Natural Infrastructure Case Study

Seadrift Wetlands

Project Details

COMPANY

Union Carbide Corporation, a wholly-owned subsidiary of The Dow Chemical Company

COUNTRY

United States of America

AUTHOR

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Constructed Wetlands for Wastewater Treatment

CONTEXT

The Dow Chemical Company (Dow) combines the power of science and technology to passionately innovate what is essential to human progress. Dow is driving innovations that extract value from the intersection of chemical, physical, and biological sciences to help address many of the world's most challenging problems such as the need for clean water, clean energy generation and conservation, and increasing agricultural productivity. Dow's integrated, market-driven, industry-leading portfolio of specialty chemical, advanced materials, agrosciences, and plastics businesses delivers a broad range of technology-based products and solutions to customers in approximately 180 countries and in high-growth sectors such as packaging, electronics, water, coatings, and agriculture. In 2014, Dow had annual sales of more than US$ 58 billion and employed approximately 53,000 people worldwide. The Company's more than 6,000 product families are manufactured at 201 sites in 35 countries across the globe. More information about Dow can be found at www.dow.com.

Union Carbide Corporation (UCC) is a wholly-owned subsidiary of The Dow Chemical Company.

The 110-acre tertiary treatment wetlands is located at the UCC plant in North Seadrift, Texas, USA. The Seadrift Facility is a large industrial complex containing several manufacturing units involved in the production of plastic resins and other organic chemicals.

Wastewater from the facility and stormwater captured in containment areas are routed through the wastewater treatment system (WWTS). The original WWTS consisted of primary/secondary (anaerobic/aerobic biological) treatment ponds and a shallow tertiary pond of approximately 267 acres with water depth ranging from 1 to 4 feet.

The tertiary pond was operated as a solar stabilization pond, with no active mixing. Lower organic loads and long retention time within the aerobic section and tertiary pond created ideal conditions for phytoplankton that can lead to algal bloom. This resulted in exceedance of the plant's discharge permit criteria for total suspended solids (TSS) and required extensive pH adjustments. To address this, UCC evaluated several design alternatives.

Relevant stakeholders include UCC, Dow, the Texas Commission on Environmental Quality (TCEQ), and Dow's "near neighbors" community.

OBJECTIVE AND PROJECT OVERVIEW

The primary project driver was ensuring long-term compliance with the U.S. Environmental Protection Agency effluent guidelines while reducing operations and maintenance (O&M) costs.

Both constructed wetlands and sequencing batch reactors were evaluated in a feasibility study. Then the constructed wetlands performance was evaluated with a pilot-scale project. Roughly one year of data was collected before launching the full-scale project – converting part of the tertiary pond into a constructed wetlands.

THE BUSINESS CASE

Natural infrastructure, in the form of constructed wetlands, was selected over gray infrastructure, the proposed sequencing batch reactor, for the following reasons:

- 100% compliant from day zero for more than 15 years while eliminating the need to adjust pH levels
- Lower capital costs – US $1.2 million to 1.4 million vs. US $40 million for the gray infrastructure alternative (1995)
- Lower O&M costs – Operational support was drastically different, as wetlands require minimal support from O&M, while the sequencing batch reactor requires onsite operators at all times
- Low energy and resource requirements with the corresponding environmental benefits – minimal equipment, no pumps, no additives, no oxygen system, and no bio-solids to handle or dispose
- Reduced construction and implementation time
- Additional ancillary benefits from this solution were also noted:
  - Providing a habitat for wildlife
  - Recreational opportunity (birdwatching/photography)
  - Community outreach and educational opportunities
  - Biodiversity of plants, animals, and micro-organisms

DECISION MAKING PROCESS

As described above, both constructed wetlands and sequencing batch reactors were evaluated. Key selection criteria included capital expenditures, installation time, ease of implementation, and ease of operation.

In this project, the upper management champion played an instrumental role in making the constructed wetland a reality. Because of the regulatory risk in not meeting effluent discharge requirements, the natural infrastructure solution was viewed with some skepticism versus the widely accepted use of traditional gray infrastructure solutions for wastewater treatment. Therefore, acceptance of the selected natural infrastructure solution required proven results of the pilot-scale study and an internal champion to drive and support the project, and facilitate upper management buy-in. Additionally, external buy-in from local and state authorities was also obtained early in the project.

Dow has undertaken significant efforts to further the use of natural infrastructure solutions within its operations. An example of Dow's effort, as a first step in realizing the business potential for natural infrastructure, is in ensuring the proper tools are available to assess projects. A full retrospective analysis of the Seadrift constructed wetlands discussed above was performed using two conventional Dow tools: a replacement cost methodology (RCM) for financial assessment and a life cycle assessment (LCA) for environmental impacts, which were completed and published in 2014 in the *Journal of Industrial Ecology*.

Key outcomes of the study included:

- The RCM data demonstrated a total net present value savings of $282 million over the project's lifetime.
- The LCA used both "conventional" impact assessment methods (TRACI) and new methods based on land use and biodiversity. The LCA results indicated the selection of the constructed wetlands – with lower associated energy and material inputs – result in a broad range of lower environmental impacts.
- Contrary to the assumption that natural treatment systems require significant land use, the land use inventory indicated the upstream land burden of a sequencing batch reactor is similar to the onsite acreage of the constructed wetlands.
- LCA-based models for biodiversity-related impacts were not well-suited for the unique land use type of wetlands in Texas. This is a key area for further development. Field observations were used to understand and partially quantify plant and bird diversity (collected at annual "Christmas Bird Counts" since 2004) benefits of the CW. Results indicate that the CW provides an opportunity for unique bird and plant species to be in this broader region.

PROJECT DETAILS

As described above, this project resulted in the creation of wetlands, which provides fresh water wildlife habitat for a broad range of species. The constructed wetlands was implemented in roughly 18 months and has been in full operation for more than 15 years, meeting all discharge requirements for TSS, eliminating the algal bloom issues, and eliminating the need to adjust discharge pH (previously required around the clock).

The initial capital investment made by UCC was US $1.2 million to 1.4 million (1995), with O&M costs reduced by approximately 95 percent.

A third-party consultant was used to investigate several alternative treatment options for reducing TSS in the effluent. A pilot-scale constructed wetlands was built using a free water surface (FWS) wetland cell and a subsurface flow wetland cell.

Inspired by the successful pilot-scale test results collected for roughly a year, the site leadership selected the FWS constructed wetlands design to solve the TSS problem and built the constructed wetlands in late 1995-early 1996. Approximately 110 acres of the 267-acre tertiary pond were converted into the constructed wetlands, with an average depth of 1.5 feet. The wetlands include four cells, which can be isolated from each other to provide maximum operational flexibility.

LESSONS LEARNED

Key lessons learned in implementing this project include:

- It is important to collaborate early on with regulatory bodies to allow time for appropriate considerations and regulatory implications.
- Critical design criteria for constructed wetlands include, but are not limited to applicable regulatory requirements, water chemistry and quality, salinity levels, soil chemistry, etc.
- Constructed wetlands and other natural treatment systems require a large, onsite physical footprint. For example, this system would require 50 acres versus 4 to 5 acres for a gray infrastructure alternative.
- Considerations for design are impacts of biotic stressors and the potential for threatened or endangered species to move into the constructed wetlands. This is unlikely in the case of the Seadrift constructed wetlands, as none of the 46 threatened or endangered species listed by the state of Texas in the vicinity of the constructed wetlands would be expected to occupy this habitat.
- It is important to have data to support natural infrastructure technologies. This may point to the requirement of more pilot-scale work in the general area of natural infrastructure.

- If there is not an obvious cost benefit (cheaper than the traditional gray alternative), a natural infrastructure solution may be more difficult to pursue.
- A proper assessment of the "full value" of the natural infrastructure – to include ecosystem services benefits and a financial assessment that include both capital and O&M costs over the full life of the asset – may help in the alternative assessment process.

FUTURE IMPLEMENTATION AND NEXT STEPS

Based on the success of this project, Dow has dedicated staff resources and is actively developing tools to evaluate each project as an opportunity to deploy natural infrastructure solutions at sites around the globe, as well as integrate natural infrastructure solutions as part of its global project management process. An example of this natural infrastructure toolbox is the Ecosystem Services Identification and Inventory (ESII) tool that is being developed through a collaborative effort between Dow, The Nature Conservancy (TNC), and EcoMetrix Solutions Group (ESG). The intent of the ESII (pronounced "easy") tool is to enable Dow and other users of the tool to evaluate benefits coming from natural assets (i.e., the production of ecosystem services such as erosion control or water quality control) and to incorporate these benefits into business and site decisions. Dow has also created an internal and external network of natural infrastructure practitioners building knowledge and experience in this emerging field.

Additionally, as part of its newly introduced 2025 Sustainability Goals, Dow has set a goal around "Valuing Nature," where it seeks to apply a business-decision process that values nature. More specifically, Dow seeks to deliver $1 billion in net present value by 2025 through projects that are good for business and good for ecosystems.

REFERENCE

- DiMuro, Johnathan L., France M. Guertin, Rich K. Helling, Jessica L. Perkins, and Scanlon Romer. 2014. *A Financial and Environmental Analysis of Constructed Wetlands for Industrial Wastewater Treatment.* Journal of Industrial Ecology. Available at: http://onlinelibrary.wiley.com/doi/10.1111/jiec.12129/abstract.

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