Executive Summary

This report contains the results of several studies that were conducted over the course of a year as required by The Pennsylvania State Architectural Engineering senior capstone project. These studies primarily revolve around the mechanical systems of Bentworth Middle School in Bentleyville, PA. The first half of the report contains a synopsis of the studies conducted last semester, including an analysis of compliance with ASHRAE Standards and LEED criteria, discussions on building load modeling and building energy modeling, summaries of the mechanical system design and operation sequences, and an overall as designed system evaluation.

The rest of the document contains information regarding several feasibility studies that were proposed in order to improve the efficiency and over quality of the building. These proposed system redesigns consist of:

- The design of a geothermal hybrid system in order to reduce initial system cost and overall energy consumption
- A redesign of the terminal heat pump units in order to eliminate ductwork and improve system efficiency
- The development of a natural ventilation system in order to decrease energy usage and improve the condition of the learning environment within the classroom
- A study pertaining to the possible energy savings that could be achieved through a decentralized pumping system
- An investigation of the practicality and usefulness of a photovoltaic array
- Development of a new façade and roofing system as deemed necessary due to the other proposed system changes

The results of these studies varied from practical and economical to expensive and wasteful and are summarized below.

- The additional upfront costs of the terminal unit redesign had a simple payback period of 12 years due to its more efficient system and energy savings
- The geothermal hybrid system is capable of reducing initial system costs by $94,150
- Natural ventilation was able to save a significant amount of energy and the system had a simple payback period of 15 years
- Do to the high amount of head created by the geothermal loop field a decentralized pump system was not deemed feasible
- The photovoltaic array is so costly that even government incentives did not make the investment reasonable