred), or pumped from one to the other. A flow meter may be added to the hydrant from which the general contractor obtains reclaimed water in order to monitor how much is being used for these activities.

Resiliency to Hazards and Adaptation to Change Allow the Project to Overcome Challenges

The rating system recognizes the importance of safety and emission reduction in sustainability (credits QL2.1, QL2.6, and CR1.2). Site observers, resident project representatives, workers, and other field staff should try to avoid fall/trip hazards, inspect ladders prior to use, communicate with machine operators, have a partner for confined space entry, and wear appropriate personal protective equipment. When applying coatings inside of a pump station or any other enclosed structure, it is important to use air exchange fans and face masks to protect the workers within from harmful fumes and particles. At the AWTF it was common practice for a worker to drive around the site in a water truck (filled with plant reclaimed water) and spray down the dirt roads for dust control on dry, windy days. This reduces the particulate matter, provides cleaner air for site personnel, and reduces air pollutants to neighboring areas.

Since this is an expansion of an existing plant, the facility must still be able to operate normally during the construction phase. Furthermore, phasing out the existing systems, which are being replaced, takes careful planning and coordination since portions of the new plant are within the existing plant's footprint. The existing plant should be resilient to the construction activities and be able to operate unin-

Continued on page 14

Continued from page 12

terrupted. That was not the case at the AWTF; system shutdowns, unintentional water line breaks during excavation, and plant drain pump station overflows during high rain events have all occurred, which affected normal operation of the existing plant. Having a response plan for short-terms hazards increases the resiliency of the system and therefore makes it less vulnerable should a similar situation occur unexpectedly in the future. Envision credits CR2.2, "avoid traps and vulnerabilities," and CR2.4, "prepare for short-term hazards," illustrate that these ideas contribute to sustainability.

Recommendations

In order to put the rating system concept into practice, there are several recommendations that any construction project could undertake:

- Utilize the Envision checklist at the beginning of the project in order to consider sustainable aspects in the design phase, and later in the construction and O&M phases.
- Hold a preconstruction workshop with the owner, design team, site observers, contractor, and subcontractors to discuss practical measures that can be implemented to improve sustainability.
- Include sustainable methods in specifications.
- List the "lessons learned" at phase milestones; what could be done better next time to improve sustainability.
- Implement the strategies described throughout this document to increase the project's score, therefore making the project a more sustainable infrastructure, as recognized by ISI.

Conclusion

Where the term "sustainability" used to be a vague concept, the Envision rating system provides a practical, numerical way to measure sustainability, and a project can be characterized by its score. Evaluating a project based on the specific credits makes it easier to assess, manage, track, improve infrastructure, and ensure utility sustainability. A higher score indicates the project is more sustainable, which could lead to better recognition and the potential for more long-term cost savings. A major advantage of the rating system is that the design team members think about the sustainable aspects of a project earlier on than they would have otherwise. Using the plant expansion of the AWTF as a case study, numerous strategies were presented that encourage sustainable practices during the construction phase of a water infrastructure project.

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References

- Yan Ji and Stellios Plainiotis (2006): Design for Sustainability. Beijing, China Architecture and Building Press. ISBN 7-112-08390-7.
- Institute for Sustainable Infrastructure, The Envision™ Guidance Manual Version 2.0, (2012).
- American Society of Civil Engineers (ASCE) Report Card for America's Infrastructure (2009).