Wastewater Project Brief

Assessing Decentralized Wastewater Technologies in Santa Barbara County.

A Project at the Bren School of Environmental Science and Management, UC Santa Barbara

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Introduction:

Millions of gallons of domestic wastewater are generated everyday from sinks, showers, and toilets. This wastewater contains pathogens that are dangerous to human health, and thus properly treating and managing it is crucial for human safety. Wastewater has conventionally been managed through large centralized treatment facilities in urban areas and septic tanks in rural areas. Today, there is an array of innovative decentralized wastewater systems that collect and treat domestic wastewater onsite. These systems can offer benefits over conventional treatment because they reduce the need for extensive infrastructure, provide recycled water for use onsite, and can reduce stress on aging central systems.

Despite these advantages, there are very few innovative systems in Santa Barbara County due to a lack of awareness and familiarity. Our clients, The Sustainability Project and Peikert Group Architects, asked our group to assess decentralized wastewater systems. With this request, we created a guidance document to provide information to architects and builders.

Economic: Total Capital, Energy Requirements, Operational Labor, Land Requirements, Biosolids Disposal
Environmental: Removal of Total Nitrogen, Soil Site Constraints, Unrestricted Water Reuse, Habitat Creation Potential
Social: Aesthetics, Odor, Noise, Education

We reviewed and analyzed 11 decentralized technologies over 21 evaluation criteria. Some of the criteria are shown in the box above. Each of the 11 treatment systems was comparatively scored for these criteria to show their strengths and weaknesses. This information was incorporated into the guidance document to provide an easy way for comparing systems. Due to tradeoffs, no treatment system received a high score for all criteria. Some systems are more appropriate than others depending on project constraints and site variations. The guidance document addresses these variations by providing information to builders and architects. This brief describes how we created the guidance document and highlights selected results from our analysis.

Project Objectives

- Compare decentralized wastewater sytems from an economic, social, and environmental perspective.
- Create a guidance document to provide targeted information to stakeholders.
- Use the guidance document to make recommendations for a development project in Santa Barbara County.

Developing the Guidance Document

We followed 3 main steps to create the guidance document.

Step 1: *Gathering Data*

We investigated options for decentralized wastewater treatment through a wide-ranging literature review. We chose to focus on 11 treatment systems which offer important features to architects, community planners, and developers. These systems were sorted into three main categories based on how they function, as shown below.

Subsurface : Leachfields, mound systems, evapotranspiration systems
Constructed Wetlands: Horizontal subsurface flow, free water surface flow, tidal flow Living Machine®, recirculating vertical flow
Prefabricated and Modular: Recirculating media filters, membrane bioreactors, activated

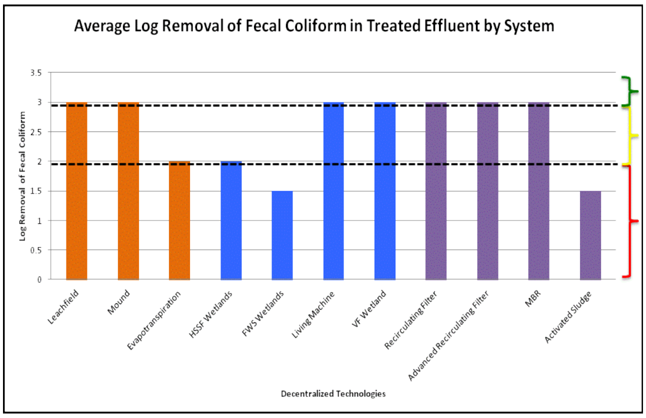
We also hosted a community workshop in November 2011 to solicit feedback from stakeholders. Additionally, we conducted interviews with regulatory agencies and visited a decentralized treatment system in Carpinteria to learn about system operational challenges that are often overlooked.

Site visit in Carpinteria, CA

Step 2: *Scoring the Systems*

We used a stoplight approach to score the systems on 11 criteria, where red indicates a low score, yellow a medium score, and green a high score. The systems were scored comparatively and we compiled the results into a decision support matrix. The decision support matrix is a fundamental part of the guidance document that allows the user to eliminate systems that do not meet project requirements.

For our report, we compiled our results into graphs showing how systems scored for each criteria. The figure below is an example of our comparative findings.



The treatment systems are on the horizontal axis, grouped by category (orange, blue, and purple). The criteria we analyzed is on the vertical axis, which in this case is the capacity of the treatment system to remove harmful pathogens. The dotted threshold lines and bracket colors of red, yellow, and green show how each system scored. For this particular criteria, many of the treatment systems performed well, while others, such as activated sludge received a lower scoring.

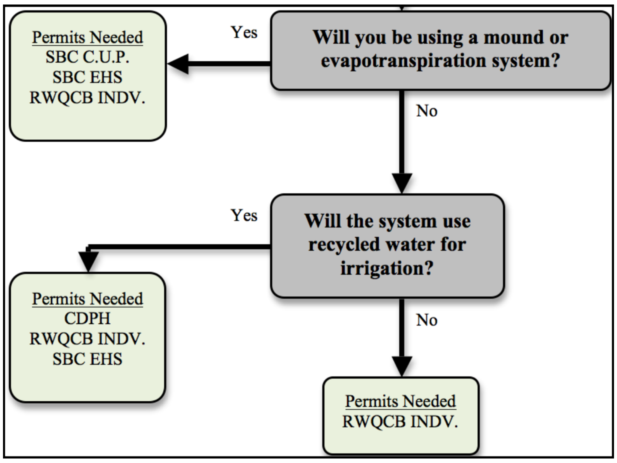
Case Study: Wastewater Treatment Options for a Residential Boarding School

Our team provided a recommendation to our client, The Peikert Group Architects, on an innovative wastewater treatment system for their project, the Children's Project Academy (CPA). The CPA will be a residential boarding school for foster children, a unique model that is the first of its kind. Located in northern Santa Barbara County, the CPA needs to meet strict wastewater restrictions in order to receive its permit and begin building. Our team applied the guidance document and made a recommendation about which innovative wastewater treatment systems would meet the project's restrictions. This was an academic exercise, and before implementing our recommendation, the CPA would consult their neighbors and the Los Alamos Community Services District.

Design of the CPA site plan

Step 3. *Permitting Flowchart*

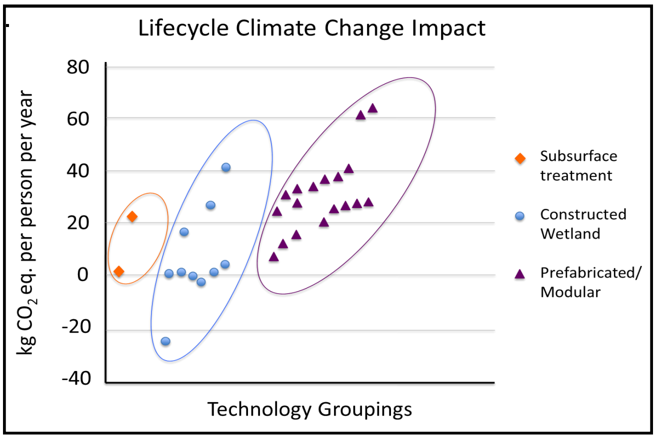
Receiving a permit for a wastewater system is challenging due to a lack of precedent and clear guidelines. We addressed this challenge by creating a permitting flowchart. The flowchart indicates which permits are required for each system and from which agency. The figure below shows an extract from the permitting flowchart specific for systems designed to recycle treated water for irrigation.



There are large discrepancies between systems. For example, a simple septic system requires only one permit, an estimated $544 fee, and a 1-2 week waiting period. An advanced system, on the other hand, requires permits from 3 different agencies. This is not only more complex and unpredictable, but also costs between $4,000-$10,000, takes at least 6 months, and must be approved on a case by case basis. The extra cost, time, and risk associated with advanced treatment systems discourages their use. Therefore, we recommend that policymakers streamline the antiquated permitting process and facilitate communication amongst agencies.

Lifecycle Assessment of Wastewater Treatment

In addition to developing the guidance document, we analyzed the lifecycle greenhouse gas emissions from wastewater systems. Lifecycle impacts are often overlooked when evaluating systems. We analyzed environmental impact data for the manufacture and installation of both wastewater treatment plants and sewage collection systems, as well as emissions from operation and disposal. We found that centralized systems have higher per capita impacts in sparsely populated areas. Therefore, we recommend considering decentralized systems in rural areas. We also found that prefabricated and modular systems have the highest lifecycle greenhouse gas emissions of all decentralized systems, as indicated in the chart below.



The negative points show how constructed wetlands can sequester carbon dioxide. However, wetlands can also release methane, a greenhouse gas 20-25 times more potent than carbon dioxide. These findings indicate the importance of considering lifecycle greenhouse gas emissions to comprehensively measure the environmental impacts of decentralized wastewater systems.

We identified the CPA project constraints as:

Cost

The CPA is a non-profit organization and has a limited budget for a wastewater system.

Land Availability

Due to site constraints, such as slope and soil type, as well as the location of buildings, the CPA has a limited amount of land available.

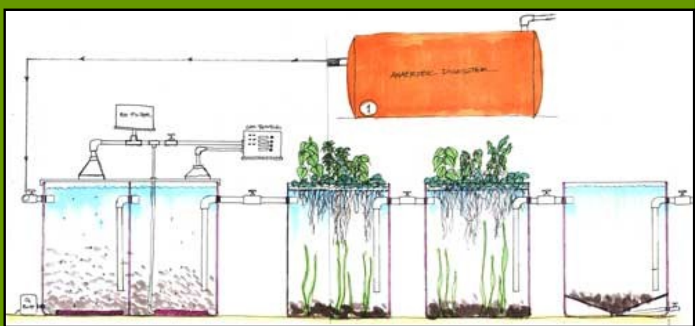
Water Reuse

The CPA would like to recycle the treated water to irrigate the open space and athletic fields.

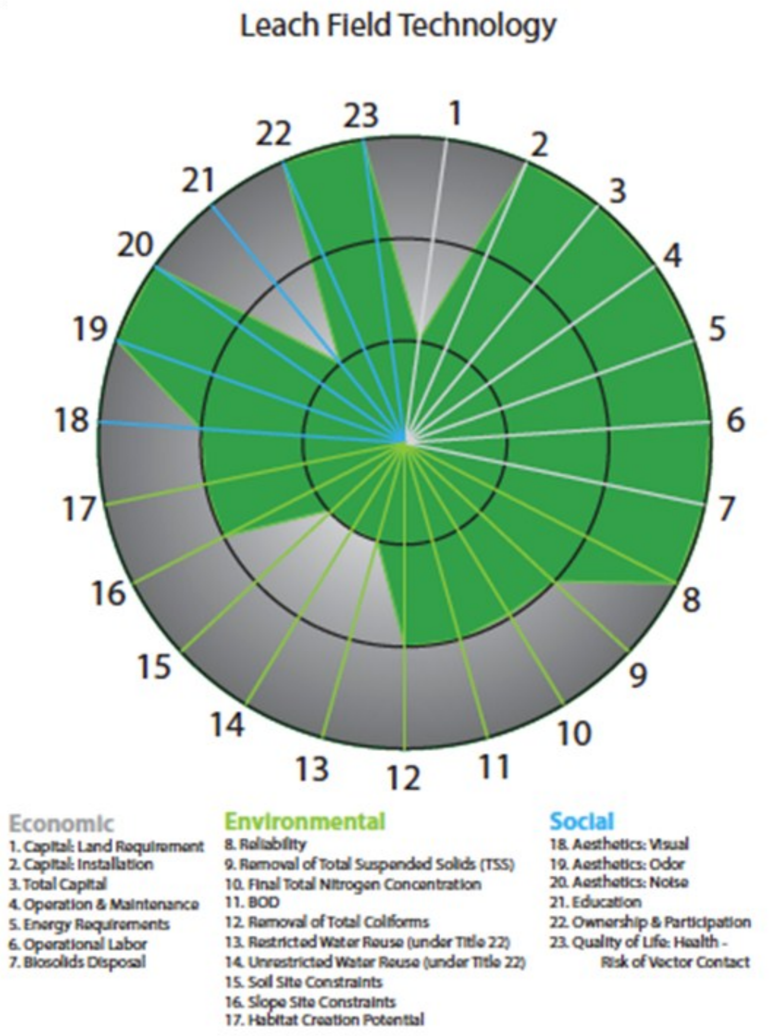
Education

The CPA prefers an interactive system that can foster education for its students and residents.

We eliminated treatment systems that did not meet these requirements, and recommended that Peikert consider the remaining two technologies: Vertical Flow Wetlands and the Living Machine®.



Design of a Living Machine system



Project Summary

- We evaluated decentralized wastewater systems from an environmental, economic, and social perspective.

- We created an innovative permitting flowchart to guide decision makers through the complex regulatory process.

- We developed a guidance document for the local community to fill the educational gap for decentralized systems.

- We applied our findings to a real world case study, showing how the guidance document can be used.

-We assessed wastewater treatment from a lifecycle perspective to comprehensively analyze cradle-to-grave environmental impacts.

The infographic above shows the strengths and weaknesses of one particular wastewater system, the leachfield. Each line corresponds to a criteria listed above, and the colored area indicates how the system was scored for that criteria. If the color reaches the outer green ring, then the system scored comparatively higher than others. The criteria are divided into economic, environmental, and social considerations to provide a quick glimpse of each system's performance.

The Guidance Document

We consolidated our comparative findings into the guidance document. The document contains the decision matrix, the permitting flowchart, and information on how each system works. We also included an infographic for each system, as well as its advantages and disadvantages.

Lastly, we incorporated the CPA case study to provide a clear example of how the guidance document can be used to identify potential treatment systems. In summary, the guidance document enables end users, such as architects and builders, to bridge the knowledge gap when considering decentralized wastewater treatment.

Team Picture here

Acknowledgements: The Bower Foundation; Bren School: Trish Holden, Arturo Keller, Sangwon Suh, Bob Wilkinson; Built Green: Karin Perissinotto; The Children's Project: Wendy Read; Peikert Group Architects: Detlev Peikert, Lisa Plowman; Santa Barbara County of Public Health: Willie Brummet, Paul Jenzen; The Sustainability Project: Karen Feeney, Eric Lohela, Paul Poirier, Adam Sharkey; Water Environment Research Foundation: Jeff Moeller

The Sustainability Project