

## **Use of Nature-Based Principles as a Design and Evaluation Tool for a Stormwater Mitigation Project in Nederland, Colorado**

*“I want to live in a place where you can’t tell where the city ends and Nature starts.”*

Matt, engineering student, CU Boulder.

This is an ambitious vision, but not an impossible one. Repurposing existing infrastructure is a place to start realizing this vision and the Town of Nederland, Colorado has begun the process, one project at a time. They started by deciding to design with Nature a stormwater mitigation project in their downtown area by consulting life’s genius using the science of biomimicry.

Biomimicry is learning from, and then emulating natural forms, processes and ecosystems to create more sustainable designs. By asking the question “*What would Nature do here?*” designers can discover a truly sustainable solution, or at least find a path to move towards sustainability.

The Town of Nederland contacted the Environmental Protection Agency’s Certified Biomimicry Professional with a request for assistance to solve a problem with flooding due to their poorly designed storm water system. Nature has developed many strategies to collect, store and distribute water with low energy process and these sustainable design ideas are available for use with the added benefit of 3.8 billion years of research and development. An initial scoping meeting was held with Town of Nederland (the Town) administrators and interested Town residents on May 31, 2012 to discuss the problem and identify a nature-based approach that could be implemented. As a result of this meeting, EPA’s Pollution Prevention and Toxics Unit, in partnership with EPA’s Stormwater Program, offered to provide the requested services for this project:

- A workshop on biomimicry designed for the Town’s selected consultants.
- A workshop designed for the public that will address sustainability topics relating to this challenge. This will provide the public with an overview of the mitigation and design options that will be addressed in greater detail during presentations of plans by the consultants.
- A stormwater/drainage specialist from the EPA who would be willing to serve on their Technical Review Committee, a group of individuals who would provide technical review and assistance to the consultants in focused meetings.

The Town released a Request for Proposal (RFP) to assist them in identifying the parameters for the final design solution. The RFP required that the selected contractor participate in an EPA sponsored two-part biomimicry education session and to hire a biologist who would assist in identifying opportunities to incorporate biomimicry’s Life’s Principles into the project design. Life on earth is made up of an ever-changing and complex network of interconnected and interdependent organisms. Scientist, working to discover how nature works, have found a pattern of common principles that all surviving organism use to fit in on this planet. These common principles are called Life’s Principles and they represent nature’s strategies for sustainability. Using Life’s Principles to guide a design provides a basis for the mind shift that must occur in order to move human designs towards sustainability.

The Town's goal for this project is a design that mimics the natural processes as much as possible, resulting in a low energy system that will adapt and evolve over time. The Town agreed to procure existing maps and resources that identify the original drainage in the watershed before human development (identify what the water wants to do) and to identify local individuals who have the specific technical expertise and the willingness to assist with this project.

The two biomimicry educational sessions were held with the Design Team (Team) that included the following individuals:

Marie Zanowick, Certified Biomimicry Professional, EPA

Greg Davis, Stormwater Program, EPA

Conor Merrigan, Principal, C2 Sustainability

Darrin Masters, Certified Wildlife Biologist, Smith Environmental & Engineering

David Kim, P.E., Huitt-Zollars

Kim A. Martin, P.E., Huitt-Zollars

During the biomimicry sessions the Team developed an understanding of the current stormwater system, identified the functions that were necessary for a sustainable system and learned how to apply Life's Principles to the design solution. Functions that have been lost due to past development include:

- Conveying of water for flood control, recharge of groundwater and improved water quality
- Providing natural habitat for aquatic and wildlife life and restore riparian areas
- Providing transportation for excess water, humans (walking, car and bike) and for other organisms (fish and wildlife)

The Team visited the site, met with the Technical Review Committee and EPA's Stormwater expert identified options for sustainable solutions to the stormwater issues (Attachment 1). The Team considered each sustainable solution recommended by EPA's stormwater expert and identified the Life Principles that was satisfied by this action (Attachment 2). Designs that meet Life's Principles will likely emerge as well adapted to the conditions in Nederland. This type of evaluation is essentially ensuring that the solution has been designed with nature in mind. Evaluating using biomimicry is a way for humans to critique the appropriateness of a design as well as check for missed opportunities. This approach provides a higher standard than conventional measurement tools such as those for quality, safety and compliance. A nature-based evaluation will improve the evaluation stage by bringing the local conditions into the conversation.

In this evaluation, the proposed solutions were matched to corresponding Life's Principle in a matrix in order to determine if all of the functions were being addressed (Attachment 2). The Team biologist from Smith Environmental & Engineering provided detailed information on appropriate structures, pathways, vegetation and culvert design that would promote a return of the necessary system functions. The Team engineers from Huitt-Zollars identified physical, cost, and/or regulatory barriers that must be considered for each design idea. Permeable pavement and

bioswales could be used to restore basic infiltration functions, although these options have limits. The most significant barriers were not enough room for bioswales in the existing easement and restrictions placed on the design by Colorado water laws and environmental regulations. For example, the use of permeable pavement in the design would decrease the amount of excess water that needs to be managed, but the amount of water that is infiltrated cannot be adequately measured and cannot be considered as a mitigating factor in calculating the final design solution.

The matrix also highlights which functions are not being addressed, such as restoring the migration pathways for animals living in the Nederland ecosystem. The biomimicry Life Principle matrix indicates how each of the design options identified by the Team contributes to restoring the functions identified as important for a sustainable solution and which Life Principles are met by these options. The overall goal of a sustainable system is to meet all of Life's Principles and to restore all necessary function to the system. Adoption of a design that meets all of Life's Principles is not economically or physically possible for the Town due to the pre-existing site conditions, existing easements and placement of buildings, and other regulatory barriers.

#### Next Steps:

- The next step in this process is to present the work of the Team to the Town. As additional design ideas are generated, they should be added to the matrix in order to generate a clear vision of which of Life's Principles are met in the final project design.
- The Town should identify which functions and Life Principles are significant in meeting their sustainability goals. The Town has a sustainability goal and how this project fits into their overall sustainability goals should be considered.
- The Town needs an overall sustainability plan for development. This project is an attempt to "green" one project, and there is no process to tie all of the individual Town projects, underway or planned, together. Addressing each one separately may not produce a sustainable outcome. For example, the Town could consider broad-based solutions such as a parking garage at one end of Town and promoting walking and biking instead of more car parking spaces throughout the street and could look at a sub-station delivery area for businesses instead of widening the roads to allow this kind of delivery to each store. A whole systems approach to Town planning to address these type of problems will result in a more sustainable solution.
- The Town has a responsibility to maintain the functions of the new system. Education on the system needs, functions, benefits and stewardship responsibilities for the finished project should be provided to Town residents, especially those who live along the affected street. The library should be considered as a possible site for interpretive and conservation education. The site would potentially include a kiosk and a meeting place for educators to discuss the scope of the Towns sustainability master plan and how it is being implemented.
- The Town should consider placing restrictions on redevelopment based on the ability to retain the system's functions.
- As the Town considers other projects, biomimicry's Life Principles should be used to evaluate the long-term sustainability of the considered solutions, as this evaluation will

highlight opportunity for sustainable, low energy options as well as identify areas where the design may fail in the future, areas where Life's Principles are not met.