

Executive Summary:

The purpose of this report is to convey the results of multiple studies conducted as requirements of the Penn State Architectural Engineering senior capstone project. This report outlines existing and proposed designs relevant to Manassas Park Elementary School; a recently designed and built LEED® Gold elementary school in Manassas Park, VA. Integral points of engineering interest include a building design summary, an existing system analysis, mechanical system modification suggestions, two breadth topics, system schematics, and etcetera.

The system modification suggestions included within this report consist of:

- Connecting the existing Outdoor Air Units (OAUs) to the ground loop to remove the direct expansion coils and/or the direct fire reheat.
- Removing the sensible wheels from the OAUs to decrease associate pressure drop.
- Rerouting ductwork from the OAUs to the Ground Source Heat Pumps (GSHPs) such that the system goes from a series configuration to a parallel configuration, thus allowing the GSHP to be bypassed when applicable.
- Adding BACNET compatible people counters which manipulate added dampers on the Outdoor Air (OA) side of the GSHPs to ramp down the OAUs blowers when applicable.
- Manipulating ventilation operation modes to optimize building ventilation performance.
- Altering the buildings envelope to synergize with the aforementioned ventilation modifications.
- Adding an off-building photovoltaic (PV) array to decrease grid dependence.

Conclusions made within this report include:

- Connecting the existing Outdoor Air Units to the ground loop would require 21 additional wells to be drilled, costing \$233,250 and having a simple payback of 10.7 years.
- Removing the sensible wheels from the OAUs reduces the capacity of the OAU supply and exhaust motors by 30%, and decreases the systems total thermal capacity¹ by over 4%.
- Putting the OAUs and the GSHPs in parallel allows the heat pumps to be de-energized whenever the OAUs can meet the thermal loads of the building, significantly decreasing annual GSHP fan energy consumption.
- People counters could be utilized to control the real-time ventilation requirements of intermittently used spaces.
- The optimal ventilation strategy does not include a natural ventilation mode.
- Replacing the operable windows with non-operable windows saves energy and decreases the chance for building occupants to be exposed to outdoor allergens.
- Adding an off-building PV array is ultimately cost-prohibitive.

¹ System total thermal capacity refers to the combined OAU and GSHP capacity.