

# THESIS PROPOSAL

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Mechanical Option

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*The New Offices for  
RLPS Architects*

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# Executive Summary

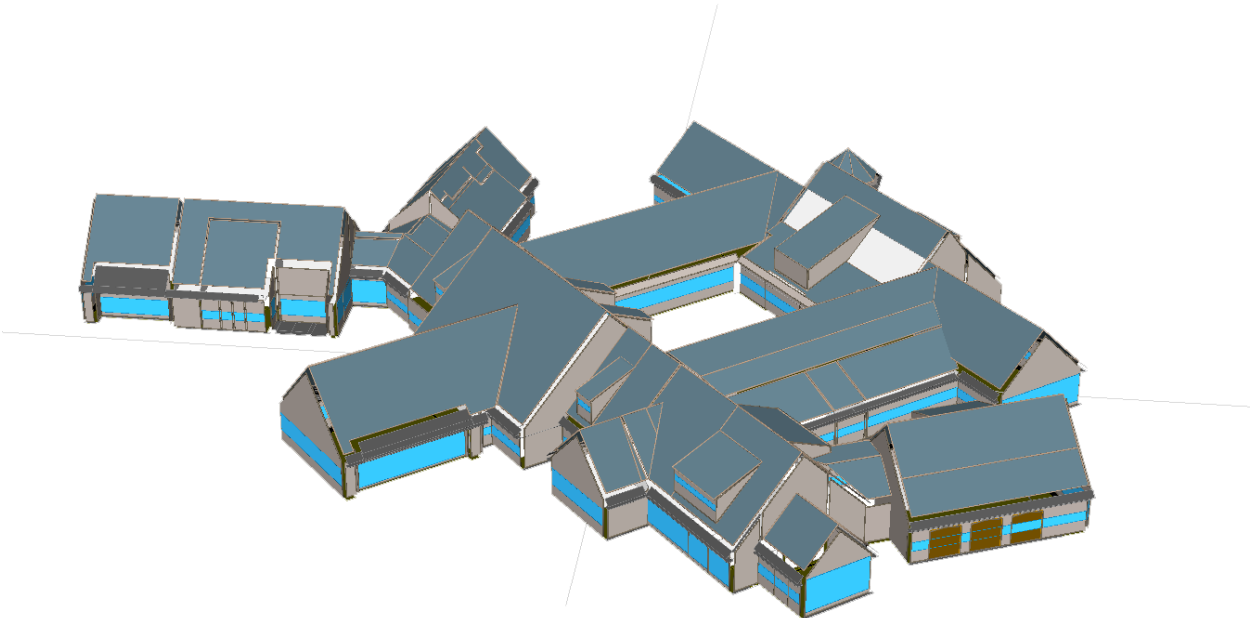
Throughout this semester it has been found that the new office building for RLPS Architects is a modern building that reflects the owner's passion for sustainability. One of the goals of these studies is to see if there are options out there that could improve the new office buildings energy performance that were not previously considered or fully thought out.

A number of ideas were thought of and researched preliminarily. However, one option was selected; the incorporation of a hybrid ventilation system with hopes that under particular circumstances it could be a natural ventilation system. What would make this system unique is its integration of a grey water reuse system and the buildings natural geometry. The new office building has an interior courtyard for with a water feature. What is being proposed is the building of a hybrid ventilation system based around the courtyard using the water feature to clean and cool the natural air. The water in the water feature would be reused grey water that was collected and stored in a subgrade cistern until it reached ground temperature.

To fully understand the ramifications of this new system, additional studies would be performed on the constructability and construction costs. Also, a reconfiguration and recalculation of the electrical system will be performed to accommodate the new equipment, but the predicted loss of heating cooling load needs.

# Building Overview

## Building Description



The New Office Building for RLPS Architects is a new construction office building located in Lancaster County, PA. It totals 22,500 square feet which is split between one full ground level and a small mezzanine area. The use of this building is primarily office spaces, studio space, or group work areas. However there also bistro or kitchen areas as well as an interior courtyard. Overall, the building is classified as Business and can be occupied by just short of 230 people. The expected completion date is January 2013.

## Mechanical System Overview

The new office building will be utilizing a ground source wellfield consisting of eight closed loops. A large capacity pump will feed the twenty-nine water source heat pump terminal units designed individually for each zone. Ventilation will be provided by four large ventilation units located in the mechanical mezzanine.

## Occupant and Project Team

<b>Owner &amp; Architects</b>	RLPS Architects Ltd.
<b>General Contractor</b>	Warfel Construction
<b>Mechanical &amp; Electrical Engineers</b>	Reese Engineering Inc.
<b>Structural Engineers</b>	Zug & Associates, Ltd. Structural Engineers.
<b>Civil Engineers</b>	Harbor Engineering
<b>Surveyor</b>	Herbert, Rowland, & Grubic, Inc.
<b>Landscaping</b>	RLPS Architects Ltd.

# Depth Studies Considered

## Hybrid Ventilation System

### Hybrid Ventilation System

To take advantage of the general layout of the new office building a hybrid ventilation system could be considered. Said system would monitor outdoor conditions including temperature and humidity. When appropriate conditions are met automated windows would open and allow for outdoor air to be used in the place of conditioned air lowering the building's energy usage. The already designed (and built) interior courtyard could be modified to create a stack effect which would cause greater airflow. This would increase the acceptable range for the natural ventilation to be used which would further lesson the buildings loads and energy consumption.

The implementation of this system would require more sensors and integration into the BAS for the monitoring of outdoor conditions as well as automated windows. Additionally, considerations would need to be made for the surrounding area that is currently being terra-formed. The current plans call for the wetlands to maintained and redeveloped to act as drainage areas. The odor and other pollutions from these wetlands would need to be considered.

### Hybrid Ventilation System Combined with Grey Water Management

A major addition to the hybrid ventilation system to be considered is the use of a subgrade grey water cistern and grey water harvesting. Unlike normal grey water systems it would not solely be harvested for water use reduction. In the instance of the new office building the water could be used in a unique fashion similar to thermal storage. A system could be designed collect the grey water into the subgrade cistern where the collected water would be allowed to remediate its temperature to the ground temperature. This remediated water would then be pumped to the water feature in the courtyard. The flow of constant temperature water would exchange heat energy with the air. With proper setup of the system and the controls this could increase the possible number of hours that natural ventilation could be used. Additionally, a different water feature could also increase the air quality of the 'natural' outdoor air as an air cleaner.

Like the traditional hybrid ventilation system, implementing this would require an increased level of monitoring outdoor conditions as well as integration into the BAS. In addition to those tools, this system would require grey water harvesting pieces and a method of monitoring the collected water for volume, temperature, etc. Additionally, different water features could be tested for energy exchange efficiency and air quality control.

## **Redesign of the Ground Source Well Field**

### **Implementation of Pond Loop System**

In a similar fashion to ground source heat pump, large enough bodies of water can be used as a heat source and heat sync. While visiting the site I noticed that there were several parts of the surrounding terrain that held water as wetlands or was terra formed recently. Additionally, the construction documents show that RLPS Architects (the owners) are only using a small portion of the land area that they own. A man made pond could be constructed for the use of a pond loop instead of the current ground loop.

The use of a pond loop would require the creation of a pond around 8 to 10 feet deep and large enough to fit the required number of loops. Additional considerations would need to be made for the northern climate the new office building resides in as the winter months could freeze the pond or at least make it unusable for assistance in heating. Also, local code authority would have to approve the terra forming and land use.

## **Depth Study Selected**

### **Hybrid Ventilation System**

The use of a hybrid ventilation system combined with grey water management will be studied. However, simulations and models will be developed for both the use of the grey water harvesting and the more traditional hybrid ventilation system. This will be done to test the effectiveness of the water feature and collected water as a heat exchange source.

## **Breadth Studies Selected**

### **Electrical System Redesign**

With the implementation of a hybrid ventilation system the electrical system would need to be overhauled for several reasons. First the use of the hybrid ventilation system would decrease the electrical loads due to heating and cooling and could allow for the resizing of the motors, panels, etc. However, the addition of the automated windows and other equipment would add on a new electrical load and require additional electrical panels. A re-configuration and recalculation loads would be required to find the balance between these two changes to the in place system and a thorough electrical study will be performed.

### **Construction Cost Analysis of Hybrid Ventilation System**

The application of a hybrid ventilation system would require a great deal more equipment to operate than the current system. The building would require at the very least new window constructions for many of the work areas. Additional pieces would also include all equipment for a grey water harvesting system, a collection cistern, and up to a different water feature. All of these items would come at an additional cost, require previously unscheduled construction, and require additional space both inside and outside of the new office building. An in depth study of the effects on the schedule and a cost analysis will be performed for all items needed to implement a hybrid ventilation system.

# Tools and Methods

## Carrier's Hourly Analysis Program v4.60

Hourly Analysis Program or HAP will be used to evaluate what effects the use of natural ventilation would have on the new office building. A model has already been developed for the current building and will be reviewed and finalized for this study. Then additional models and simulations can be developed for comparison.

## RS Means

RS Means will be used extensively to estimate the cost of construction for the proposed system. This estimate will later be used with simulations for the energy models to perform a life cycle analysis to see if the proposed system additions are financially an improvement.

## Additional Programs and Documents

Additional programs will also be needed for the energy simulations and cost estimate calculations. These programs include Microsoft Excel and Autodesk's AutoCAD 2013 which will be used for equipment and material takeoffs as well as data collecting. Furthermore, documents including the National Electric Code and the construction documents provided by the project engineer will be needed to perform both the depth and breadth studies.

## Preliminary Research

United States Environmental Protection Agency. "Storm Water Technology Fact Sheet Bioretention." (1999): n. pag. Print.

Perdue University. "Simulation-based Hybrid Ventilation System Design and Evaluation." (2010): n. pag. Print.

Air Conditioning and Refrigeration Technology Institute. "Simulated Performance of Natural and Hybrid Ventilation Systems in an Office Building." (2005): n. pag. Print.

United Kingdom Environment Agency. "Reusing Greywater and Harvesting Rain Water" (2003): n. pag. Print.