Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Full Report

University of Washington's Integrated Design Lab

with support from

Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

Heather Burpee & Joel Loveland

in collaboration with

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ABSTRACT

Cost control, maintaining quality healing and working environments, and more sustainable, energy efficient operations are topics of many conversations in healthcare today. The University of Washington's Integrated Design Lab, in collaboration with a team of experts in design, engineering, operations and hospital ownership have developed research directed at much higher performing buildings – targeting both energy performance and interior environmental quality, for little capital investment.

This research provides a conceptual framework and decision-making structure at a schematic design level of precision for hospital owners, architects and engineers. It offers access to design strategies and the cost implications of those strategies for new hospitals to utilize 60% less energy.

Two acute care hospital prototypes have been developed at a schematic level of architectural and mechanical systems detail. These two prototype architectural schemes and six energy performance options have been modeled for energy use and cost of construction. Both architectural schemes were able to achieve more than a 60% reduction in energy use from typical operational examples, meeting the 2030 Challenge for 2010. This research and design exercise has shown that there is little cost implication for high levels of energy efficiency with an overall premium of approximately 2% of the total project cost, a premium reconcilable through the prioritization of project specific goals and outcomes at the schematic design phase, or easily recaptured in a short-term simple return on investment.

The report of this project is designed as a tool and frame of reference for moving energy efficiency goals forward in project teams, providing a path towards achieving 2030 Challenge energy goals, and providing evidence that these goals do not require substantially increased project capital commitment.

EXECUTIVE SUMMARY

PROJECT RATIONALE

Energy + Interior Environmental Quality: Buildings in healthcare use an immense amount of energy; approximately 4% of all energy consumed in the United States today, including all of the energy used by industry, transportation and building sectors[1]. Hospitals are responsible for an enormous amount of greenhouse gas emissions; one average sized hospital emits approximately 18,000 tons of carbon dioxide into the atmosphere annually. Thus, the fields of hospital design, construction and operation offer a great opportunity for energy resource acquisition.

Hospitals also have a reputation for being less than ideal environments for patients to heal and staff to work. Designers, researchers and health professionals have long recognized that healthy healing interior environments are imperative for patients, but are now coming to realize that such high quality interior environments are equally important for staff who work in these critical care settings. Thus it is crucial to incorporate high interior environmental quality attributes such as abundant daylight, fresh air, views of the outdoors, and the greatest opportunities for individual personal control of light, temperature and fresh air into new hospital developments. It is also important for hospital owners and designers to understand both the energy and cost implications of these design decisions.

Energy Goal Setting: In order to reduce energy use it is imperative to first establish reasonable and testable goals for energy reduction. To set these goals, it is helpful to understand how much energy current hospitals use, and then develop reasonable energy reduction targets. Annualized energy use for buildings is often reported as an Energy Use Index or EUI. The EUI for a building is the total amount of energy used by the building, most commonly electricity and natural gas, per square foot of floor area, metered on an annual basis. Buildings' EUI are often reported in units of KBtu/SF·Year. This is a way of comparing different buildings to each other, much like comparing different cars to each other using a miles per gallon rating. The U.S. Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS)[2] is a national database of building operational energy use that provides a reference to how much energy buildings consume by climate zone and by building use type. The average energy use index (EUI) for hospitals surveyed by CBECS in the Puget Sound climate region is 270 KBtu/SF·Year. A second database of 12 regional Pacific Northwest hospitals has been developed by the Northwest Energy Efficiency Alliance, which verifies the operational energy use that CBECS reports. It confirms a comparable operational EUI for similarly sized regional hospitals, at 263 KBtu/SF·Year[3].

Targets of Opportunity: What are the largest targets of opportunity for energy savings in Puget Sound hospitals? A survey of the operational energy use data concluded that over 50% of the energy used in a hospital is used for the heating of either spaces or hot water. This comes as quite a surprise, and quite an irony, since an EQuest simulation of a baseline ASHRAE 90.1, 2004 code compliant 225 bed hospital in the Puget Sound found that hospitals generate enough heat from internal mechanical or electrical sources to need no additional heat until the outside temperature reaches below 20 degrees. This is of particular note given that it rarely reaches below that temperature; the 99% design low temperature condition is 28.4 degrees F.

The knowledge of these energy demand profiles and climate conditions helped guide an integrated building systems approach in this research. Heating as the predominant energy load became the largest target of opportunity for energy reduction, specifically re-heat energy. Simplified, re-heat is a process used in building systems where outside air is all cooled to a common low temperature, often dictated by the perimeter zones or the hottest areas within the building. Then, when this over-cooled air is re-distributed through the building, in most cases it is re-heated to a more comfortable temperature. The process of cooling then re-heating the air back to a comfortable temperature is a severely energy intensive process. The knowledge of high energy demands on the heating side, coupled with the low thermal balance point temperature of this building type, made the heating systems a first priority for the application of energy efficiency strategies. However, to achieve significantly reduced energy use in hospitals, a complete re-assessment of all systems is required.

STUDY FRAMEWORK: THE 2030 CHALLENGE FOR 2010

What is the 2030 Challenge? The 2030 Challenge is an energy goal that is being adopted by architects, engineers and owners in an effort to greatly reduce energy consumption and greenhouse gas emissions in buildings. It is a progressive goal where every five years a greater reduction in energy use is targeted. For new buildings being designed for operation between 2010-2015, the goal is a 60% reduction from standard operational energy use and by 2030 the goal is to reach net zero annual energy demand. Compliance with the 2030 Challenge is measured by a building's modeled energy performance compared to operational energy use for a median performing building of the same-type and climate zone. Operational energy performance is determined by comparison to the Commercial Building Energy Consumption Survey from 2003 (CBECS), a national database that houses information on different building types in various climate zones. Target Finder is a web interface used to identify energy information from the CBECS database normalizing for building typology, climate, size, use, etc[4].

A 2030 Challenge Hospital, At What Cost? The research question for this project was whether the research team could design a hospital that met the 2030 Challenge, a 60% reduction in energy use, at little additional capital cost to the owner. In order to meet this energy goal in the Pacific Northwest, a project must have a simulated energy performance of less than 108 KBtu/SF year, a 60% reduction from 270 KBtu/SF·Year, the average operational EUI for hospitals in the Seattle climate region as documented by Target Finder and used as the baseline reference for Architecture 2030. The project team set an EUI of 100 for its goal, thus creating the title "Target 100."

Two Architectural Schemes, Three Energy Options: In this study, two architectural hospital prototypes were developed to a schematic level of detail. One prototype, "Scheme A," has a post-war hospital form with a five-story patient room tower centered atop a two-story tall and very deep-plan block of diagnostic and treatment (D&T) spaces. The other prototype, "Scheme B," has a thinner, more articulated D&T base platform, allowing greater potential for daylight, views and natural ventilation at all floors for all hospital functions. Both architectural prototypes were developed with three energy options: 1, 2, and 3. Option 1 is an energy code compliant baseline, Option 2 targets a 60% reduction from typical operational hospitals in the Pacific Northwest (named "Target 100," since they target 100 KBtu/SF·Year). At the central plant level, Option 2 utilizes an extensive ground-source heat pump plant as a major energy reduction strategy. Option 3 also targets an EUI of 100, but utilizes a more conventional heat recovery plant at the central plant level. Thus, three conceptual mechanical Options 1, 2, and 3 were developed for each architectural Scheme A and B. Subsequently, six energy models were developed and analyzed for these two architectural schemes. Similarly, cost models were developed and the first cost of construction was determined and compared between the six options[5].

Looking to Scandinavia: Achieving the 2030 Challenge is a monumental achievement for hospital projects, and one that has not yet been achieved in practice in the U.S. Other countries, especially regionally in Scandinavia, have been achieving greater energy performance with high interior environmental quality for several decades. Many of the strategies that were employed in the Target 100 options are referenced from recent University of Washington research on Scandinavian hospitals[6]. Looking at overall energy use in these countries and the mechanical strategies used to attain this level of energy efficiency provided a valuable trajectory for this research. Scandinavian countries consistently use half to one quarter the amount of energy in their healthcare facilities than is used in the U.S. They implement this level of efficiency using mechanical strategies that are possible to incorporate into our North American healthcare facilities today. In concert with energy efficiency, human connections to the outside environment via the abundant use of daylight, views and the opportunity for fresh air from operable windows are prevalent throughout these facilities. Since these countries have light and weather climate conditions similar to the Pacific Northwest, they provided a helpful framework for this research. Although there are cultural distinctions that make each country's hospital environment unique, there are many lessons that can be learned from Scandinavia, and applied to hospital design in the U.S.

How Can a Hospital Achieve the 2030 Challenge? In order to achieve a 60% reduction in energy use, an entire re-evaluation of many of the architectural systems, building systems and mechanical systems must take place. Adhering to a code-compliant path, following relevant mechanical, architectural and health related guidelines, the following building and mechanical concepts were found to be integral to achieving a high performance, Target 100 hospital design that achieves the 2030 Challenge:

The 2030 Hospital Integrates:

- Full **Project Team** and **Project Design Integration**.
- **Goal Setting, Energy Modeling, and Benchmarking**: Attention to designing to an energy goal, continuously verifying design performance through all stages of project schematic design through operations and maintenance.

Architectural Systems

- **Daylighting**: increase interior environmental quality and decrease electric lighting use.
- **Solar Control**: minimize peak loads for cooling and increase thermal comfort.
- **High Performance Envelope:** balance heat loss and radiant comfort with thermal performance.
- **Building Form and Orientation**: maximize the form of the building in relationship to the outside environment.

Building Systems

- **De-centralized, De-coupled Systems**: separate thermal conditioning from ventilation air.
- Optimized **Heat Recovery** from space heat and large internal equipment sources.
- Advanced HVAC and lighting **Controls:** turn off what is not in use.

Plant Systems

- **Advanced Heat Recovery** at the central plant with **Heat Pumping** or enhanced heat recovery chillers and highly efficient boilers.

Some of these concepts are major departures from standard design practice, but must be addressed to achieve high quality, low energy healthcare designs that incur little upfront additional capital cost investment.

It is critical to recognize that the strategies employed in this research study are ***one*** integrated solution. They represent a snapshot of strategies that were bundled to accomplish the goal of achieving the 2030 Challenge. These strategies are a conceptual framework for this study, and can be seen as one solution for achieving this goal. However, there are a range of strategies that would be suitable for achieving the goal of reaching the 2030 Challenge. A framework of Architectural Systems, Building Systems and Plant Systems can help conceptualize the categories that efficiency strategies bridge.

OVERALL ENERGY AND COST RESULTS

Energy Outcomes: Based on a highly integrated bundle of schematic architectural, building systems, and plant system designs described above and detailed in the final report and appendices, both architectural schemes A & B were able to achieve more than a 60% reduction in energy use from the 2030 baseline operational examples described in CBECS, thus meeting the 2030 Challenge goal for 2010. The major energy end use reduction was in heating energy, specifically re-heat energy. This was expected, as heating energy was identified as the single largest energy load, and therefore the best target of opportunity for energy savings. The key moves to decreasing the heating load were the decoupling of space tempering and the ventilation of most spaces; fluid rather than air-transport of heat and cooling for peak conditions; and the final distribution of heating and cooling to each space via a bundle of decentralized systems such as radiant panels, chilled beams and fan coil units. This decoupled and decentralized scheme of heating, cooling and ventilating systems acting in close coordination with heat recovery from most every significant powered or heated energy source and a large ground source heat pumping system reduces the required energy use for heating (space and water) by 92%, and reduces the overall energy use for the building by just over 60%, to an overall EUI of 100 KBtu/SF·Year. A second option, with a centralized heat recovery plant in place of the ground source heat pump system, was also found to be highly effective, reducing the overall energy consumption by just under 60%. Domestic hot water heating energy, cooling load reductions, and lighting power reductions through daylighting strategies were other areas of focus where significant energy savings were achieved.

Integrated Team, Integrated Systems: Achieving results with such a dramatic reduction in overall energy use requires an integrated approach where engineering, architectural, construction contracting, ownership and utility groups all work together to achieve highly bundled and integrated, commonly held goals. This project has focused on a bundled or holistic approach to energy reduction and quality improvement, and the overall cost implications of these strategies.

One result of this highly integrated, high performance design is a large change in the dominant fuel source. The typical fuel split in hospitals is approximately 40% for electricity and 60% for natural gas (mainly for heating). The relationship between the demands for electricity and natural gas changes significantly in the Target 100 Options; there is a large reduction in natural gas consumption, and a modest reduction in electricity consumption with a fuel split of approximately 82% electricity and 18% natural gas.

COST ANALYSIS

Synergistic Savings: Given potential utility incentives, there is a 1.7% capital cost investment required to implement energy efficiency measures that achieve the 2030 Challenge for 2010. The integrated nature of building and systems create complementary savings in both energy and cost; cost savings in some categories paid for incremental energy improvements in other areas. For example, reduced cooling loads were realized by the addition of retractable louver shades, thereby reducing the first-cost of the cooling system. De-coupled systems concepts also reduced loads having a major impact on primary ventilation duct sizing, creating room in the ceiling plenum to drop the floor-to-floor height on patient floors by one foot. Cost savings realized by floor height reductions and reductions in ventilation ducting offset the increased cost for other energy efficiency improvements. These integrated building and systems strategies work in concert, thereby this effort has been approached as a bundled set of whole building strategies in a holistic analysis[7].

Cost Outcomes: The cost implications of the energy efficiency options was an overall premium of about 2.7% of the total project cost without any utility or other incentives. A schematic approach to understanding the range of possible utility incentives, in discussion with regional gas and electric utility efficiency engineers, yielded a potential whole building incentive that could subsidize first-cost of energy efficiency strategies at a value of approximately $4/Sq.Ft., or approximately $2.1 million. With this potential incentive, the total cost premium for energy efficiency strategies that meet the 2030 Challenge goal would be approximately 1.7% of the total project cost. It is important to consider that these architectural, mechanical and cost models are at a schematic level of design, thus this low percent difference between the code baseline energy option and the Target 100 energy option give great promise for the ability for new hospital projects to incorporate significant energy efficiency in their design at relatively low first-cost.

The Cost of a Highly Articulated Form: The cost of the change in architectural form, from Scheme A to Scheme B, was greater than the premium for energy efficiency. The change in form incurred an incremental cost of 8.4% with increases in cost for exterior surface, building envelope and greater articulation of the perimeter. There is a cost premium for the overall increase in surface area for Scheme B; however, the increased building perimeter improves the potential benefit of connectivity between the interior and exterior environment. Development of hospitals with better direct connection to daylight, view and potential for access to nature must be weighed with the benefits obtained from patient healing, staff well-being, productivity, satisfaction and retention in a hospital that has much higher interior environmental quality. Although this study's focus was not on the economic benefit that can be recaptured from better work environments and healing environments, this has been the subject of other studies, and can far outweigh the small increase in capital cost investment required to provide a superior quality building.

Simple payback: It was found through this work that the Target 100 energy options would save between $700,000 and $850,000 annually on total energy costs compared to newly constructed, energy code compliant options based on simple Puget Sound Energy non-negotiated rate structures. Based on these savings, the initial capital cost investment would take less than eight years to recover. If whole building utility incentives were available, the investment would take less than five years to recover. These figures are not taking into account the time-value of money, escalation or capitalization rates, therefore they are the most conservative, simple payback estimates. It is worthwhile to note that these savings are compared to other newly constructed hospitals, whose operational energy use is also lower than typical energy use of average existing infrastructure today. If these savings are compared to a similarly sized, average operational hospital today, the Target 100 hospital would save over $1M on utility bills, annually.

Putting Energy Savings Into the Operational Budget: The savings accrued by the energy efficiency strategies are significant, especially if considered as part of the net operating income for the hospital. In a 4% operating environment, it takes $25 of gross revenue to generate $1 of net operating income. That is, $25 worth of services must be provided to yield $1 of profit, or net-operating income. Energy savings can be viewed as an ongoing, high yield, low risk investment or revenue stream that does not require services to provide income to the bottom line of the hospital. In order to accrue $700,000-$850,000 of net operating income, (the savings achieved annually on energy bills) $18,000,000-$21,000,000 worth of services would have to be delivered annually.

Carbon and Beyond: If looked at from a carbon perspective, adopting these strategies would save 7,800 tons of carbon[8] entering the atmosphere annually (based on national electrical source assumptions). If only one project attains this goal it would be equivalent to taking over 1,300 passenger cars off the road[9] or planting over 300,000 trees[10]. This is a monumental amount of carbon savings – and it is an attainable, affordable goal that can be achieved if a commitment is made early by a motivated and dedicated integrated design, construction and ownership team.

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[1] EIA, 2006 Energy Information Administration (EIA), Commercial Buildings Energy Consumption Survey (CBECS): Consumption and Expenditures Tables. "Table C3A". US Department of Energy, 2006.

Architecture 2030. "The 2030 Challenge". http://www.architecture2030.org/2030_challenge/index.html.

CBECS 2006 estimates energy consumption of all healthcare buildings at 594 trillion Btu of 6,523 trillion Btu for all buildings, thus 9% of all buildings' energy use. Architecture 2030 estimates that buildings use 48% of all source energy in the U.S. with industry and transportation sharing the remaining energy. Therefore, healthcare uses 4% of all site energy in the U.S.

[2] EIA, 2003 Energy Information Administration (EIA), Commercial Buildings Energy Consumption Survey (CBECS). US Department of Energy, 2003.

[3] Burpee, Heather, Hatten, M., Loveland, J., and Price, S. "High Performance Hospital Partnerships: Reaching the 2030 Challenge and Improving the Health and Healing Environment." Paper presented at the annual American Society for Healthcare Engineering (ASHE) Conference on Health Facility Planning, Design and Construction (PDC). Phoenix, AZ, March 8-11, 2009.

[4] http://www.energystar.gov/index.cfm?c=new_bldg_design.bus_target_finder

[5] All energy options maintain Washington State Health and Energy code compliance.

[6] Burpee, Heather, Hatten, M., Loveland, J., and Price, S. "High Performance Hospital Partnerships: Reaching the 2030 Challenge and Improving the Health and Healing Environment." Paper presented at the annual American Society for Healthcare Engineering (ASHE) Conference on Health Facility Planning, Design and Construction (PDC). Phoenix, AZ, March 8-11, 2009.

[7] Cost estimates for the project are based in the Seattle, Washington construction market and were priced at fair market value for the Winter of 2010. They are first cost of construction estimates and do not include land acquisition, site work, or professional fees.

[8] Hatten, M., and J. Jennings. "2009 AIA Portland Design Awards CO_2 Calculator." 2009.

[9] United States Environmental Protection Agency. "Emission Facts: Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks" http://www.epa.gov/oms/consumer/f00013.htm.

[10] Trees for the Future: "How to calculate the amount of CO2 sequestered in a tree per year" http://www.treesftf.org/resources/information.htm#agfotech. Tree offset calculation is based on a tree planted in the humid tropics absorbing on average 50 pounds of carbon dioxide annually over 40 years.

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TABLE OF CONTENTS

FULL REPORT

SECTION I: INTRODUCTION

INTRODUCTION OF PROJECT AND PROJECT TEAM

Funded by the BetterBricks Program of the Northwest Energy Efficiency Alliance, the University of Washington's Integrated Design Lab with the collaboration of Solarc Architecture and Engineering, TBD Consultants, Cameron Macallister, NBBJ Architects, Mahlum Architects, and Mortenson Construction has developed a body of work that encompasses: 1) knowledge about the actual operational energy-use characteristics of hospitals in the Pacific Northwest and abroad, 2) methods for radically reducing energy use in the hospital sector to meet the 2030 Challenge for 2010, 3) two prototype hospital configurations that meet the 2030 Challenge for 2010 and 4) cost implications for these prototype hospitals.

As part of this work, the group has developed strategies for reducing energy in hospitals by more than 60% in the Pacific Northwest, and provided a schematic path to meeting the 2030 Challenge and a road-map to even greater energy savings. Interior environmental quality was addressed in addition to energy goals. Scandinavian case studies illustrate that achieving these aggressive energy goals is possible while simultaneously creating superior interior environmental qualities for patient care and staff retention, and they serve as a model for this work.

LAYOUT AND CONTENT

This document is intended as a summary of work to date in a three-year research effort that culminated in gathering energy and cost data for six prototype hospital designs. In Section I, an introduction to the project rationale with a context of energy use in operational hospitals in the Pacific Northwest is addressed. Section II covers the framework for the research project and describes the prototypes that were developed and studied. Section III reports the results of the energy modeling efforts and discusses the outcomes of these results. Section IV similarly reports the outcomes of the costing models, reporting and discussing the first cost implications for each of the six prototype hospital designs. Finally section V addresses next steps, and the future of this research. Four Appendices follow the main document containing more detailed content including architectural description, mechanical design, energy results, and cost analysis.

INTRODUCTION OF PROJECT RATIONALE

With growing attention on climate change and a developing focus on sustainability, it is important to address the energy use of buildings and understand what it takes to build high performance hospitals. The building sector consumes approximately 50% of the total energy used in the United States (Architecture 2030). Within the building sector, healthcare is the second most energy-intensive building type, using 594 trillion Btu in 2003, accounting for 9% of all building energy use (CBECS 2003). Looking at energy as the sum of the transportation, industrial, and the building sectors, healthcare as a building type accounts for approximately 4% of all energy consumed in the United States today, and approximately 1% of energy consumption worldwide. Thus, hospitals represent a monumental target of opportunity for energy reduction nationwide.

When addressing energy efficiency for new construction projects, it is useful to strive toward a common energy goal. The 2030 Challenge that has been adopted by the U.S. Congress of Mayors, the American Institute of Architects, and by numerous architecture firms, mechanical engineering firms, and some hospital organizations. The 2030 Challenge is a carbon reduction goal at its core, but measures this reduction through total energy reduction from typical operational energy use. Its goals are progressive: for 2010-2015, the target is to reduce energy from baseline energy use (in similar building types and climates) by 60%, in 2015 it will be a 70% reduction in energy use, and in 2030 the goal will be net-zero energy use.

Reducing energy use by 60% in a newly constructed hospital, the stated 2010 goal for the 2030 Challenge, is a very aggressive goal. Hospitals are well positioned in the marketplace to make a transition toward energy efficiency from a community and stakeholders point of view. Hospitals and building professionals are not well positioned, however, to carry out the steps that are necessary to radically reduce energy consumption in hospitals to a level that is required to meet an aggressive energy goal such as the 2030 Challenge. Hospitals would like to adopt changes to reduce their energy use significantly, and foster greater community stewardship, but many hospital organizations and design teams are not prepared to make that transformation. This research provides a road-map for owners and design teams to embrace, adopt, or adjust their projects' particular needs with a goal of reaching the 2030 Challenge. It also provides a groundwork for understanding the energy, design, and cost implications of radically reducing energy use in a hospital project.

Energy efficiency is only one focus of a high performance hospital. High quality environments for patients, visitors, and especially staff are equally important in the healthcare setting. High quality healing environments have been well recognized for patients and continue to be critical part of design parameters. For staff, however, there is vast room for improvement to create more healthy and productive workplaces. The hospital workforce is a chronically stressed population, making life-or-death decisions while working extremely long shifts. They often work without a glimpse of daylight, a view from a window or a place of respite away from this stressful environment. There is vast room for improvement in our hospitals. High quality attributes such as daylight, views of nature, green space, fresh air and increased personal control of one's environment are imperative components to high performance hospitals. The configuration of the contemporary hospital, however, has transformed into a building style that often does not reflect a connection with the outside environment. This research looks to identify the energy and cost implications of transforming a typical deep span hospital, with little connection to the outside environment, to one that sets up opportunities for greater access to natural daylight, views, natural ventilation, and green space.

More context and background for this work can be found in this group's previous published research "High Performance Hospital Partnerships: Reaching the 2030 Challenge and Improving the Health and Healing Environment (Burpee et.al. 2009)."

CHARACTERIZING HOSPITAL ENERGY USE: BENCHMARKING OPERATIONAL HOSPITALS

It is well established that hospitals are large energy consumers (CBECS). It is important, however, in an effort to characterize hospital energy use to understand the detailed patterns of use and measure performance of actual hospitals. In 2006, this group started an in-depth research initiative to first benchmark energy use and evaluate energy use patterns in operational hospitals, which as an initial effort laid the ground work for more in-depth research goals. Next steps, which are embodied in this paper include: a) developing methods for radically reducing energy use in the hospital sector to meet the 2030 Challenge, b) determining the cost differential of typical hospitals built today vs. radically reduced energy models and c) determining the first cost of construction and energy use between a typically configured hospital and an architectural prototype that is configured to incorporate more access to daylight.

Characterizing hospital energy use involves developing expectations for the amount of energy used, the type of fuel used, and the breakdown of energy end use categories: heating, cooling, equipment and fans, lighting, etc. One could consider this as "taking the temperature of the hospital." To evaluate the amount of energy used by a building, it is best practice to first estimate an annualized Energy Use Index (EUI), expressed in KBtu/SF•year (thousands of British Thermal Units per square foot per year). The EUI is estimated by summing the annual energy use of all fuels used on-site (typically electricity and one or more fossil fuels metered for use at the project site location), converting to a common energy unit (typically the Btu or KBtu in the US), and dividing by the applicable conditioned area of the facility. Once estimated, an EUI can be interpreted by comparison to a database of energy use statistics for similar facilities, a process called benchmarking.

When creating goals for new construction, or when benchmarking current facilities, it is helpful to reference databases that contain information on average operational energy use in similar building types. In this project, two energy use databases were referenced. The 2030 Challenge recommends using the EPA's "Target Finder" to determine the baseline energy use for measuring success in achieving the percentage reduction goal. For healthcare facilities, this database references the Electric Power Research Institute's (EPRI) Energy Benchmarking Survey completed in 1997 and calibrates the data for climate and building size. For a 225 bed, seven story 520,000 SF acute care hospital with tertiary care, located in Seattle Washington, Target Finder estimates the baseline EUI to be 270 KBtu/SF•year. A second dataset that was referenced is one that has been developed with the Northwest Energy Efficiency Alliance's (NEEA) building operations program. This database consists of eleven existing acute care hospitals, ranging in size from 190,000 SF to 1.4 million SF, located in Montana, Idaho, Oregon, and Washington. Hospitals in this database consume approximately 260 KBtu/SF•year in total energy confirming the approximate operational energy use reported in Target Finder.

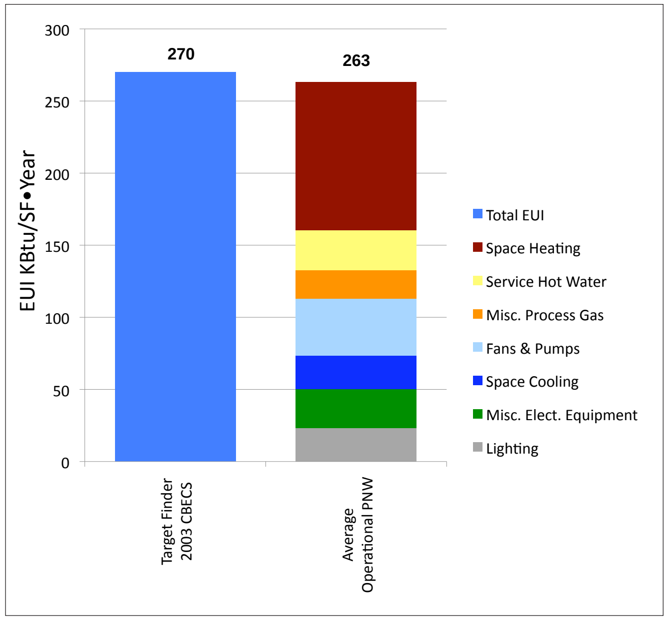

Figure 1.0: Two operational baselines for hospitals: CBECS as identified by Target Finder and average operational data identified by NEEA.

BACKGROUND, ENERGY USE PATTERNS IN EXISTING HOSPITALS

The NEEA dataset provides more detail on the energy use patterns in existing hospitals, and is seen as a robust set of data from the point of view that project team members were directly involved in collecting the information in the dataset. This dataset of regional hospitals in the Pacific Northwest indicates that the fuel use split tends to be about 40% electricity and 60% fossil fuel, typically natural gas. The majority of this energy is used for heating; approximately 40% of total energy is used for space heating. Of that amount, reheat coils with ducted air cooling systems account for most of the load. Other major loads are domestic hot water, at about 15%, and building fans and pumps, at about 16%. In typical hospitals, energy used by the heating, ventilating, and air conditioning (HVAC) systems represents over 70% of the total annual energy use. Significant energy reduction in U.S. hospitals must focus attention on the design and operation of HVAC systems. For new hospitals, this focus should occur within a context of design integration that includes a profound understanding of the loads being served by hospital HVAC systems.

While the energy problem in hospitals, at least those located in Department of Energy (DOE) marine climate zone four (Seattle), can safely be described as heating, the loads problem is actually related to cooling, i.e. getting rid of heat. People, lights, medical equipment, etc. contribute to this internal heat-gain load, but much of the heat-gain is actually imposed by the mechanical equipment itself. It is common for large hospital central cooling plants to be enabled when outside air temperatures are quite low (44°F to 48°F, and sometimes lower). Monitored facility-level electric loads range from 2.5 to 3 watts/SF during the peak heating season, and tend to be quite flat over a 24-hour cycle. Much of this electric load is converted into heat. This electrical load density means that US hospitals are internal load driven facilities. With modern envelopes, driven by energy code requirements, it is not unusual for hospitals to have a greater need for heat rejection than heat addition, even when outside air temperatures drop well below freezing. Calibrated energy and loads modeling performed on a conventional, core dominated prototype hospital design supports this observation. For most climates, these load patterns suggest that hospitals should never really need to add heat if the design would accommodate moving heat from those zones that need to get rid of it to those that need it. It is no small irony that the load problem imposed on the HVAC systems by the modern hospital program and its corresponding architecture involves cooling while the energy problem created by the typical hospital HVAC system is all about heating. This certainly underscores the importance of focusing attention on the HVAC systems, especially on the problem of reheat.

The typical HVAC system type found in modern hospitals is a multi-zone overhead ducted air system. It may be variable air volume (VAV) or constant air volume (CAV). Some systems are return air capable, while other are designed as `100% outside air' systems. In all cases, these systems will be equipped with reheat capability. Reheat is the energy transfer process where heat is added to air that has already been cooled. In hospital HVAC systems, the air is cooled at the air handling unit, either with a cooling coil or by mixing cool outside air with warmer return air. In either case, the temperature of the air delivered to the ductwork is determined by the space calling for the most cooling. Much of the time, this will have the tendency of over-cooling all other spaces connected to the same HVAC system. Terminal reheat is used to compensate for this overcooling effect. Both steps of this process require energy. Extra cooling energy is used at the air handling unit and extra heating energy is used at the reheat coil. An appropriate analogy might be driving with the accelerator constantly engaged and using the brake to adjust the speed.

While reheat can be a consequential energy issue for many building types, it has particularly significant energy implications for hospitals. This is because of the hospital specific code requirements that can limit minimum air flow as well as emerging functional protocols that translate to exceptionally low supply air temperatures for certain spaces, for example, operating rooms. Pacific Northwest teams must design HVAC systems to comply with state and national health codes, which require patient rooms to have a minimum air circulation of six air changes per hour (ach) when room tempering is delivered through the airstream. For conventional room geometry, this is equivalent to about 1 cfm/SF, and represents a severe limitation to the ability of a Variable Air Volume (VAV) terminal unit device to turn down during low load conditions. Many hours throughout the year could be expected to have cooling loads that require significantly less than 1 cfm/SF, yet a patient room terminal unit cannot deliver lower air flows. The magnitude of reheat is directly related to the minimum air flow setpoint at the VAV terminal unit. By way of comparison, non-regulated buildings are allowed, and even encouraged by energy codes and incentive programs, to turn down to flow rates as low at 0.1 cfm/SF.

Ultimately, to address a goal of radically reducing energy use in hospitals, a comprehensive whole building approach is necessary. Benchmarking baseline energy use in hospitals is the first step. Understanding these load profiles and other characteristics that are unique to hospitals can help identify the most effective strategies for attaining comprehensive approaches to achieving marked improvement in energy efficiency.

BACKGROUND SCANDINAVIAN EXAMPLES

When embarking on new methods for designing systems, it is helpful to look to others who have already been successful in implementing these strategies. Scandinavia as a region is a leader in sustainability and has focused on increasing building energy efficiency for far longer than the U.S. Scandinavian hospitals can serve as a useful resource to evaluate for achieving energy reductions in our hospitals.

Figure 2.0: St. Olav's Hospital patient room. This room has an accessible exterior deck and well controlled solar shading devices as well as under window radiant heat.

The Integrated Design Lab (IDL) had begun an analysis of actual energy use in Scandinavian hospitals in conjunction with the research that was being undertaken to achieve significant theoretical energy reductions in U.S. hospitals. Through that research, and subsequent site visits with leaders of the healthcare design community in the Pacific Northwest, it was established that Scandinavian hospitals use, on average, half to one quarter the amount of energy of our typical operational hospitals today. They also incorporate high quality aspects such as daylight and fresh air throughout. Mechanically, these Scandinavian examples do not use technologies that are new to design teams in the Pacific Northwest, however they may be re-formulated and applied in new ways. Their architectural forms are much different than typical hospitals that are built in the Pacific Northwest today, incorporating connection to the outside environment wherever possible, throughout the hospital facility. These operational hospitals in

Scandinavia provided a framework for this research effort in many aspects including the mechanical designs, energy implications, and overall architectural solutions.

SECTION II: CONCEPTUAL FRAMEWORK

DEFINING THE 2030 HOSPITAL FOR 2010

As described earlier, the 2030 challenge goal for 2010-2015 states a 60% reduction from operational energy use within similar building type. The baseline operational energy use data for this reduction target is accessed through Energy Star's Target Finder, which for healthcare facilities uses energy data from the Electric Power Research Institute's (EPRI) Energy Benchmarking Survey completed in 1997. According to Target Finder, the average Pacific Northwest 520,000 SF hospital consumes 270 KBtu/SF Year. A 60% reduction from this target implies an EUI of 108 KBtu/SF·year for a new actue care hospital. Based on this information, the research team established an energy goal for this project of 100 KBtu/SF Year, comfortably below the 2030 Challenge reduction target of 108 KBtu/SF Year, and nicknamed the energy reduction "Target 100." The lowest EUI in the regional Pacific Northwest database was verified to be 199 KBtu/SF·year, for a hospital that is generally acknowledged as one of the regional leaders in energy efficient design and operation. Thus, it was recognized that "Targeting 100" would be a significant and difficult challenge to meet.

INTRODUCTION TO FRAMEWORK OF RESEARCH AND MODELS

The 2030 Challenge in its current form represents energy goals for hospitals that are very aggressive, especially considering the current documented range of performance for this building type. It is a performance goal for which there are no documented large hospital precedents in commonly used energy tracking databases, and has not been embraced with much enthusiasm by many hospital facility managers or design team leaders for this reason. Most health care design and operations experts in the US are at somewhat of a loss about how to respond to such an aggressive goal, one that seems impossible to achieve for 2010, much less for the 2030 target of net-zero.

In an effort to address the 2030 Challenge and provide tools for design and ownership teams for an accessible target in the hospital sector, this research team composed of architects, mechanical engineers, and cost experts met over the course of three years to develop energy and cost models that address this goal for hospitals. Mike Hatten from Solarc Architecture and Engineering performed the energy modeling of the prototypes, TBD Consultants performed the primary cost estimates, and a team of experts from NBBJ Architects, Mahlum Architects and Mortenson served as primary consultants under the leadership of the University of Washington's Integrated Design Lab. This team of experts met on a bi-monthly basis to develop the architectural, energy, and cost models for the project. This group came together to develop a series of design strategies that have the potential to significantly reduce energy use in a theoretical hospital and to then estimate the first-cost implications of the theoretical design. The final result of this project are six prototype energy models, with associated first cost estimates. These models serve as prototypes for design and ownership teams, and provide models of what it may take to implement strategies that lead to achieving the 2030 Challenge for 2010, a 60% reduction from typical operational hospitals in this region.

CONTEXT FOR HIGH PERFORMANCE DESIGN STRATEGIES

The strategies and design solutions that are employed in this study are concepts that seem new at first glance. However, they are tested solutions that have been employed in conventional U.S. hospitals of the 20th century and are common practice for hospitals in Scandinavia. The systems that are described in this project are representative of a conceptual framework for a layered, distributed systems concept, whereby heating, cooling, and air distribution can be de-coupled and delivered to smaller distributed zones. These are concepts that are implemented in energy efficient designs in Scandinavia, and in a few example hospitals in the U.S. For example, conventional hospitals in the U.S. before the common use of constant air volume systems relied on similar distributed systems strategies that are implemented here. Layering of systems with de-coupled heating and ventilation is common in radically low-energy use commercial buildings in the U.S.

and common in Scandinavian buildings, including hospitals. Thus, these are not new strategies to healthcare design, and are tried and tested with real world experience. In this project we are re-envisioning common practice in the Pacific Northwest to design hospital prototypes that meet or exceed the 2030 Challenge for 2010, using methods that may push the envelope, but are certainly not new technologies.

THE SCHEMATIC NATURE OF THIS PROJECT

This project is a proof of concept exercise, which investigates how to design a hospital that meets the 2030 Challenge, as well as the first cost implications of these design decisions as compared to a conventional approach. The energy and cost estimates are based on a schematic level design, and as with any building project, would evolve with greater precision as the project approached greater completion. Within that framework, the precision of these numbers, while stated concretely, are really within a margin of adjustment of +/- 10%. The bases of the assumptions for this project are made as explicit as possible so that others can follow the logic of this exercise. This team has a strong basis in practice and research, with knowledge and expertise that guided the process ensuring a plausible foundation and results. Ultimately, the outcome is a tool that can be referenced as a framework for the energy implications and first costs associated with overarching design decisions that approach the 2030 Challenge goals for 2010-2015, without impinging on any current Washington State Energy or Health related codes. If health and safety codes are re-evaluated with both safety and energy in mind, and this research were undertaken in a non-code compliant path, an even greater energy savings might be achieved. In that way, this project is a stepping-stone to future work for even further reduced energy consumption in hospital design and operations.

ARCHITECTURAL CONFIGURATIONS OF MODELS: SCHEME A AND SCHEME B

This study tested energy use and cost of construction for two hospitals with distinct architectural configurations: Scheme A and Scheme B. Scheme A reflects a "typical" configuration, with a form similar to the common mid-20th century era form of a two story, 250' deep by 400' long, diagnostic and treatment block, with a five story patient tower placed on top (Figure 3.0). Our research shows that US hospitals often have a configuration similar to this, one that maximizes the buildings' compactness and quantitatively definable efficiency metrics, but limits human connection to the outside world. Scheme A was modeled to demonstrate the effect of energy efficiency in a typically configured hospital, and to ascertain the difference in energy consumption and first cost of construction between a typically configured hospital and a form that is more articulated; a form that allows more opportunities for connection to the exterior environment.

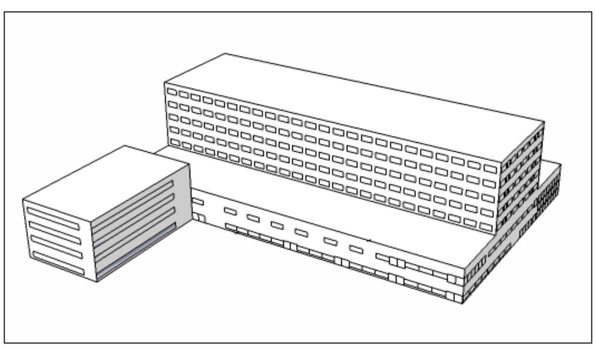

Figure 3.0: Three dimensional configuration of Architectural Scheme A: the Typical form

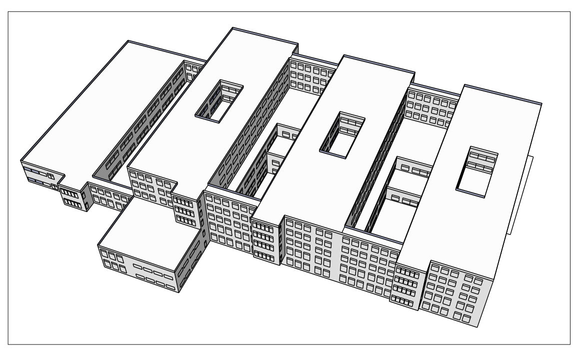

Figure 4.0: Three dimensional configuration of Architectural Scheme B: the Perforated form

Scheme B has a more articulated, "perforated", configuration that introduces more exterior perimeter to the overall form. We consider this form to be more sustainable because it provides opportunities for daylight and fresh air, as well as creating greater connection to the exterior environment, especially in the diagnostic and treatment areas of the hospital (Figure 4.0). Research shows that a connection to the outside environment is a powerful influence on well-being (Ulrich, 2008, Joseph, 2006). Scandinavian examples built and operated over the last 20 years provide examples that lead the effort in re-imagining hospital forms that are humanistic from both patient care and staff retention points of view. This Scheme was developed for simulation to demonstrate the energy and cost implications of increasing the perimeter area of a hospital that is similar in scale to the typically configured prototype.

As many aspects as possible were held constant between the two architectural schemes; program areas, window to wall ratios, interior finishes, etc. Scheme B uses slightly more site area than Scheme A and the two programs are spatially configured with slight differences in program arrangement due to the quite different building forms of the two schemes. Where both have a basement, and two levels of above ground diagnostic and treatment, the distribution of patient care areas is slightly different. More detail about the program and schematic program layout of the two hospitals can be referenced in Appendix 1.0.

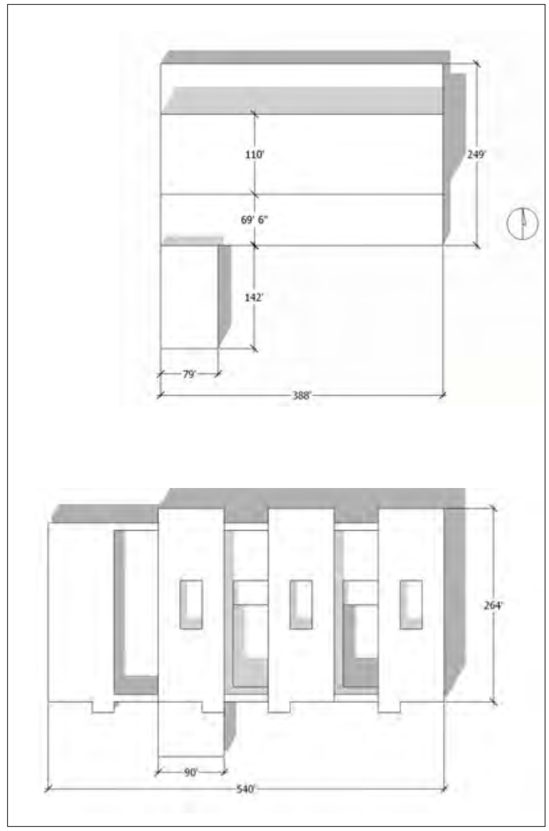

Figure 5.0: Comparison of the overall site coverage of Schemes A and B; 107,830 SF for Scheme A and 144,360 SF for Scheme B.

INTEGRATED DESIGN

The schematic mechanical designs, energy models and cost estimates in this study are for a snapshot of strategies that accomplish the goal of achieving the 2030 Challenge. These strategies are a conceptual framework for this work, and can be seen as ***one*** solution for achieving this goal. However, there are a range of strategies that would be suitable for achieving the goal of reaching the 2030 Challenge.

Strategies were identified through previous research efforts of this group and through the team's expertise. Instead of parametrically analyzing each of the energy strategies individually, or groups of strategies compared side-by-side, two alternative code compliant paths were modeled as integrated packages and compared to a Code Baseline model. Strategies such as continuous commissioning, Green Guide for Healthcare recommendations, load reduction strategies, alternative mechanical strategies, and control strategies, which were modeled as a precursor to this research, and served as starting point for the mechanical designs. Additionally, lessons learned from Scandinavian hospitals, which use half to one quarter the amount of energy from typical U.S. hospitals were used as a road-map for alternative, energy reducing mechanical strategies.

Design decisions for architectural systems, mechanical systems, and plant systems are intricately intertwined where they necessarily support each other, thus various components cannot be value engineered out of the projects, or replaced, without effecting the energy results overall. This is supported by the intricacy of hospital buildings, where a small change in one system tends to ripple throughout the building's myriad of systems, especially in highly energy efficient designs.

After several years of research we have come to realize that significant energy savings are only possible through close and continuous integrated efforts from the earliest stages of project planning, with involvement from core planning, design, construction and facility operation team members. This integrated project delivery approach creates a re-formulated set of architectural, mechanical and plant systems that are developed from a holistic performance-based project perspective. Interaction between all disciplines including ownership, design, engineering, energy modeling, utility and construction teams is integral in producing the most energy efficient, highest quality outcome.

The focus of this research effort has been to assess the whole-building performance of six distinct hospital designs. Although our previous research has looked at the incremental energy savings of a variety of architectural and mechanical strategies, in this project we have considered each of the designs to be an integrated whole, or a bundled set of strategies per hospital design option within each architectural scheme.

SCHEMATIC MECHANICAL CONCEPTS

The strategies that are bundled together fall generally in three categories: **Architectural Systems**, **Building Systems**, and **Plant Systems**. A comprehensive analysis of energy intensity and cost implication for low, mid, and high performing options within each of these three categories (architectural systems, building systems, and plant systems) would be ideal. However, this would be very time, and cost intensive and beyond the scope of this phase of research, thus in this report two alternates paths, or Options, to a code baseline option are explored.

For each of the architectural Schemes A and B, three schematic “Energy Options” were developed. These mechanical concepts were conceptualized as bundles of strategies, each using an integrated, holistic design approach. An energy code baseline model was developed and two energy reduction bundles were compared to the baseline model and operational averages. The team established an energy reduction goal of 60% from typical operational performance, to meet the 2030 Challenge. Thus, a target EUI of 100 KBtu/SF·year was established and the energy reduction strategies were named “Target 100.” The two Target 100 bundles vary only at the central plant level. One has an extensive ground source heat pump plant, and the other has a highly effective heat recovery plant with no bore field. Figure 6.0 shows the two architectural schemes with their associated energy options A1, A2, A3 and B1, B2, and B3 clarifying these naming conventions.

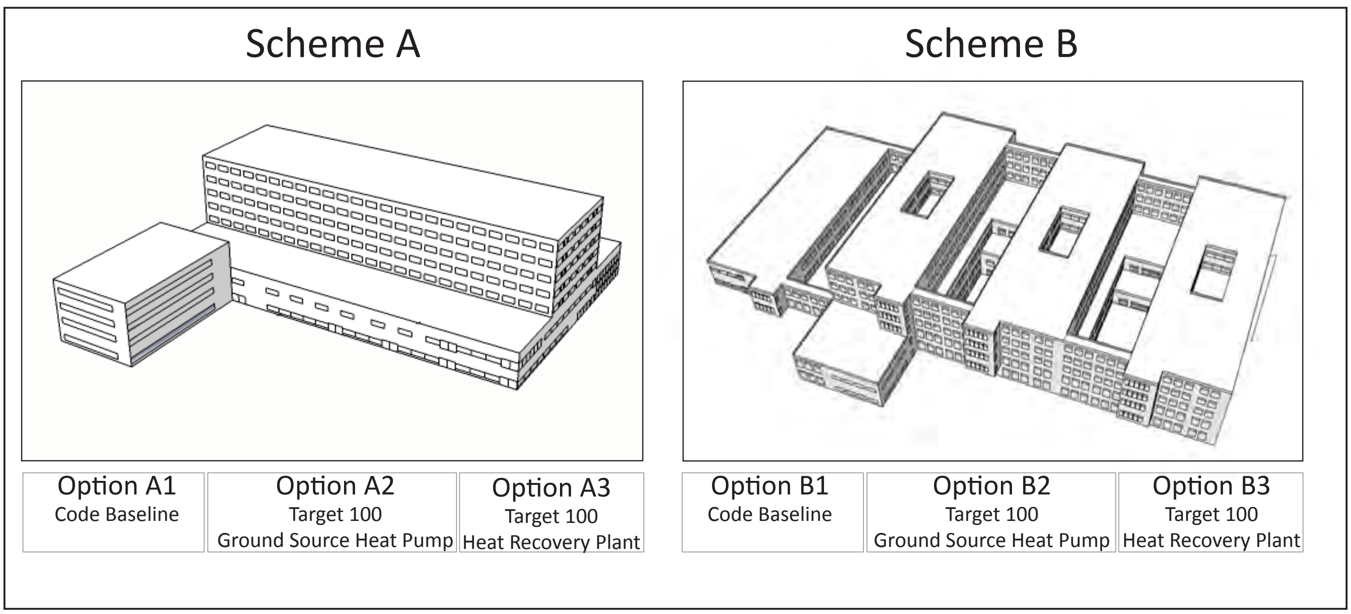

Figure 6.0: Description of the four prototype models: Scheme A, Options 1-3 (A1, A2, and A3) and Scheme B, Options 1-3 (B1, B2, and B3). Architectural Scheme A is tested with both a code baseline design and with energy reduction strategies, targeting 100 KBtu/SF year with two central plant strategies. Architectural Scheme B is tested with similar strategy sets, “Code Baseline” and “Target 100.” These energy models are compared to average operational examples as reported in Target Finder to determine percent reduction for the 2030 Challenge and other energy reduction goals.

OPTION 1: BASELINE ENERGY PERFORMANCE

Code-compliant “Baseline Energy” designs were developed for each of the Architectural Schemes and named Energy Options A1 and B1. These Baseline Energy designs use Washington State Energy Code 2006 for envelope performance standards and ASHRAE 90.1 2004 for non-envelope energy performance standards (See Appendix 1.0 for more detail). The baseline mechanical concepts are typical for today’s new hospitals. Though constant-air-volume (CAV) HVAC systems are quite common in the region, even in new hospitals and large additions, the research team assumed a significant improvement, in that secondary HVAC systems are predominantly variable air volume (VAV) with return air capability, and reheat at all VAV terminal units. Systems serving laboratories, kitchens, and laundry spaces are (CAV) 100% outside air systems. Larger systems serving the primary laboratory space and the kitchen have heat recovery capability. Central plant infrastructure consists of a central natural gas-fired steam boiler plant and a water-cooled central chiller plant. The steam plant provides steam to meet process loads (sterilization, cooking, humidification), space heating loads, and potable water heating loads. The chilled water plant is comprised of large centrifugal water chillers with dedicated cooling towers. The major concepts within each category are described with more detail in Table 1.0 in section "The Specifics: Strategies Used to Develop Energy Models."

TARGETING 100: OPTIONS 2 & 3

The team then drew on its previous research to identify a set of mechanical strategies that as an integrated whole result in significant energy savings targeting the goal of an energy use index (EUI) of 100 KBtu/SF Year. For all Schemes, a code compliant (or better than code) path was followed to achieve our goals. That is, the AIA Guidelines, ASHRAE 90.1 2004, Washington State Department of Health and other regulating codes were adhered to in developing this conceptual framework.

The Target 100 Strategies can be conceptualized as a bundle concepts subcategorized as: Architectural Systems, Building Systems, and Plant Systems.

ARCHITECTURAL SYSTEMS

Architectural Systems describe the components that come together to comprise the building "skin" and the building's relationship to the site. These include a large range of inter-related systems including building siting, orientation, exterior fenestration, exterior shading, and building structure, opaque wall enclosure including materials such as insulation and thermal mass. A multitude of variations of any of these components could contribute to achieving a high performance building. One path to the goal of meeting the 2030 Challenge was chosen in this project, and these strategies established a discrete point for energy modeling and cost modeling purposes.

The Target 100 Options (A2, A3 and B2, B3) use the Draft Washington State Energy code for 2009 as a guideline for envelope performance (see Appendix 1.0 for more details), and re-formulated mechanical and electrical strategies for integrated building performance targeting this progressive goal.

Integrated Concept: One strategy chosen for the Target 100 models was dynamic exterior shades on the South, West, and East facades. These shading systems are critical to the success of the overall integrated concept of the Target 100 energy strategy because they ensure that no direct solar radiation enters the façade, reducing heating loads on the building. This in turn reduces the cooling capacity necessary in the building, reducing the size and cost of units needed to accommodate those cooling loads. In addition to the benefit of using smaller cooling units, reduced cooling loads enable a de-coupled systems concept that results in reduced ducting size for the air systems. The reduction of ducting size allows more flexibility in the ceiling space, and in this model, the team determined that the increase in flexibility was great enough to reduce floor to floor heights on patient floors from fifteen feet to fourteen feet. All of these integrated systems are critical to one another to achieve success. One cannot be removed without affecting the overall energy and cost results. Qualitatively, the dynamic shading also increases comfort for the occupants of the building. They enable increased interior environmental quality by maintaining radiant temperature, decreasing glare, and providing occupant control.

Other solutions for mitigating direct solar radiation on the building envelope are also available, however they were not included in the energy and cost models for this project. These include electrochromic glass, blinds interior to the glass, and architectural solutions such as exterior overhangs. All of these solutions have benefits and drawbacks, which must be weighed related to, performance, cost, maintenance, and durability.

BUILDING SYSTEMS

Building systems represent the secondary mechanical and electrical systems that serve the building. In the Target 100 building systems, the big change from conventional practice is a de-coupling of ventilation from heating and cooling. The de-coupled system concept includes dedicated outside air systems (DOAS) with high effectiveness heat recovery capability, and zonal heating and cooling systems at each thermal zone (modeled as four-pipe fan coil units for this effort). Surgery suites, emergency department, and other spaces with high exhaust air requirements were not defined to be served by de-coupled systems. These systems remain as overhead ducted cool air systems with reheat but employ advanced controls to reduce fan energy use during periods of no or little occupancy, and to manage reheat via aggressive temperature and pressure resets.

The use of 4-pipe fan coils, dedicated outside air systems, and advanced VAV systems represent one design solution that relies on reduced cooling loads, de-coupled heating and cooling, and heat recovery. Other system solutions that can accomplish similar energy goals are radiant heating and cooling, chilled beams, and/or variable refrigerant flow (VRF) air-source heat pump systems. These systems have advantages and disadvantages, and were not explored on a quantitative level in this study.

Potable hot water loads are addressed using heat recovery from warm shower water drainage. Using a separated waste system, approximately 50% of the shower water heating load can be met from recovered heat. The remaining load is met by the central heating plant.

PLANT SYSTEMS

Option 2: Ground Coupled Heat Pump Plant

Both plant options (2 and 3) serve identical building system cooling and heating loads. Plant option 2 is a modular water-source heat pumping plant comprised of water-to-water heat pumps (or potentially heat recovery chillers) that can exchange energy with an earth-coupled closed loop vertical borefield. During the cooling season, this system can store excess heat in the ground and can then extract that heat when needed via heat pumping. Cooling and heating distribution systems are 4-pipe hydronic systems with low temperature heating water (120 deg F heating water supply) and moderate temperature chilled water (60 deg F chilled water supply). If de-humidification is required, it would be accomplished at the DOAS units using chilled water of conventional temperature (45 deg F chilled water supply). The zonal cooling units are intended to function providing sensible cooling only. Much of the conditioned space is not served with conventional outside air economizers. Mechanical cooling and heating are provided year-round. When the loads are not in balance, then heat exchange occurs between the plant heat pumps and the thermal mass of the earth.

Potable hot water is pre-heated by one or more dedicated heat pump water heaters, connected to the vertical borefield. Heating of water above about 120 deg. F is accomplished using gas-fired condensing water heaters. A downsized steam boiler plant meets the remaining process heat loads, such as sterilizers.

Option 3: Heat Recovery Plant

The ground-coupled heat pump plant was identified as an excellent plant concept for improved hospital energy performance, but it was recognized that this solution is not always possible to implement in new projects. Required land space, increased cost, and site development logistics can be impediments to the development of large vertical borefields. An alternative to the ground-coupled heat pump plant was developed to provide greater accessibility to this research. Option 3 includes heat recovery chillers in combination with peaking fossil fuel fired hot water boilers and cooling towers to handle peak load conditions. Supplemental sources of heat include enhanced heat recovery through chilled water coils in exhaust air streams of the remaining VAV systems to meet most heating needs. Heat recovery chillers provide both chilled water and heating water as the primary source of cooling and heating. When cooling load is insufficient, even when supplemented with heat recovery from exhaust air, the peaking boilers can provide additional heating. When cooling load is greater than heating load, peaking cooling towers can provide additional heat rejection. Similar to Option 2, the distribution system is a 4-pipe hydronic system.

Potable hot water is pre-heated using condenser water from one of the heat recovery chillers. When insufficient to meet load, supplemental heating is provided by condensing gas-fired water heating equipment. A downsized steam boiler plant meets the remaining process heat loads, such as sterilizers.

ENERGY MODELS

Energy models were built to simulate energy performance for each of these Energy Options and analyzed to determine energy performance. Energy simulations were produced using DOE2.2 as embodied in EQuest using Seattle, Washington weather files and standard Puget Sound Energy electric rates of $0.0655/kWh and natural gas rates of $1.07/Therm, at the time of the last research project simulations in early 2010. These energy simulations are compared to databases of operational hospitals such as Target Finder and the Pacific Northwest database developed by this research team.

THE SPECIFICS: STRATEGIES USED TO DEVELOP ENERGY MODELS

A detailed description of the individual components that were included in the Baseline Energy and Target 100 Energy schematic mechanical concepts can be referenced in Appendix 2.0. The following table, Table 1.0, outlines the major strategies that distinguish the Baseline Energy Option 1 from the Target 100 Energy Options (Options 2 & 3). Options 2 and 3 only vary at the central plant level, and those distinctions are noted at the end of the table.

Table 1.0 Specific Strategies Used to Develop Energy Models:

ARCHITECTURAL SYSTEMS - Option 1, 2 & 3

High Performance Glazing

Strategy: Reduce heat loss through windows, control window to wall ratio

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Reference: Washington State Energy Code 2006. Thermally broken frames with calculations normalized to 4 x 6 foot shape with no intermediate mullions, per the NFRC test procedure.	• Reference: Draft Washington State Energy Code 2009. Thermally broken frames with calculations normalized to 4 x 6 foot shape with no intermediate mullions, per the NFRC test procedure.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.
• Energy modeled at U-value (center of glass) of 0.47, and solar heat gain coefficient of 0.45. Cost analysis with higher performing system, see footnotes.	• Energy modeled at U-value (center of glass) of 0.29, solar heat gain coefficient of 0.40. Cost analysis with similar performing system, see footnotes.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.
• Window to wall ratio 30%	• Window to wall_ratio 31%, window area stays constant, but wall area decreases due to decreased floor to floor height.		• Window to wall ratio 32% overall, window area stays constant, but wall area decreases due to decreased floor to floor height.

Window performance footnote:

The envelope performance standards were based on the Washington State Energy Code: For the Baseline Energy options, Options A1 and B1, Washington State Energy Code for 2006 and for the Target 100 Energy cases, Options A2 and B2, Draft Washington State Energy Code for 2009. For the Baseline Energy options, the code specifies minimum performance of U=0.55 and SHGC of 0.45. The window assembly that was chosen for costing in this process is somewhat more efficient than these values for two reasons. Solarban 60 with clear low-e coating (center of glass U=0.29 SHGC=0.38) was chosen since regular low-e glass does not meet the SHGC requirements in the code (code SHGC=0.45 typical double-pane clear SHGC=0.70). Secondly, window assemblies must be thermally broken in order to achieve the maximum U value requirement of 0.55, therefore Kawneer System 2250 (center of glass U=0.31, Assembly U=0.43) was chosen as a representative assembly. Non-thermally broken assemblies increase the assembly U values to the U=0.60 range. The energy model represents a middle ground between the Washington State Energy Code for 2006 and the specified window assembly for the U values: center of glass U=0.47 and SHGC=0.45.

The window to wall ratio was set at 30% for the Baseline Energy options A1 and B1, and the same total window area was used in the Target 100 Energy options, A2 and B2. This window to wall ratio increased slightly from the Baseline Energy option to the Target 100 Energy option in both cases due to the reduction in floor to floor height in the patient towers (from 30% to 31% Option A1 to Option A2 and from 30% to 32% Option B1 to Option B2).

Motorized External Shading

Strategy: Active exterior shading substantially reduces solar heat gain through glazing, in turn reducing cooling load.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• No external shading is included.	• Shades modeled on S, E, W facades are set to deploy whenever transmitted solar gain (from direct and diffuse radiation) exceeds 25 Btu/hr-SF. When activated total solar radiation is reduced by 87.5%, with visible spectrum reduced by 75%.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Opaque Wall Conduction

Strategy: Reduce Wall U-value by adding more insulation

Strategy: Smaller wall areas reduce area of heat loss (lower floor to floor heights due to reduction of air side heating and return air ducting).

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Per Washington State Energy Code 2006. U-value is 0.059 Btu/hr-SqFt-°F (see Appendix 1.0 for wall section detail of code).	• Per Draft Washington State Energy Code 2009. U-value is 0.045 Btu/hr-SqFt-°F (see Appendix 1.0).	• Same as Typical Geometry Baseline.	• Same as Typical Geometry Target 100.
• Floor to floor heights on the patient tower are 15 feet and 18 feet on the diagnostic and treatment floors (see Appendix 1.0 for building section).	• Floor to floor heights on the patient tower are reduced from 15 feet to 14 feet, resulting in a modest reduction of overall wall area (from 152,532 SF to 147,552 SF). Diagnostic and treatment floors remain constant (see Appendix 1.0 for building section).	• Same as Typical Geometry Baseline.	• Same as Typical Geometry Target 100 with wall areas reduced from 251,208 SF to 242,214 SF.

Natural Ventilation:

Strategy: Areas close to the perimeter can be cooled with operable windows where permitted by code.

Scheme A: Typical Geometry Baseline Energy (Option A1)	*Scheme A: Typical Geometry* Target 100 Energy (Option A2 & A3)	*Scheme B: Perforated Geometry* Baseline Energy (Option B1)	*Scheme B: Perforated Geometry* Target 100 Energy (Option B2 & B3)
• No natural ventilation is used.	• No natural ventilation is used.	Same as Typical Geometry Baseline.	• South-facing corridors and south-side lobby zones are designed to allow natural ventilation. • When in ventilation mode fan energy reduces to near-zero, cooling is delayed until the thermostat reaches 82 deg. F, and heat recovery is disabled.

Improved Roof Reflectance

Strategy: Keep roof surface cooler in summer to reduce cooling loads.

Scheme A: Typical Geometry Baseline Energy (Option A1)	*Scheme A: Typical Geometry* Target 100 Energy (Option A2 & A3)	*Scheme B: Perforated Geometry* Baseline Energy (Option B1)	*Scheme B: Perforated Geometry* Target 100 Energy (Option B2 & B3)
• Roof 30% reflective.	• Roof 70% reflective (similar to white roof surface).	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Daylighting Control of Electric Lighting

Strategy: Daylight provides necessary illumination, allowing reduced reliance on electric lighting. This saves energy and reduces internal heat gain.

Scheme A: Typical Geometry Baseline Energy (Option A1)	*Scheme A: Typical Geometry* Target 100 Energy (Option A2 & A3)	*Scheme B: Perforated Geometry* Baseline Energy (Option B1)	*Scheme B: Perforated Geometry* Target 100 Energy (Option B2 & B3)
• No daylight controls are modeled.	• All perimeter zones with significant windows, including patient rooms, have daylight controls. Control zones are assumed to penetrate approximately 20 feet into space. Patient rooms have simple manual on/off control, with a 50% probability that lights will be turned off if light levels exceed 50 fc. Lighting control in all other spaces is modeled as continuous dimming, with minimum lighting output of 10%. Lighting is dimmed to maintain a setpoint of 50 fc.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Efficient Electric Lighting

Strategy: Use careful design and product choices to light spaces with less energy use.

Scheme A: Typical Geometry Baseline Energy (Option A1)	*Scheme A: Typical Geometry* Target 100 Energy (Option A2 & A3)	*Scheme B: Perforated Geometry* Baseline Energy (Option B1)	*Scheme B: Perforated Geometry* Target 100 Energy (Option B2 & B3)
• Standard electric load is modeled.	• A reduction of 20% from standard is modeled for interior lighting. • An 20% reduction is also modeled in exterior lighting load (from 20kW to 16kW)	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Occupancy Sensor Lighting Controls

Strategy: Switch off lights when spaces are unoccupied, reducing energy use and internal heat gains.

Scheme A: Typical Geometry Baseline Energy (Option A1)	*Scheme A: Typical Geometry* Target 100 Energy (Option A2 & A3)	*Scheme B: Perforated Geometry* Baseline Energy (Option B1)	*Scheme B: Perforated Geometry* Target 100 Energy (Option B2 & B3)
• Standard electric load is modeled.	• A 10% reductionin lighting energy use is modeled for all spaces, regardless of proximity to building perimeter.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

BUILDING SYSTEMS - Option 1, 2 & 3

Zonal Heating & Cooling via Fan Coil Units:

Strategy: De-Couple heating and cooling from ventilation air and limit use of re-heat.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Secondary systems are a mix of return air capable variable air volume (VAV) and constant volume 100% outside air systems. VAV systems serve all of the diagnostic and treatment areas, patient towers, and medical office building. Constant volume (CV) systems serve dietary (kitchen and dining), labs (clinical and pathology), and a small laundry.	• Secondary systems are primarily four-pipe fan coil units with minimum ventilation provided via dedicated ducted outside air system(s) with heat recovery instead of large central station VAV units with reheat for all zones except surgery suites, emergency department, regulated zones of diagnostics and treatment floors, kitchen, laboratories, laundry, and the server room.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Improved Ventilation Heat Recovery:

Strategy: Heat from outgoing air is recovered and used to preheat incoming fresh air.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Ventilation heat recovery for kitchen and lab 100% OSA units is set at 50% effectiveness.	• Ventilation heat recovery for kitchen and lab 100% OSA units is improved to 65% effectiveness. All fain coil units are served by dedicated ventilation heat recovery units with 70% minimum effectiveness, and variable speed control of fans based on duct static pressure	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Hot Water Heat Recovery

Strategy: Gravity film heat exchanger (GFX) technology captures waste heat in order to preheat incoming potable hot water.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• A standard water system is modeled.	• Heat recovery from shower drainage is modeled by reducing the load imposed by showers by 50%. For the building as a whole, this is a reduction in peak flow from 101 gpm to just under 73 gpm.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Variable Flow Heating Water System:

Strategy: Variable flow systems consume less energy by being able to match flow rates to load.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Variable flow chilled water system and constant flow heating water system	• Variable flow systems for both heating and chilled water. Pumps are controlled by variable frequency drives (VFDs.)	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Efficient “Plug Load” Equipment

Strategy: Exercise care when choosing electronic equipment, such as computers, televisions, etc.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Standard plug load power density is modeled.	• A 2% reduction to the standard plug load density is assumed.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Reduced Air Pressure in Large Fan Systems:

Strategy: Lower air pressures are used in large ducted systems to reduce fan energy consumption.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Standard pressures are used.	• Pressure requirements for large fan systems are reduced by 10%.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Maximum Efficiency Fan Motors:

Strategy: "Best in class" fan motors will consume slightly less energy during operation.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Standard fan specifications and energy consumptions are modeled.	• All large fan system motors will be specified as "best in class." Return/exhaust fans are assumed to gain2% improvement in combined efficiency. Supply fans are assumed to gain 1% improvement in combined efficiency.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

PLANT SYSTEMS - Option 1, 2 & 3

Advanced Plant Controls:

Strategy: Temperature reset points within the hyronic plant can be maximized for efficiency.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2 & A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2 & B3)**
• Chilled water temperature resets between 42 and 45 deg, F, based on load. • Hot water temperatures reset between 180 and 170 deg. F, based on load.	• Chilled water resets range widens to 42 to 48 deg. F, based on load. • Maximum hot water system temperature is only 120 deg. F; reset occurs between 120 and 115 deg F based on load.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

PLANT SYSTEMS - Continued Next Page

PLANT SYSTEMS - Option 2 ONLY

Modular Ground-Coupled Heat Pump Plant:

Strategy: A field of 300-foot deep bores with loop piping that exchanges heat and "coolth" with the earth's thermal mass, providing an effective energy source for the hospital's modular heat pump-based heating and cooling plant.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A2)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B2)**
• 6.10 COP centrifugal chillers and boilers with 82% full load combustion efficiency provide heating and cooling for the mechanical system. A steam boiler creates process steam.	• A ground-coupled heat pump plant generated 42 deg F minimum chilled water supply temp. and 120 deg. F maximum heating water temp. Rated coefficient of performance is 5.0 for heat pumps (heating mode). • Heat recovery is integral to the plant via energy exchange with the earth. When heat pumps operate in cooling mode to meet need for chilled water, rejected heat is stored in the earth. When heat pumps operate in heating mode, stored heat is extracted from the earth. • Heating water, generated by heat pumps, is also used for potable water pre-heating up to 115 deg. F. High efficiency gas-fired booster heaters increase potable hot water temperature is final setpoint. • A steam boiler system, significantly downsized relative to the baseline system, generates process steam.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100.

Ground Source Heat Pump footnote:
The ground-source bore-field could require as much as 166,000 SF of land, assuming a well spacing of 20 X 20 feet. This is 3.75 acres, and could be located under surface parking, planting areas, recreational fields and the like, or along the sides of circulation drives or street rights-of-way. This land would not be subsequently available for future building construction. The well field drilling operation would require a full year even with a few rigs running simultaneously, or else contracts would be let out to several separate drilling companies that would all get out there simultaneously and get it done in a couple of months. It is also possible to locate the wells under buildings or parking structures, but this requires extensive coordination and time. The drill rigs need 30 feet overhead working clearance (plus the aforementioned year for completion). It is also possible to drill fewer, deeper holes, but this involves some extra risk and difficulty for the drillers. Either of these options would add cost.

PLANT SYSTEMS - Option 3 ONLY

Enhanced Heat Recovery Chiller Plant:

Strategy: Employ a heat recovery chiller plant that can be additionally loaded using chilled water coils in the exhaust air stream of the VAV systems serving the surgery, emergency, and imaging areas. When required, supplemental boilers and cooling towers provide added heat generation and/or heat rejection.

Scheme A: Typical Geometry		*Scheme B: Perforated Geometry*	
Baseline Energy (Option A1)	**Target 100 Energy (Option A3)**	**Baseline Energy (Option B1)**	**Target 100 Energy (Option B3)**
• 6.10 COP centrifugal chillers and boilers with 82% full load combustion efficiency provide heating and cooling for the mechanical system. A steam boiler creates process steam.	• Heat recovery chillers generate 42 deg F minimum chilled water supply temp. and 115 deg F maximum heating water temp. Rated coefficient of performance is 4.55 (for cooling mode.) • Up to 100 tons of additional cooling load is available when needed via cooling of the exhaust air streams. • Recovered heat is used for pre-heating of potable hot water. Potable hot water booster heating will be accomplished using high efficiency gas-fired booster heaters to increase potable hot water temperature to final setpoint. • When recovered heat from the chillers is not sufficient to meet load, supplemental gas-fired condensing boilers will fire to provide additional heating. When need for recovered heat is not sufficient to accommodate required heat rejection, supplemental cooling towers will operate to reject heat. • A steam boiler system, significantly downsized relative to the baseline system, generates process steam.	Same as Typical Geometry Baseline.	Same as Typical Geometry Target 100 except: • Up to 115 tons of additional cooling load is available when needed via cooling of the exhaust air streams.

SECTION III: ENERGY RESULTS

ACHIEVING THE 2030 CHALLENGE: SCHEME A

The results from the energy modeling are reported in Figure 7.0. The first two bars represent typical performance for existing hospitals, using information from the EPRI database, as accessed through Target Finder and from the regional database for Pacific Northwest, representing specific hospitals in Montana, Idaho, Oregon, and Washington. Colors represent the energy predicted to be required for different end-uses from heating to lighting. The subsequent bars represent the energy modeling results from this research project.

The results of the energy modeling analysis indicate that the typical schematic architectural configuration with code baseline mechanical strategies has a modeled energy use index of 223 KBtu/SF·year (Scheme A1). Option A2, the Target 100 Energy model with a Ground Source Heat Pump, predicts an EUI of 100 KBtu/SF•year, a 63% reduction from the CBECS baseline and a 55% reduction from its modeled baseline energy performance. This easily exceeds the 2030 target EUI of 108 KBtu/SF•year for 2010. Reaching this goal is noteworthy, especially for a hospital, and attaining this level of energy efficiency requires a complete re-evaluation of

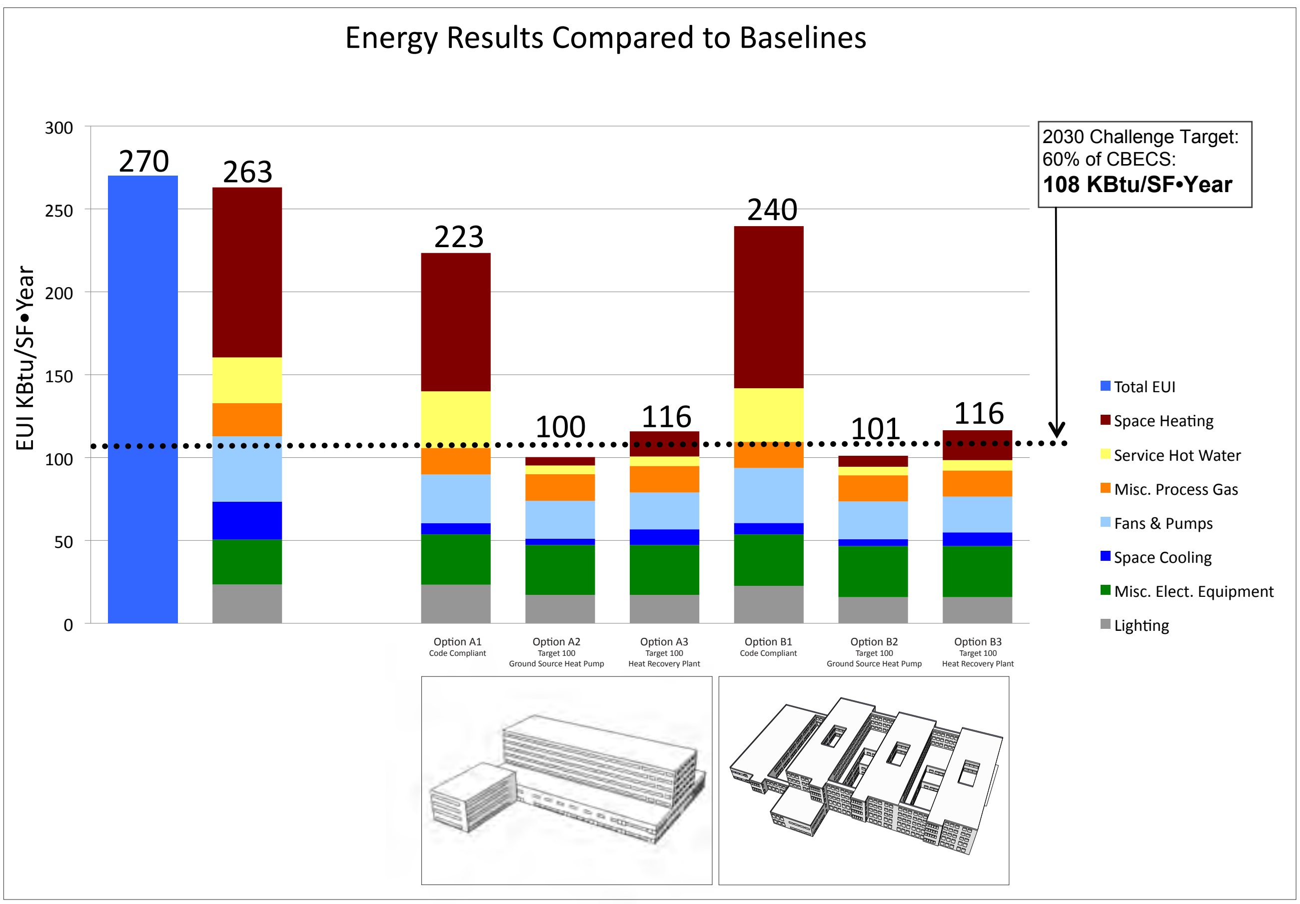

Figure 7.0: Results from energy models for A1, A2, A3 & B1, B2, and B3 as compared to EPRI database as referenced through Target Finder and Pacific NW database. The results indicate that Scheme A1 has a modeled energy use index of 223 KBtu/SF year. This same architectural configuration, with Target 100 mechanical strategies applied (and a ground source heat pump plant), exhibits a modeled EUI of 100 KBtu/SF year (Scheme A2). With a heat recovery central plant strategy this Scheme exhibits an EUI of 116 KBtu/SF year. The perforated architectural Scheme, with code baseline mechanical strategies applied (B1) yielded a modeled energy use index of 240 KBtu/SF year. This same Scheme, with "Target 100" mechanical strategies applied (and a ground source heat pump plant), had a modeled energy use index of 101 KBtu/SF year (Scheme B2). These Scheme with a heat recovery central plant exhibited an EUI of 116 KBtu/SF year. Thus, both Option 2 "Target 100" models resulted in at least a 60% reduction from baseline operational examples, far exceeding the 2030 Challenge goal for 2010, and the Option 3 models represent strategies that nearly meet the 2030 Challenge goals for 2010, and as seen in the following sections, at less additional first cost.

the entire hospital with a layered, integrated approach to how the hospital's systems, envelope, and overall performance are conceived.

Option A3, the Target 100 energy model with Heat Recovery Plant, exhibits a modeled EUI of 116 KBtu/SF·year. This does not quite meet the 2030 Challenge Goal, but is still a noteworthy 57% reduction from typical operational energy use and a 48% reduction from modeled code baseline.

A lot of emphasis has been placed on reaching the 2030 Challenge goal. This is a target that allows for goal setting for projects in new construction, but beyond the Challenge, the concern of this research project is also to determine at a specific level how to improve upon commonly constructed, code compliant hospitals of today. The Baseline Energy Option, A1, is used as basis of comparison for the Target 100 Options A2 and A3 to analyze energy use between a commonly constructed hospital and a hospital that achieves the 2030 Challenge.

ENERGY END USES AND SYSTEM DESIGN: SCHEMES A1, A2, AND A3

HEATING

As discussed in the "*Background, energy use patterns in existing hospitals*" section above, it became clear that many of the loads within the hospital typology are system imposed loads. That fact drove the trajectory of this research study to focus heavily on the configuration of the systems, and optimize them for energy performance. The focus was to address the loads issues with an integrated problem solving approach where architectural, building, and plant systems work together to synchronously achieve the Target 100 energy goal.

As previously noted, one of the greatest uses of energy overall is in heating, specifically space heating, which is ironic since this building type is so internally cooling load dominated. For Energy Option A1, about 37% of the predicted building energy use is attributed to space heating as an end use. This end use is the biggest target for opportunity for energy savings, thus was a substantial area of effort for this project. In Energy Option A2 (Target 100), over a 93% reduction from Option A1 (Baseline) was achieved in space heating alone. For Option A3, an 82% reduction in space heating is achieved utilizing the primary strategies below. These strategies are similar for Architectural Scheme B, except as noted in "Achieving the 2030 Challenge Scheme B" in the section below.

Common Elements: Options 2 & 3

- De-coupled Zonal Heating and Cooling Systems with Dedicated Outside Air and Heat Recovery: The de-coupled system concept eliminates reheat loads that in most conventional overhead ducted systems, result in the majority of heating energy use in regional hospitals. Reheat loads are a special energy problem in overhead ducted systems in hospitals because of the applicable state codes and standards that dictate minimum air circulation rates in many of the spaces. For example, minimum circulation rate requirement in patient rooms is six air changes per hour (about 1 cfm/SF). Much of the time the cooling load in patient rooms requires much less than this minimum flow rate, resulting in a "system-imposed" reheat load for many hours throughout the year. Dedicated outside air systems can be sized to provide the minimum fresh air rates (2 ACH in patient rooms) and thus can be much smaller than central overhead ducted systems. The ventilation air is still tempered (typically introduced at about 62 deg. F to 68 deg. F using heat recovery from the exhaust air for most conditions). This can function as the first stage of cooling, but it may not be sufficient to meet peak cooling loads. Peak cooling and heating is provided by zonal heating and cooling systems. These systems, physically located in or near the space they are serving, can take many forms. Four-pipe fan coils were defined for the "Target 100" systems, allowing code-dictated minimum air circulation rates to be maintained without imposed reheat loads. In European Hospitals, zonal systems include radiant heating and cooling, chilled beams, as well as fan coil units.

- Optimized Heat Recovery From Multiple Internally Generated Sources: Improved ventilation heat recovery is applied to all 100% outside air systems. Minimum heat recovery effectiveness is 65% effectiveness for systems in Option A1 that are defined as 100% outside air (such as the kitchen system), and 70% for the dedicated outside air systems (discussed above).
- Advanced Controls for Ducted VAV Systems Serving Surgery Suites and Emergency Department Zones: Significant heating energy use reductions can be achieved in "conventional" ducted VAV systems by significantly reducing total system flow rate during periods when the spaces served by the system have little or no occupancy. Almost all systems serving surgery suites experience this condition. By using occupancy sensing controls, VAV terminal units can be positioned to an "unoccupied" minimum air flow position, allowing variable frequency drives (VFDs) to slow fan speed, and dramatically reducing (if not eliminating) reheat loads for unoccupied zones. Efforts to aggressively reset supply air temperatures, especially during unoccupied periods, can work effectively in combination with occupancy sensor controls, to reduce energy use associated with reheat. A more basic form of the "advanced control" concept can apply to entire systems where all zones are unoccupied for discrete periods, and the entire fan system can be de-energized during the unoccupied period. The laundry is served by one such system.
- Reduced Piping System Losses: Both alternative plant concepts include a low temperature heating water distribution system. Supply water temperature is typically delivered to coils at 115 to 120 deg F. Return water temperature ranges from 95 to 100 deg F. There is no steam distribution involved. Compare this to the typical plant in the Baseline Energy Model that has several large steam boilers with high pressure steam distribution, steam pressure reducing valves, numerous steam traps, steam-to-hot water heat exchangers, and heating water piping with heating water supply temperatures of 180 deg F. The distribution system losses associated with a central steam system can be significant, especially over time as traps fail and piping and valves begin to leak. These losses are virtually eliminated in the low temperature heat pump plant.

Options A2 and A3 vary at the central plant level, affecting heating, cooling, and pumping energy performance. For Option A2, the central plant involves a modular heat pumping plant with coupling to the thermal mass of the earth. Thus heat energy can be can be rejected in cooling mode and extracted/recovered in heating mode through ground storage and heat pumping. For Option A3, the central plant does not include ground-coupling. Instead, "real-time" heat recovery is achieved through the use of heat recovery chillers that are combined with supplemental peaking boilers and cooling towers.

Option 2: Modular Ground-coupled Heat Pump Plant

- The heat pump-based plant in Option A2 generates heat for space and potable water heating with a coefficient of performance in the range of 5.0 (compared to a conventional steam plant that may operate at an "equivalent" efficiency of 0.8). In terms of heat generation, a heat pump-based plant is over 5 times as efficient as a conventional fossil fuel-fired plant. Heating water is generated using modular water-to-water heat pumps (operating in heating mode) that extract heat from the thermal mass of the earth via water circulated through a piping arrangement in contact with the ground. Cooling water is generated by water-to-water heat pumps operating in cooling mode and rejecting heat to the earth. Plant equipment configurations can be flexible. Heat pumps can be dedicated to heating or cooling, or can alternate between heating and cooling models. The plant can employ integral heat recovery in the form of heat recovery chillers with condenser water temperatures of 115 to 120 deg F, that can be used to meet space heating and much of the potable water heating loads (that remain after reheat loads have been virtually eliminated). Waste heat rejection from the heat recovery chillers would be to the earth.

Option 3: Heat Recovery Plant

- The heat recovery plant eliminates the ground-coupling as well as the water-to-water heat pumps that are part of the ground-coupled heat pump plant. Instead, the plant is configured around heat recovery chillers that make 115 deg F to 120 deg F condenser water while responding to cooling load. In periods of low cooling load, the chillers can be false-loaded by cooling warm exhaust air via chilled water coils in the exhaust air streams, and still meet heating load with recovered heat. In periods of high heating load, when loads are greater than the heat recovery potential, supplemental gas-fired hot water boilers are used. In periods of high cooling load, when heat rejection requirements exceed the need for recovered heat, supplemental cooling towers are used.

WATER HEATING

For Option A2, energy demand for service hot water is reduced by about 85% from the Baseline Energy Option to the Target 100 Option; from a Baseline Energy End Use representing just over 15% of the total energy consumption (34 KBtu/SF•year), to an end use comprising about 5% in the Target 100 Scheme (5 KBtu/SF•year). For Option A3, The potable water heating end use is reduced by about 83%, compared to the Baseline (Option A1). These reductions in potable water heating energy are achieved with three primary strategies:

Common Elements: Options 2 & 3

- Shower Waste-Water Heat Recovery: A dedicated shower drain system is proposed for the Target 100 option that allows the installation of a centralized gravity film heat exchanger system that can preheat incoming cold water using the warm outgoing drain water. Overall heat recovery effectiveness is at least 50% resulting in a 50% reduction in the load that showers impose on the potable water heating system. This results in just over 20% reduction in need for potable

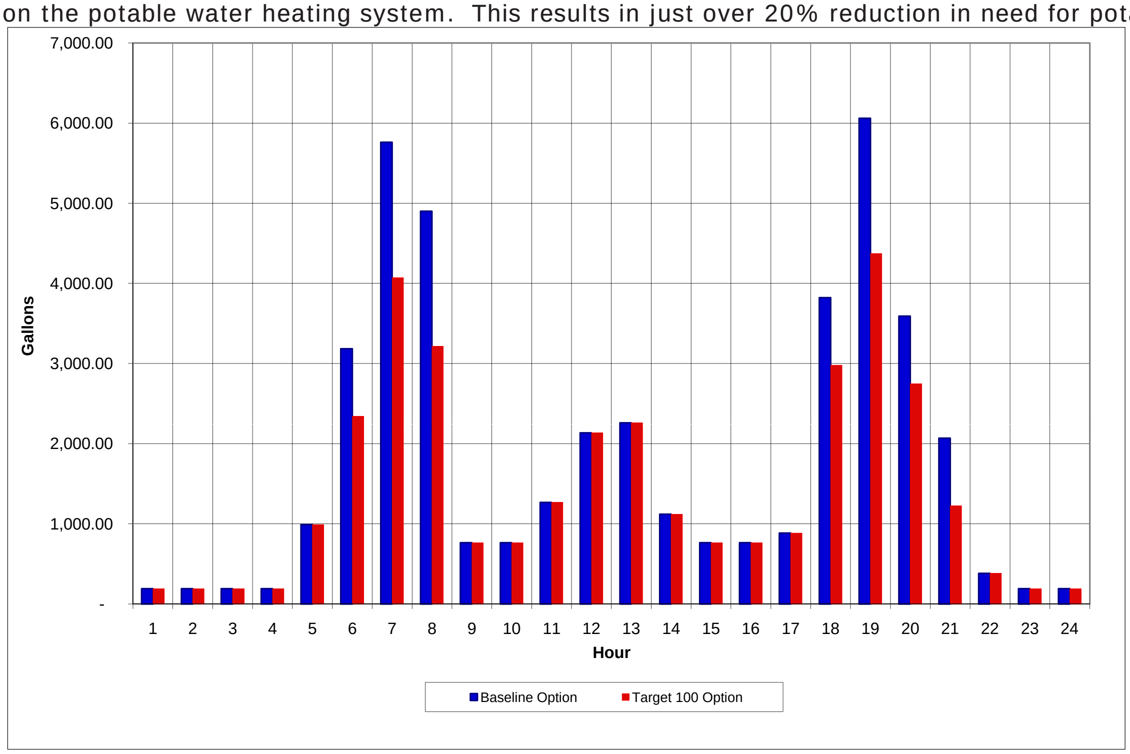

Figure 8.0: Potable Hot Water Loads– Baseline vs. Target 100.

hot water heating on a hospital-wide basis (Figure 8.0).

Option 2: Ground-coupled Heating Pumping with Supplemental Condensing Water Heater

- Primary Heat Generation From Heat Pump Plant: The primary source of heat to meet potable water heating loads is provided by the modular heat pump plant, via water-to-water heat exchangers that can heat incoming cold water to about 115 deg F. Primary water heating coefficient of performance is expected to be at least 4.5 (i.e., 4.5 units of heat delivered for every unit of electric heat input).

- Secondary Heat Generation From High Efficiency Gas-fired Water Heater: Condensing, modulating gas-fired water heaters provide the final heating for the potable hot water system, from 115 deg. F up to the final hot water temperature setpoint. Final water heating efficiency is expected to average at least 86%.

Option 3: Heat Recovery Chiller Pre-heat with Supplemental Condensing Water Heater

- The heat recovery plant relies on condenser water from the heat recovery chillers (115 deg. F to 120 deg. F) to pre-heat the potable hot water. Prior to modest storage, water is then boosted to temperatures of about 135 deg. F using condensing gas fired water heaters, with efficiencies similar to Option 2.

SPACE COOLING

As an overall energy end use, space cooling is relatively modest, representing about 3% of the total predicted energy use of the Option A1 hospital (3,528.1 MMBtu/yr, or 6.8 kBtu/SF Yr). Depending upon the plant option, cooling is predicted to decrease or increase modestly in Option A2, compared to A1.

Common Elements: Options 2 & 3

- The building system concepts discussed as part of "*Space Heating*" section above also affect the space cooling energy use by profoundly altering the cooling loads. De-coupled heating, cooling, and ventilation systems reduce cooling load by eliminating the over-cooling effect that is an integral part of ducted cool air system concepts. On the other hand, the reduced ventilation system air flow rates limit the amount of internal heat gain (cooling load) that can be met with air-side economizer functions, and result in the need for mechanical cooling during cold weather months.
- Improved air-to-air heat recovery reduces cooling load imposed during periods when outside air temperatures are high.
- Advanced VAV systems should also contribute to reduced cooling load by reducing fan heat, and reducing over-cooling at the central chilled water coil via supply air temperature reset.

Option 2: Ground-coupled Heat Pumping Plant

- The space cooling energy end use for the Option 2 plant is predicted to be reduced compared to the Baseline Option A1 (1967.8 MMBtu compared to 3,528.1 MMBtu). This represents about a 44% decrease from the Baseline Energy Option to the Target 100 Energy Option. Overall chiller efficiency is predicted to be slightly improved with the Target 100 Option, at 0.69 kW/ton vs. 0.74 kW/ton for the Baseline Energy Option. This is due to improved matching of chiller/heat pump capacity to actual load, resulting in improved part load efficiencies. Despite increased wintertime cooling, the annualized cooling load is significantly reduced (by about 40%) in the Target 100 Energy Option, resulting in a predicted increase in cooling energy end use. Note that peak loads are reduced in the Target 100 Option, and the peak efficiency of the Target 100 Energy Option (COP=5.00) is not quite as good as the Baseline Energy Option (COP=6.10). Refer to the discussion in the "Cooling and Heating Loads Details" section below for a more detailed documentation of the differences in cooling loads.

Option 3: Heat Recovery Plant

- In Option 3, the heat recovery chillers are false-loaded when additional recovered heat is needed. The added cooling load is imposed on the plant by cooling exhaust air streams from the advanced VAV systems in the hospital. With this added load, the space cooling energy end use for the Option 3 plant is predicted to be increased compared to the Baseline Option 1A (4,925.8 MMBtu compared to 3,528.1 MMBtu) This represents a 40% increase compared to the Baseline Energy Option.

COOLING AND HEATING LOADS DETAILS

Cooling Loads

Contributors to cooling loads include envelope loads driven by conduction, air infiltration, and direct solar gain; internal heat gains from people, lights, and equipment; and system-imposed loads from fan heat, ventilation, pump heat, piping losses, and over-cooling/reheat. Figure 9.0 shows the overall chilled water loop loads for Options A1 and A2.

Peak cooling coil load is markedly reduced in Option A2 at 750 tons (695 SF/ton) compared to Option A1 at 1089 tons (478 SF/ton). Accounting for pump heat and piping gains, peak cooling loads imposed on the cool-

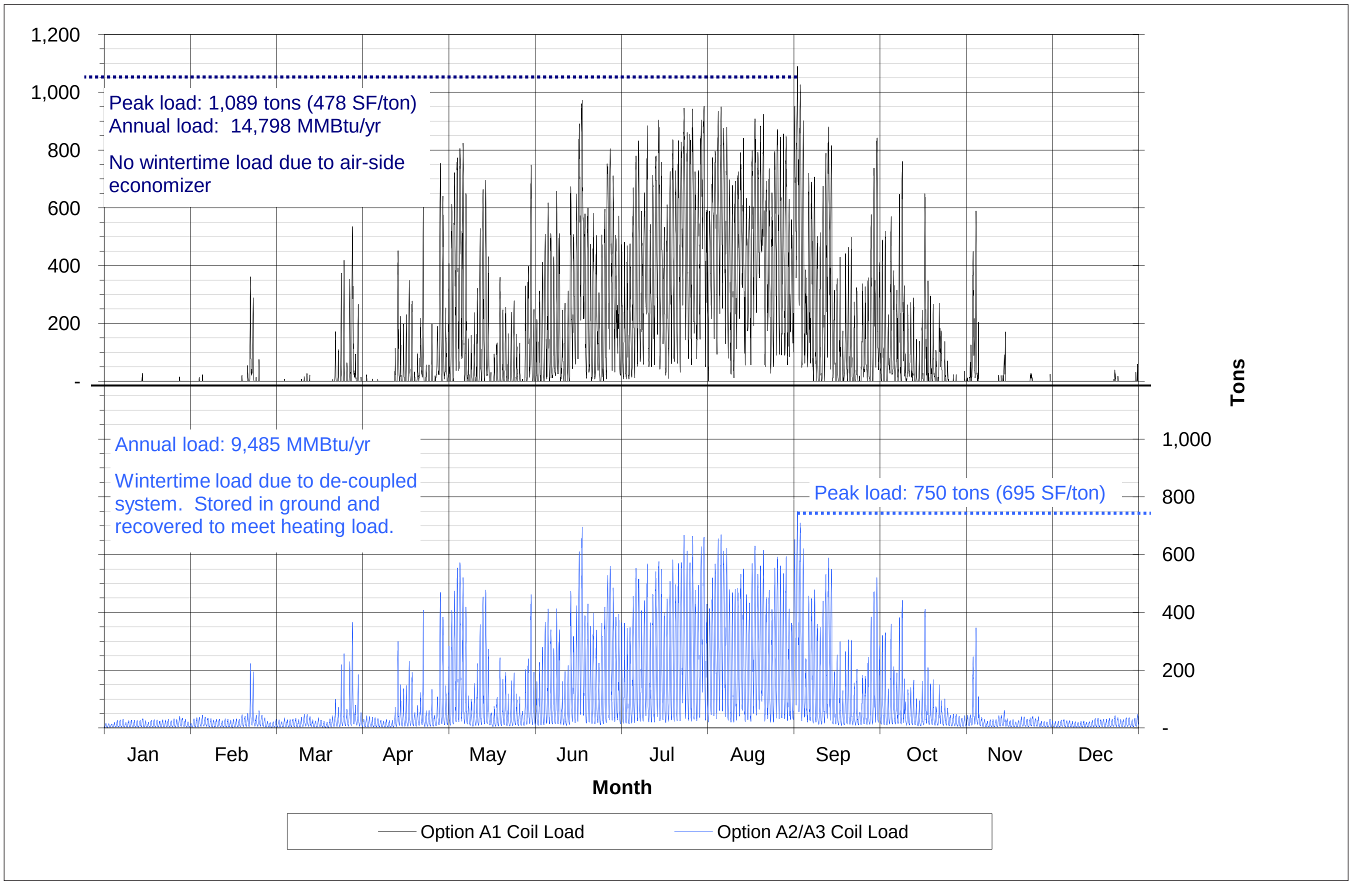

Figure 9.0: Cooling Coil Loads Over Entire Year – Option A1 vs. A2 (A3).

ing plant are 767 tons (Option A2) and 1146 tons (Option A1).

The peak and annual cooling loads for Option A3 are identical to A2 except for the “false-load” imposed on the plant by cooling the exhaust air streams associated with the advanced VAV systems. Those loads were modeled by comparing the load associated with cooling the exhaust air flow rates by 18 deg F to the need for recovered heat. Hourly exhaust air flow rates for the advanced VAV systems vary significantly over the course of the year from a maximum of 143,000 cfm to a minimum of 44,000 cfm. Need for recovered heat also varies. The load vs. need profiles were simplified to represent average daily profiles for each month. The average peak load imposed on the chillers was estimated at 100 tons. The monthly load profiles are summarized in the table below.

Table 2.0 Monthly Load Profiles for A3:

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	39	40	40	42	44	41	29	14	37	46	42	40
2	39	40	40	42	44	44	39	20	39	47	42	39
3	39	40	40	41	43	42	37	26	41	46	41	39
4	39	40	40	41	45	47	51	45	49	47	41	39
5	39	40	48	58	70	81	91	79	81	73	45	39
6	47	52	50	58	73	85	100	97	80	74	58	49
7	47	51	51	63	82	86	91	75	85	77	58	49
8	48	54	55	66	65	47	10	2	50	69	59	50
9	52	58	59	60	44	20	2	-	22	51	60	52
10	53	60	63	63	41	16	1	-	18	54	58	53
11	56	62	68	69	44	17	0	-	17	57	60	56
12	59	65	68	67	40	12	0	-	12	55	65	59
13	61	65	59	54	20	3	-	-	4	35	67	62
14	61	65	53	46	8	1	-	-	2	23	64	61
15	60	60	52	43	9	-	-	-	2	20	61	60
16	59	59	51	43	10	1	-	-	2	22	60	58
17	57	59	60	68	40	10	-	-	18	59	61	58
18	55	69	72	85	69	39	16	3	58	88	65	58
19	53	65	67	81	66	44	15	2	66	86	67	56
20	51	61	48	50	43	37	10	5	42	55	61	54
21	40	43	43	48	39	26	5	2	30	47	45	41
22	40	42	42	45	39	26	6	2	29	42	43	41
23	39	41	41	43	41	33	11	5	32	44	42	40
24	39	40	41	43	43	38	17	12	35	46	41	40

In addition to reducing the over-cooling/reheat load component (due to fan coil units) and the ventilation load component (due to heat recovery), the envelope load and internal heat gains are reduced due to better performing windows, retractable louver shades, improved lighting, and aggressive daylighting control of electric lighting. These strategies as a whole are more expensive than the baseline case building, but implementing them as integrated strategies also means reduced cooling loads overall, thus less initial investment in cooling equipment is necessary.

While wintertime cooling increased due to reduced airside economizer capacity, total annualized cooling loads are about 40% less in Option A2 (at 10,219 MMBtu/yr) compared to Option A1 (at 17,195 MMBtu/yr). With the addition of the exhaust air cooling load, total annualized cooling loads for Option A3 are 17,514 MMBtu/yr.

Heating Loads

Contributors to heating load include envelope loads driven by conduction and infiltration, and system-imposed loads from ventilation, piping losses, and over-cooling/reheat. Figure 10.0 shows the overall heating water loop (and/or steam loop) loads associated with space heating for Options A1 and A2.

Peak heating coil load is markedly reduced in Option A2 at 3,697 MBH (7.1 Btu/hr-SF) compared to Option A1 at 5,982 MBH (11.5 Btu/hr-SF). Total peak heating loads, including piping losses, are 6,981 MBH for Option A1 and 3,874 MBH for Option A2. Total peak heating load for Option A3 is essentially identical to A2, predicted to be 3,916 MBH.

In addition to reducing the over-cooling/reheat load component (due to fan coil units) and the ventilation load component (due to heat recovery), piping losses are reduced by eliminating the steam system and reducing the piping fluid temperatures by 60 to 100 deg F. In addition, the envelope load is reduced due to improved insulation, and better performing windows.

Annualized heating loads are also significantly lower in Option A2 at 13,002 MMBtu/yr and A3 at 13,660 MMbtu/yr compared to Option A1 at 36,078 MMBtu/yr.

A number of reports from the DOE2 energy simulation runs are also contained in Appendix 3.0 including additional heating, cooling, and electric load information. The LS-C report shows a summary of building-level heating and cooling peak loads at a single interior reference temperature (72.5 deg F). Loads as reported on the LS-C report are summarized below; these are the loads imposed by the building envelope and inter-

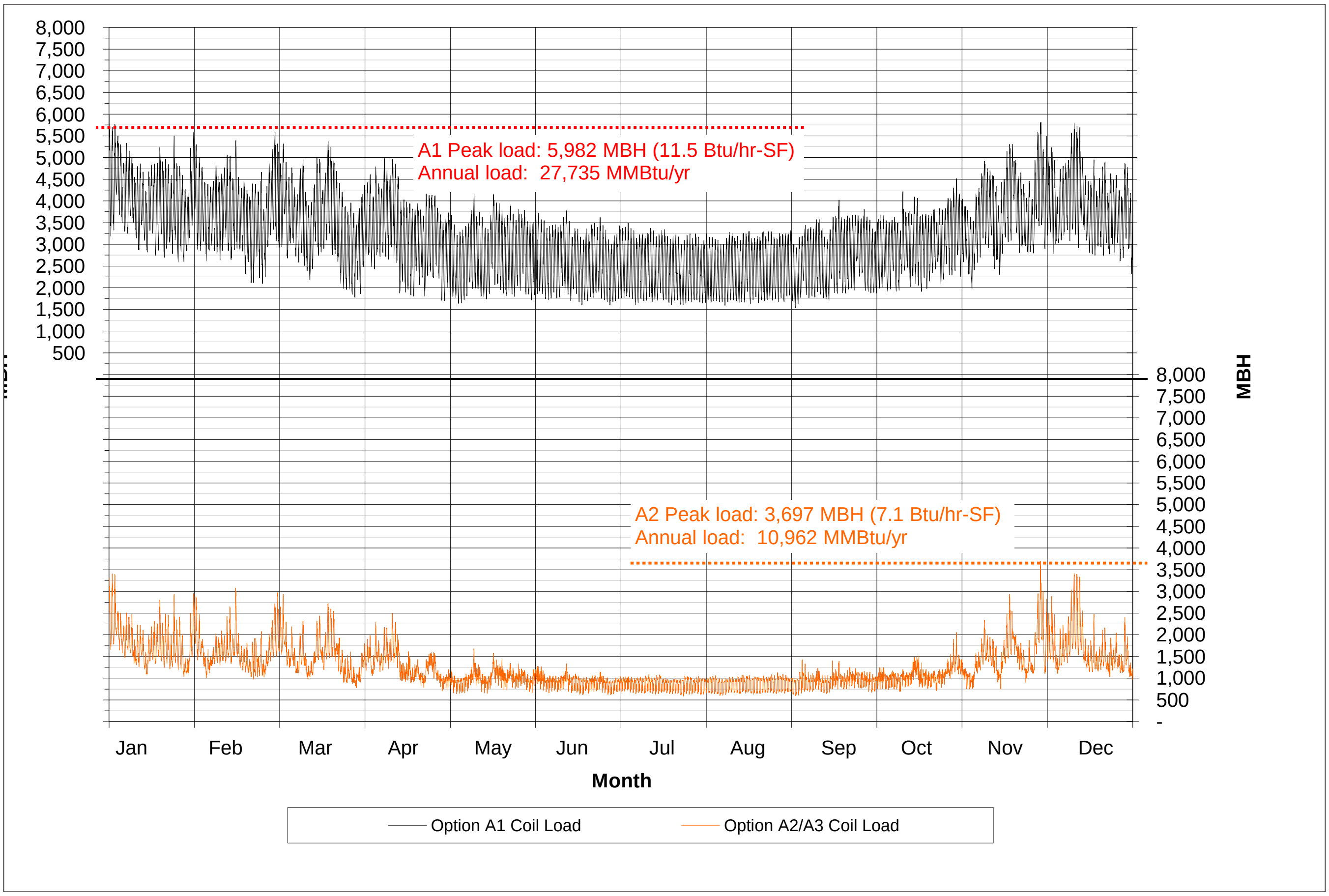

Figure 10.0: Heating Coil Loads Over Entire Year – Option A1 vs. A2 (A3).

nal loads (people, lights, and equipment). Loads imposed by HVAC systems (fan heat, reheat/over-cooling, ventilation, pump heat, and piping system losses) are not shown.

- Option A1 peak cooling load: 6,335,500 Btuh (528 tons), or 987 SF/ton
- Option A2 & A3 peak cooling load: 4,728,200 Btuh (394 tons), or 1322 SF/ton
- Option A1 peak heating load: 969,500 Btuh , or 1.9 Btuh/SF
- Option A2 & A3 peak heating load: 736,700 Btuh, or 1.4 Btuh/SF

Energy Options A2 and A3 peak cooling load (as contributed by envelope and internal gains) is about 25% less than Energy Option A1. The peak heating load for Options A2 and A3 is about 24% less than Option A1. For all options system-imposed cooling loads represent about half of the overall load imposed on the cooling plant. Heating loads imposed by the systems (reheat, ventilation, and piping losses) represent virtually all of the peak loads imposed on the heating plant.

LIGHTING

Interior and exterior lighting is a significant energy end use that represents between 10% to 17% of the overall building energy usage (11,912.4 MMBtu/yr for Option A1, 8,763.6 MMBtu/yr for Options A2 and A3). Options A2 and A3 are predicted to use about 26% less energy for lighting than Option A1. The reduction in lighting energy use is achieved by employing the following design strategies:

Common Elements: Options 2 & 3

- Ultra-efficient Interior Electric Lighting: A combination of refined design criteria, maximum efficacy light sources, and additional installation of occupancy sensor controls on interior lighting is projected to reduce overall connected load from 1.248 watts/SF to an effective 0.993 watts/SF.

- Daylighting Controls: A combination of manual and automatic controls in selected perimeter daylight zones are projected to result in a 8% reduction in interior lighting annual energy use.
- Efficient Exterior Lighting: A combination of refined design criteria and maximum efficacy light sources is are projected to reduce overall connected load from 20 kW to 16 kW.

ACHIEVING THE 2030 CHALLENGE: SCHEME B

The second set of energy models represent the "Perforated" configuration, or Scheme B, which was developed in order to understand the energy and cost implications of creating a hospital with increased exterior surface or wall area and, therefore, greater potential connection to the exterior environment. The Baseline Energy Option (B1) in this configuration has been modeled and is predicted to use 239.6 KBtu/SF·year, somewhat more energy than the Baseline Energy Option for Scheme A, the typically configured hospital. The Target 100 Energy Option for the Perforated configuration (B2) predicts an EUI of 101.1KBtu/SF·year, a 63% reduction in energy use compared to operational hospitals in the same climate region (Target Finder) far exceeding the 2030 Challenge target for 2010. The Target 100 Option (B2) achieves a 58% reduction from the code Baseline Energy simulation of this same configuration (B1).

System and plant concepts are similar in Options B1, B2, and B3 to that described above for Options A1, A2, and A3. Cooling and heating load differences are discussed below.

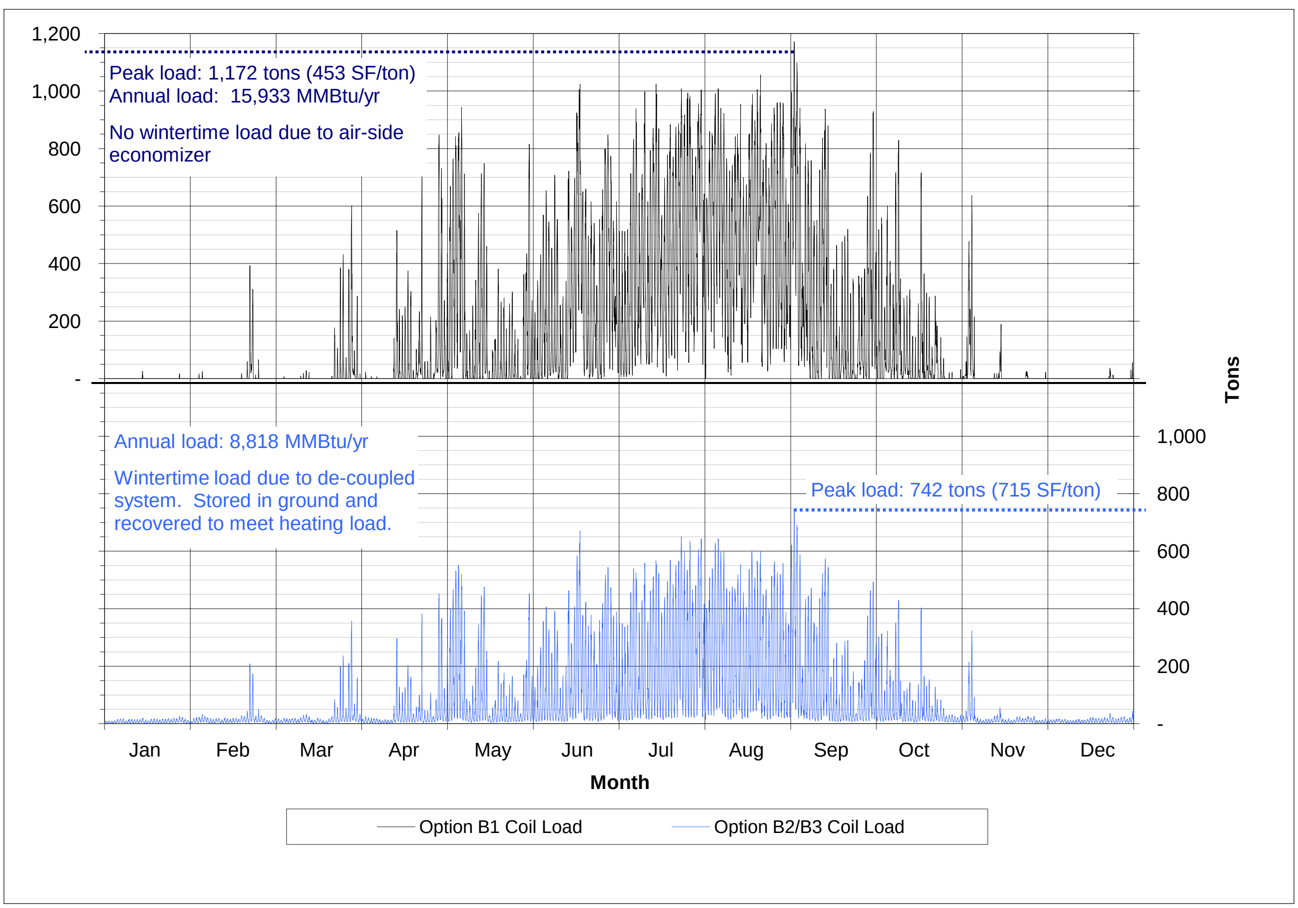

Figure 11.0: Cooling Coil Loads Over Entire Year – Option B1 vs. B2 (B3).

COOLING AND HEATING LOADS DETAILS

Cooling Loads

Contributors to cooling loads include envelope loads driven by conduction, and direct solar gain; internal heat gains from people, lights, and equipment; and system-imposed loads from fan heat, ventilation, pump heat, piping losses, and over-cooling/reheat. Figure 11.0 shows the overall chilled water loop loads for Options B1, B2, and B3.

Peak cooling coil load is markedly reduced in Option B2 at 742 tons (715 SF/ton) compared to Option B1 at 1,172 tons (453 SF/ton). Peak total cooling loads, including pump heat and distribution system gains, are 778 tons (Option B2) and 1,232 tons (Option B1). This is a 37% reduction in peak load imposed on the cooling plant. Despite an increase in wintertime mechanical cooling, annualized total cooling loads are also reduced in Option B2 at 12,034 MMBtu/yr compared to Option B1 at 18,371 MMBtu/yr.

The peak and annual cooling loads for Option B3 are identical to B2 except for the “false-load” imposed on the plant by cooling the exhaust air streams associated with the advanced VAV systems. Those loads were modeled by comparing the load associated with cooling the exhaust air flow rates by 18 deg F to the need for recovered heat. Hourly exhaust air flow rates for the advanced VAV systems vary significantly over the course of the year from a maximum of 163,000 cfm to a minimum of 33,000 cfm. Need for recovered heat also varies. The load vs. need profiles were simplified to represent average daily profiles for each month. The average peak load imposed on the chillers was estimated at 115 tons. The monthly load profiles are summarized in the table below.

Table 3.0 Monthly Load Profiles for B3:

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	33	37	37	40	42	37	24	14	37	44	38	35
2	33	36	36	40	43	39	30	20	39	44	37	34
3	33	36	36	39	43	40	32	25	40	44	38	34
4	33	36	36	39	45	46	46	43	48	46	38	34
5	33	36	57	72	86	98	106	94	95	88	38	34
6	56	63	61	71	90	102	114	115	96	89	70	59
7	56	62	62	76	97	101	105	89	99	92	70	58
8	58	64	66	76	68	43	8	2	47	73	73	59
9	62	69	72	75	58	27	3	-	31	67	70	62
10	64	72	77	77	54	25	3	-	27	68	70	64
11	67	75	83	83	58	29	2	-	27	74	73	68
12	71	79	81	82	54	20	2	-	18	69	78	71
13	74	80	70	65	27	4	-	-	6	42	80	73
14	74	77	65	57	15	2	-	-	4	31	76	72
15	73	73	64	57	17	-	-	-	3	29	75	71
16	72	71	62	57	18	1	-	-	3	32	73	70
17	69	74	75	89	58	19	-	-	34	80	71	70
18	66	83	86	100	83	53	22	5	71	105	77	69
19	64	78	79	95	76	47	14	2	72	99	80	68
20	62	74	47	48	42	38	11	5	43	53	76	65
21	35	39	42	47	39	28	6	3	32	47	42	36
22	37	41	40	44	37	26	6	3	30	42	42	38
23	36	39	39	42	39	30	10	6	32	44	39	37
24	34	38	38	41	40	33	16	11	34	44	38	36

Due to the false-loading of the heat recovery chiller plant in Option B3, the annualized cooling load is 17,384 MMBtu/yr, much higher than Option B2.

Heating Loads

Contributors to heating load include envelope loads driven by conduction and infiltration, and system-imposed loads from ventilation, piping losses, and over-cooling/reheat. Figure 12.0 shows the overall heating water loop (and/or steam loop) loads associated with space heating for Options B1and B2.

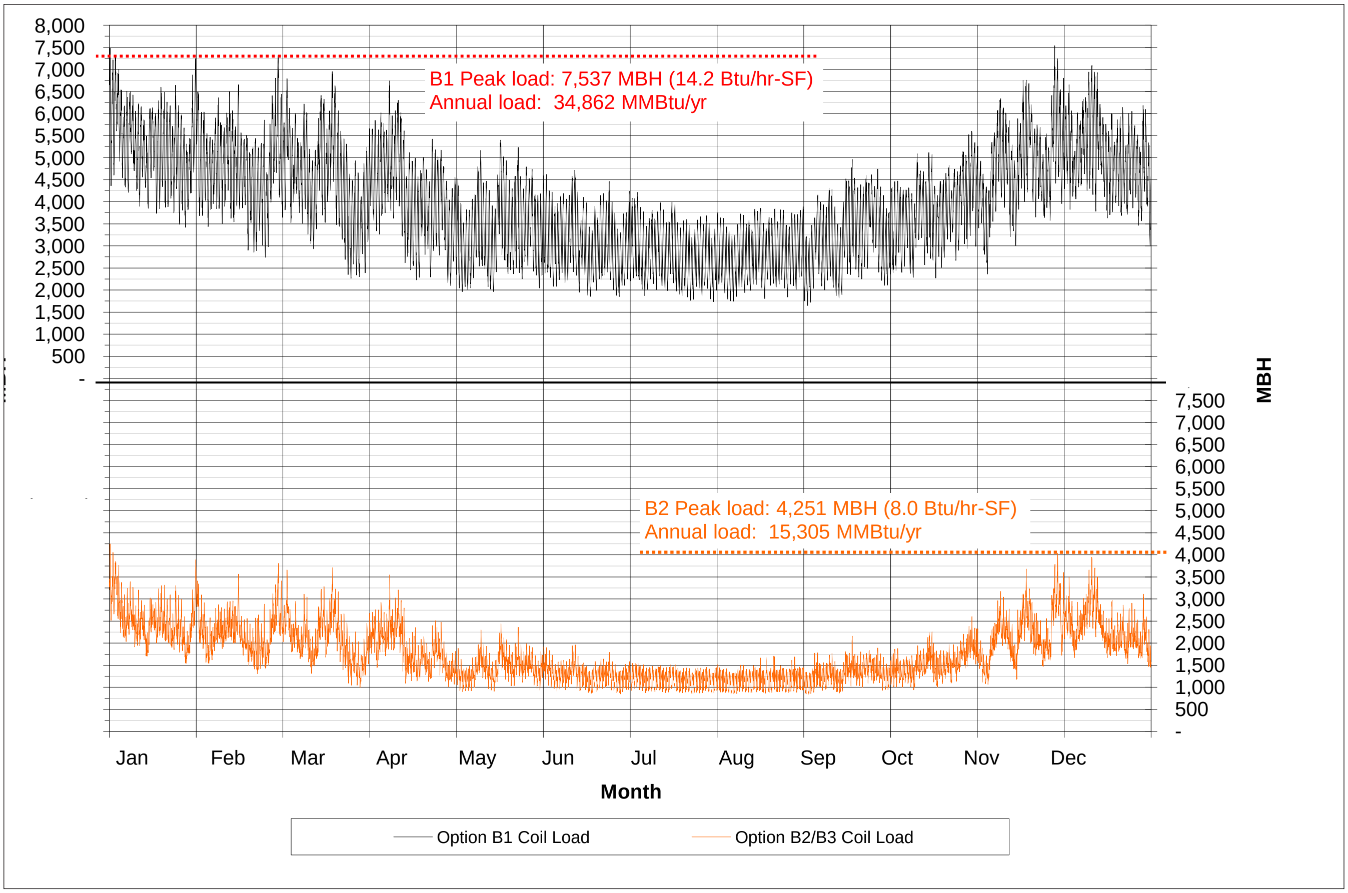

Figure 12.0: Heating Coil Loads Over Entire Year – Option B1 vs. B2 (B3).

Peak heating coil load is markedly reduced in Option B2 at 4,250 MBH (8.0 Btu/hr-SF) compared to Option B1 at 7,537 MBH (14.2 Btu/hr-SF). Total peak heating loads, including piping losses, are 8,406 MBH for Option B1 and 4,388 MBH for Option B2. Total peak heating load for Option B3 is essentially identical to B2, predicted to be 4,447 MBH.

Annualized heating loads are also significantly lower in Option B2 at 16,651 MMBtu/yr and B3 at 17,366 MMBtu/yr, compared to Option B1 at 42,663 MMBtu/yr.

Additional heating, cooling, and electric load information is contained in appendix 3.0 including a number of reports from the DOE2 energy simulation runs. The LS-C report is an excellent summary of the peak loads imposed by the building and its internal heat gains. Loads are estimated at a single interior reference temperature (72.5 deg F). Loads imposed by HVAC systems (fan heat, reheat/over-cooling, ventilation, pump heat, and piping system losses) are not included below. Comparison of the peak loads listed below to those discussed earlier provide an insight into the magnitude of the overall loads that are related to system effects rather than the building itself.

- Option B1 peak cooling load: 7,593,900 Btuh (633 tons), or 838 SF/ton
- Options B2 and B3 peak cooling load: 5,414,000 Btuh (451 tons), or 1176 SF/ton
- Option B1 peak heating load: 2,181,500 Btuh , or 4.1 Btuh/SF
- Options B2 and B3 peak heating load: 1,719,000 Btuh, or 3.2 Btuh/SF

For energy Options B2 and B3, the peak cooling load (as contributed by envelope and internal gains) is about 29% less than Energy Option B1. For Options B2 and B3, the peak heating load (envelope and internal gains only) is about 21% less than Option B1. In all cases, system-imposed cooling loads add just under half of total load imposed on the cooling plant. Heating loads imposed by the systems (reheat, ventilation, and piping losses) represent about 60% to 70% of the peak loads imposed on the heating plant.

COMPARING SCHEMES A AND B

The Baseline Energy Option B1 indicates that the perforated building morphology uses more energy than the typical configuration. The difference is essentially in the energy predicted to be used for space heating and fan systems. A review of the heating load profile figures shows a significant increase in predicted reheat coil load and central coil load for Option B1, compared to Option A1. Review of peak electric load reports generated by energy models shows an increase in peak fan electric load of about 100 kW in Option B1, compared to Option A1. This is due to a higher overall required air flow rate in Option B1.

The reheat coil load is a function of the specific call for heating (or less cooling) at the zone level, compared to the required supply air temperature at the system level. The system and zone configurations are similar in concept but different in arrangement between the two options, making direct comparison of the energy results challenging. Nonetheless, Option B is clearly more dominated by envelope loads and has less internal core zone and more perimeter zone compared to Option A.

Some conclusions appear to be able to be drawn:

- Perimeter dominated geometries will be sensitive to excessive reheat loads, unless an effort is taken to use de-coupled systems (as in Option B2 and B3), or to group zones with similar loads on individual systems.
- In many climates, perimeter dominated geometries will tend to experience higher peak cooling loads thus requiring more air flow and greater fan energy when loads are met with conventional cool air HVAC systems. De-coupled system concepts can alleviate this issue as well.
- For temperate climates, it appears that the cooling energy penalties associated with additional building envelope area show up as increased fan energy rather than increased cooling energy due to the effectiveness of air-side economizer cooling in these climates.

DAYLIGHTING AND NATURAL VENTILATION

These energy modeling results also point out, however, that there may be more potential for energy savings with Scheme B, the Perforated configuration. With the Target 100 energy saving strategies applied (Option B2), the Perforated configuration is predicted to produce a 57.8% energy reduction from its slightly more energy intensive code Baseline Energy model (Option B1) as compared to 55.1% for Scheme A, the Typical configuration. One of the greatest contributors for this potential for savings is the increased building perimeter of the hospital, thereby increased opportunity for incorporating passive systems such as daylighting and natural ventilation where appropriate and allowed by current code. To predict the savings achieved by increased daylight, the energy models reflect a combination of manual and automatic control of electric lighting in perimeter zones. In the energy models, control zones are assumed to penetrate approximately 20 feet into the space. Daylighting control of electric lights is included in all perimeter zones with windows, including in patient rooms. In the patient rooms, manual on/off control is assumed with a 50% probability that the lights will be turned off if light levels exceed 50 foot candles. In all other spaces, lighting is assumed to be continuously dimmed with daylight availability with minimum electric lighting output of 10% to a maintained set-point of 50 foot candles. Using these assumptions, daylighting is predicted to save 14% of the lighting energy predicted between the Baseline Energy Option B1 and the Target 100 Energy Option B2 in the perforated morphology.

Natural ventilation and cooling is a climate-responsive energy efficiency strategy that is more accessible to a facility that has a geometry similar to Scheme B. Option B2 distinguishes several areas, programmatically identified as lobby and/or some corridors as particularly applicable for natural ventilation and passive cooling. These areas also do not interfere with clinical activities, thus remain code-compliant. This is one of the contributors to the decrease in peak cooling load between Options B1 and B2.

OTHER MAJOR OUTCOMES

FLOOR-TO-FLOOR HEIGHT REDUCTION

De-coupled system concepts have an impact on air duct sizing, and the associated vertical clearance required in the utility space above ceilings in a hospital. Duct sizing, especially large centralized return ducts, can be a primary influence on the floor-to-floor height of hospitals. In traditional mechanical systems, most tempering is delivered through the air. In a de-coupled systems heat and coolth are transported predominantly through water, thus requiring smaller duct sizes and less space. In this project this had a significant impact by changing the main ventilation ducts (exiting a vertical riser shaft) from 22" diameter (typical) to 12" diameter. In addition, a 20" diameter return duct main was eliminated. Here, with de-coupled systems, duct size reductions allow the patient care floors to be reduced by at least 1 foot (from 15' to 14' floor-to-floor heights in this project). For Schemes A and B, this strategy was incorporated for the patient floors only, where Options 2 and 3 have been reduced from 15' floor-to-floor to 14' on the patient floor levels. If a project does not want to reduce floor-to-floor height, the reduction in duct size can be viewed as increased flexibility in the ceiling cavity with more room for service coordination and future changes.

ALTERNATIVES TO GROUND-COUPLED HEAT PUMPING

Both European hospital examples and early research results identified the use of ground-coupled heat pumping as one of the significant design strategies to achieve serious energy use reduction in hospitals. Exploration of central plant alternatives that incorporate enhanced heat recovery but do not have ground-coupled thermal mass, such as the heat recovery plant discussed herein show that hospitals can achieve very nearly similar results using partial or no ground-coupling. Many hospital projects are unable to implement ground-coupling due to site constraints. These projects should consider a heat recovery chiller based plant concept as a viable alternative.

ENERGY USE: FUEL SPLIT AND $ SAVINGS ON ENERGY

To note, the strategies that are employed in the Target 100 Energy Options imply a switch in fuel source from primarily natural gas to primarily electricity use. In the Baseline Energy Option, A1 the fuel split is 41% electricity and 59% natural gas. In the Target 100 (Option A2) case, the fuel split changes to 82% electricity and 18% natural gas use (this fuel switch encompasses a reduction of 86.3% in natural gas and even though a large percentage of the total fuel use has been switched to electricity, there is a decrease of 9.3% in electricity use). In Option A3, the fuel use split is 77% electricity and 23% natural gas (1.3% reduction in electricity and 80% reduction in natural gas).

While the focus of this project has been on overall energy reduction (in total site energy units) as the end product, it is also useful to discuss the total dollars saved in utility bills. This is a savings metric that may be of more interest from a business perspective. This is also the metric used for accessing energy credits through the Leadership in Energy and Environmental Design (LEED) accreditation process. The overall decrease in energy use from 223 KBtu/SF•year (Option A1) to 100 KBtu/SF•year (Option A2) reduces the predicted annual energy bill over 44% from about $1.65 Million to $920,000, an annual savings of about $730,000. For Option A3, a 37% reduction is seen on the energy bill from about $1.65 million for A1 to $1.036 million for A3, an annual savings of about $614,000. For these calculations, a non-negotiated Puget Sound Energy Electric rate schedule 26 and Gas rate schedule 31 were used, translating to melded rates of $0.0655/kWh and $1.07/therm. See Figure 13.0 below.

Similar to the Scheme A, the strategies employed in the Perforated Scheme B imply a fuel switch to achieve the very low energy use of the Target 100 Energy Option (B2). The fuel split for this configuration in the Baseline Energy case is 39% electricity and 61% natural gas. The fuel split for the Target 100 Energy case is 82% electricity and 18% natural gas (a reduction of 12% in electricity use and a decrease of 87.7% in natural gas use). Ultimately, the overall energy use profile from 240 KBtu/SF•year to 101 KBtu/SF•year reduces the predicted annual energy bill by just under 50% from about $1.786 Million to $939,000, an annual savings of about $847,000 based on Puget Sound Energy rates. For Option B3, a 41% reduction is seen on the energy bill from about $1.786 million for A1 to $1.047 million for B3, an annual savings of about $739,000.

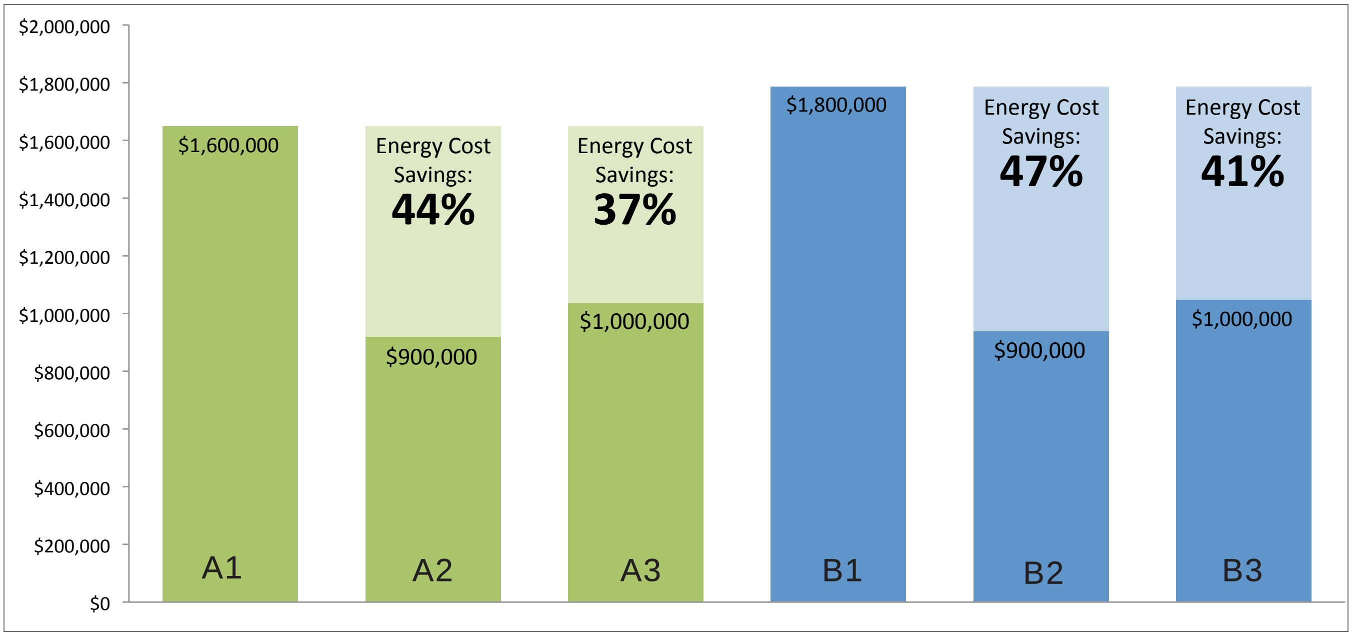

Figure 13.0: Energy cost and energy cost savings for Target 100 strategies.

When these savings are subjected to some basis life cycle costing analysis over a study period of 30 years with an escalation rate of 2% and a real discount rate of 3%, the net present value of the savings is $30 to $35/SF for Scheme A and $35 to $40/SF for Scheme B.

IMPLICATIONS ON HOSPITAL OPERATIONS AND MAINTENANCE

Distributed Systems Concept

A distributed systems concept implies that more of the central plant systems will be distributed throughout the building, becoming building systems. For example, 4-pipe fan coil units located in patient rooms provide additional heating and cooling that is de-coupled from the building ventilation air. This is a concept that can save on cooling energy, heating energy as well as fan power and duct sizes. Another way to de-couple systems is to use radiant sources for additional heat such as radiant heating panels and chilled beams. These strategies bring more equipment to the patient floors, and away from the central plant.

As part of our research process, we have included discussions with mechanical and owner teams on these subjects. We strategized that the fan coil units can be located above the toilet room and accessed from the corridor for ease of maintenance, while limiting disruption to clinical activities. Some participants felt that location within the room was better for maintainability; when necessary, a room can be shut down for the unit to be serviced, which is less disruptive to overall clinical functions. It was felt by the research team and reviewers that additional maintenance was not a barrier for these kinds of distributed systems concepts. In fact, positive attributes of redundancy of equipment were cited as advantages. For example, having extra equipment that can be swapped out in the case of failure, and in the case of failure, only one room would be affected in the transition time. Anecdotal evidence from one team member who manages a distributed de-coupled system, which has been in place for seven years, cited that maintenance times are about the same or less than a similarly sized facility with a centralized system concept. The initial installation period was critical for fine-tuning the units and working out the maintenance schedule for the system.

Ground Source Heat Pump Plant

The ground source heat pump that is conceptualized for energy Option 2 is a centralized heat pump system at the central plant level. This kind of system can bring additional advantages beyond energy savings. For example, a significant amount of water can be saved compared to an open cooling tower; this is advantageous when analyzing systems in terms of total cost of ownership for hospital management teams.

Typically, maintenance for the outdoor components (vertical bore-field or piping trenches) are considered separately from the indoor components (water-to-water and/or water-to-air heat pumps). The outdoor components are relatively static in nature, consisting of underground piping. There are a number of construction issues worth considering, such as keeping the piping clean and free of debris, size of site and coordination of construction (time and space), groundwater accumulation in vertical bores, and proper piping termination with pressurization and monitoring. Once built, there are relatively few maintenance issues. Indoor maintenance and start-up includes air venting and maintaining water quality in the building hydronic loops, avoiding short-cycling of heat pump compressors, some manual valve positioning as a seasonal maintenance, and a potential compressor replacement (often after 15 years). Pressure and temperature monitoring on the earth loops and building loops are valuable in ongoing operations to ensure that the efficiency of the system is being maintained, and that there is no seasonal degradation of system performance.

In discussions with ownership and design teams there is consensus that these systems provide a shift in maintenance capability from boilers/chillers to the heat pumps/compressors at the central plant level. Some representatives feel that this kind of system may require maintenance than a traditional central plant system once the equipment is set-up and tuned appropriately.

Some ownership teams are moving toward third party agreements for various energy generation strategies, including ground source heat pumps. In these types of arrangements, a third party will install and maintain a ground source field over a contracted period of time and a facility can utilize the benefits of that field without having to maintain or incur the burden of responsibility of the field over the contract period. For solar photovoltaic power generation this has become a more prevalent strategy, as it is emerging for ground source heat pump systems.

Building Operators – Education and Training and Transition from Design to Ownership

With any high performance building, it is critical to have ownership buy in, and a plan for hand-off to building operations management and users. The strategies that are presented in this research are all technologies that are readily accessible today, and have been implemented in numerous buildings across the United States. In order to achieve the goal of energy efficiency at the greatest level, however, an ongoing commitment from the team who owns, operates, and uses the facility is critical. In order for this commitment to resonate with the entire organization, a cohesive effort in education and training about the importance of the strategies and operations of systems that are implemented is critical to ultimately succeed in the highest energy efficiency goals. Sometimes this requires a culture shift within an organization. It was felt in our discussion with owner and operation teams that there is a shortage of trained work-force in the area of operating high performance buildings, thus there is an opportunity for educational programs to provide the skills necessary to operate high-performance, low energy buildings that are being designed and constructed today.

SECTION IV: COST RESULTS

INTRODUCTION TO COST ANALYSIS

The final analysis is a cost comparison of the six energy model simulations: Schemes A1, A2, A3 and B1, B2, and B3. The cost for each was attributed as a first-cost, cost of construction for the project. This calculation was performed on a per square foot basis and is reported as a percentage change from the respective code baseline model A1 vs. A2 or A3 and B1 vs. B2 or B3. These cost estimates are based on a schematic level design, and with any building project, would evolve with greater precision as the project approached greater completion. These estimates are the closest step to the cost of construction that this, or any group to-date have gathered, and they represent a work in progress. Any true test of these concepts will be represented in actualized projects being built and operated at documented energy savings and known costs for construction. Given the precision of the schematic nature of the underlying groundwork of these cost estimates, the numbers reported in this discussion are rounded, for cost/SF to the nearest whole dollar, for total cost to the nearest $10,000, and for percentage to the nearest full percent.

As this process continues, and more development occurs, more precision will be possible. Additionally, as discussion continues about these results and realizations about the process and outcomes are solidified, these will be recorded and added as footnotes as support to this discussion. At the time of the writing of this report, mid-2010, several projects are being designed in Puget Sound that borrow from the strategies developed in this project. The pricing and energy efficiency of this work is being documented and will be available in the near future, after this report has been finalized.

DETAILS OF COST ESTIMATE FRAMEWORK

The cost estimate of the Schemes and Options developed in the project are based in Seattle, Washington using fair market values for Spring 2010 assuming a stable competitive market, assuming normal rates; with the current market conditions and economic climate, pricing could vary significantly. The estimate is based on standard industry practice, professional experience, and knowledge of the local construction market costs. This is an estimate of cost, not a guarantee of material and labor costs, contractors' methods of establishing prices, or the market and bidding conditions at the time of an actual bid. For the estimate, subcontractor's markups are included as are the general contractor's general conditions, overhead and fees. The cost estimate includes the cost to construct the building, but excludes land acquisition, site work, and all professional fees associated with that work. A detailed description of the cost estimate and basis of the estimate can be found in Appendix 4.0.

OVERVIEW OF COST RESULTS

A summary of cost results is detailed in Tables 4.0 and 5.0 as well as Figure 14.0 below. For a detailed comparison, the costs are sub-divided by standard construction categories, resulting in the following total cost, percent changes, and dollar changes between Schemes A and B and their respective energy Options. Note that these values are directly from the cost estimate, thus are not rounded.

SCHEME A

Scheme A1 represents the most basic architectural scheme and the baseline energy option and provides the initial basis for comparison for the Target 100 Options. Based on this schematic level cost estimate, the total cost of construction for this scheme is $406/SF with a total project cost of $213,060,000.

Scheme A2, the Target 100 Option with ground source heat pump, increases 3% to $417/SF, $218,890,000 total, an increase of $5.82 million compared to Scheme A1. Scheme A3, the Target 100 Option with heat recovery plant, represents a mid-point between the baseline A1 and A2 with a cost per SF of $413 and overall project cost of $216,640,000, an increase of 2% over A1.

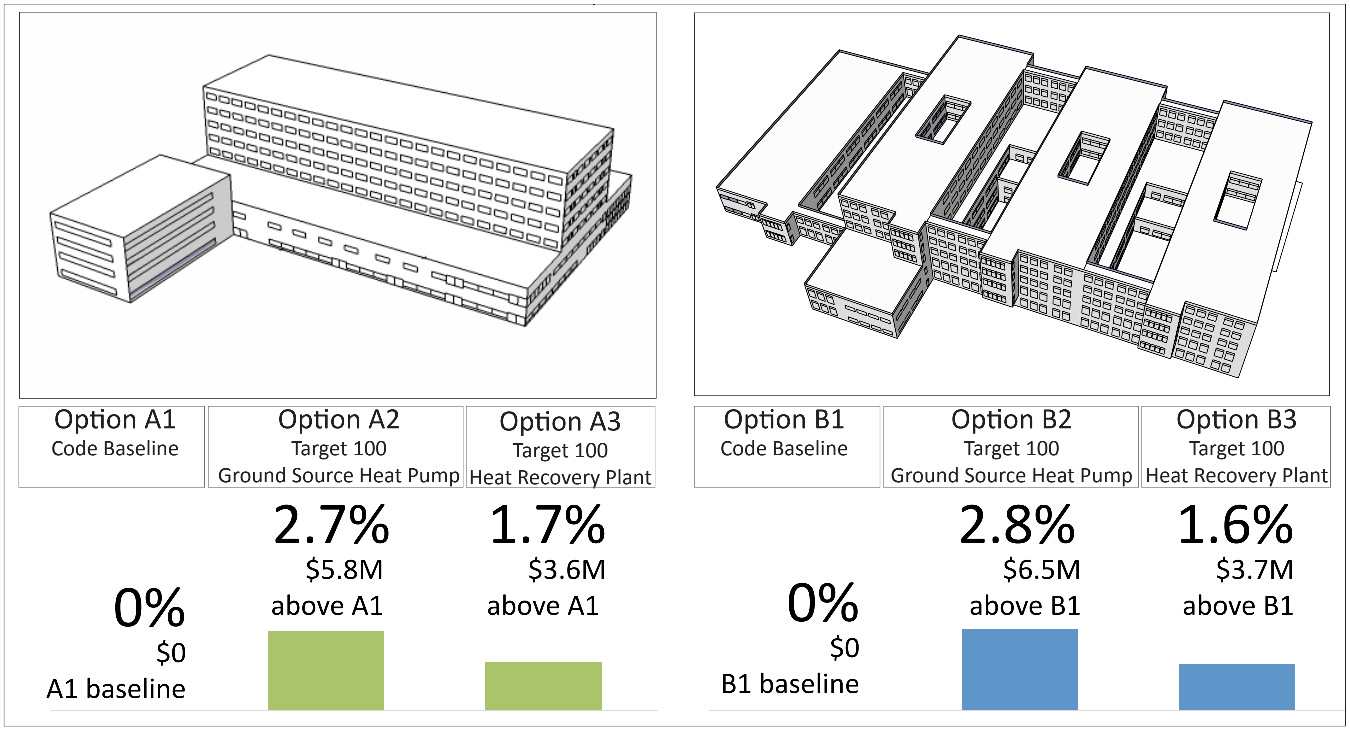

Figure 14.0: Incremental cost above baseline by percent and dollars (see projected energy differences in Figure 7.0 and energy costs in Figure 13.0).

The areas that represent the greatest cost increase between A1 and A2 are the exterior enclosure (24% of the total increase) and the mechanical systems (76% of the total increase). These figures are somewhat misleading, however. Due to the integrated nature of the building and systems design, some categories increase in cost, while others decrease, even within the category. One item may cost more to include on a first-cost basis, but its implementation may cause a decrease in cost for other categories; this points to the intertwined nature of this process, and the difficulty to parse the data on an individual, itemized level.

In the Baseline Energy Option A1, the basic code minimum mechanical design has an estimated total cost of $56.94 million, 27% of the total construction cost. For Schemes A2 and A3, the Target 100 mechanical has been completely re-envisioned to include a distributed systems concept, decoupled heating and ventilating systems with use of radiant heat, heat recovery systems. At the plant level these systems vary including either a ground coupled heat pump system or heat recovery plant. Details of the differences between the cost estimates for the mechanical systems are outlined in Table 6.0. There are many interactive effects that both increase and decrease costs in the Target 100 Options. Changing to the system for Option A2 appears to increase total cost of the mechanical system by $4.44M compared to A1 (or an 8% difference between the two mechanical systems). Yet this same system requires less space, allowing the building to require less vertical floor-to-floor heights, saving money on skin, façade, and total energy use. In another example, the exterior louver shading system reduces the solar heat gain through the envelope, thereby reducing the cooling load and up-front cost of cooling equipment. Thus, a component-by-component analysis is nearly impossible, due to the integrated nature of both the building and the systems.

In one example, the increase in cost for exterior enclosure of $1.3M is primarily due to a premium for a) thicker insulation (+$143,000) and b) retractable exterior louver blinds on the East, West, and South facades (+$1.6M), which is partially offset by the elimination of interior roller blinds in those windows (-$250,000). Decreasing the floor to floor height from 15' to 14' on patient floors also decreased costs in exterior closure (-$410,000), superstructure (-$480,000), and interior construction (-$260,000). Overall, the reduction in floor-to-floor heights from 15' to 14' on three patient floors resulted in a decrease of (-$1.15M). As discussed above, these concepts are all integrated, working together to achieve high energy performance at reduced cost. Limiting solar heat gain on the façade is integral to reducing cooling load, thus reducing the amount of mechanical cooling necessary; this can create the opportunity for more flexibility for vertical space and the potential for a modest reduction in floor to floor height.

Table 4.0: Detailed cost results for each Scheme and Option with estimate totals and cost per square foot. Potential utility incentives are also calculated and resulting total cost and cost per square foot are reported.

Total Costs

Ref.	Building Section	Option A1	Option A2	Option A3	Option B1	Option B2	Option B3
	BUILDING SF		524,902			524,710	
A10	FOUNDATIONS	10,444,137	10,444,137	10,444,137	11,639,164	11,639,164	11,639,164
A20	BASEMENT CONSTRUCTION	3,951,626	3,951,626	3,951,626	5,501,592	5,501,592	5,501,592
B10	SUPERSTRUCTURE	24,230,370	23,746,566	23,746,566	25,993,542	25,496,058	25,496,058
B20	EXTERIOR CLOSURE	16,299,979	17,685,879	17,685,879	25,804,737	28,541,260	28,541,260
B30	ROOFING	3,252,153	3,314,694	3,314,694	3,917,673	3,987,631	3,987,631
C10	INTERIOR CONSTRUCTION	34,321,356	34,057,094	34,057,094	33,051,218	32,631,373	32,631,373
C20	STAIRCASES	1,397,800	1,397,800	1,397,800	1,325,880	1,325,880	1,325,880
C30	INTERIOR FINISHES	17,029,480	17,029,480	17,029,480	17,026,139	17,026,139	17,026,139
D10	CONVEYING SYSTEMS	2,635,520	2,635,520	2,635,520	3,424,320	3,424,320	3,424,320
D15	MECHANICAL	56,939,964	61,377,968	59,018,919	60,284,699	64,362,739	61,625,421
D50	ELECTRICAL	37,761,788	38,694,904	38,800,304	38,093,830	39,081,647	39,079,795
E10	EQUIPMENT	1,674,437	1,674,437	1,674,437	1,673,825	1,673,825	1,673,825
E20	FURNISHINGS	3,126,349	2,879,805	2,879,805	3,234,870	2,751,534	2,751,534
F10	SPECIAL CONSTRUCTION	0	0	0	0	0	0
F20	SELECTIVE BUILDING DEMOLITION	0	0	0	0	0	0
G	BUILDING SITE WORK	0	0	0	0	0	0
	ESTIMATE TOTAL	**$213,064,958**	**$218,889,910**	**$216,636,261**	**$230,971,488**	**$237,443,160**	**$234,703,991**
	COST /SF	**$406**	**$417**	**$413**	**$440**	**$453**	**$447**
	POTENTIAL UTILITY INCENTIVE @ $4/SF	-	($2,099,608)	($2,099,608)	-	($2,098,840)	($2,098,840)
	RESULTING TOTAL COST W/ INCENTIVE	-	**$216,790,302**	**$214,536,653**	-	**$235,344,320**	**$232,605,151**
	RESULTING COST/SF WITH INCENTIVE	-	**$413**	**$409**	-	**$449**	**$443**

Percent Changes

Ref.	Building Section	A1 vs A2	A1 vs A3	B1 vs B2	B1 vs B3	A1 vs. B1
A10	FOUNDATIONS	0%	0%	0%	0%	11%
A20	BASEMENT CONSTRUCTION	0%	0%	0%	0%	39%
B10	SUPERSTRUCTURE	-2%	-2%	-2%	-2%	7%
B20	EXTERIOR CLOSURE	9%	9%	11%	11%	58%
B30	ROOFING	2%	2%	2%	2%	20%
C10	INTERIOR CONSTRUCTION	-1%	-1%	-1%	-1%	-4%
C20	STAIRCASES	0%	0%	0%	0%	-5%
C30	INTERIOR FINISHES	0%	0%	0%	0%	0%
D10	CONVEYING SYSTEMS	0%	0%	0%	0%	30%
D15	MECHANICAL	8%	4%	7%	2%	6%
D50	ELECTRICAL	2%	3%	3%	3%	1%
E10	EQUIPMENT	0%	0%	0%	0%	0%
E20	FURNISHINGS	-8%	-8%	-15%	-15%	3%
F10	SPECIAL CONSTRUCTION	-	-	-	-	-
F20	SELECTIVE BUILDING DEMOLITION	-	-	-	-	-
G	BUILDING SITE WORK	-	-	-	-	-
	INCREMENTAL COST	**2.7%**	**1.7%**	**2.8%**	**1.6%**	**8.4%**
	POTENTIAL UTILITY INCENTIVE @ $4/SF	-1.0%	-1.0%	-0.9%	-0.9%	-
	RESULTING INCREMENTAL COST	**1.7%**	**0.7%**	**1.9%**	**0.7%**	-

Dollar Changes

Ref.	Building Section	A1 vs A2	A1 vs A3	B1 vs B2	B1 vs B3	A1 vs. B1
A10	FOUNDATIONS	0	0	0	0	1,195,027
A20	BASEMENT CONSTRUCTION	0	0	0	0	1,549,966
B10	SUPERSTRUCTURE	-483,804	-483,804	-497,485	-497,485	1,763,172
B20	EXTERIOR CLOSURE	1,385,900	1,385,900	2,736,523	2,736,523	9,504,758
B30	ROOFING	62,541	62,541	69,958	69,958	665,520
C10	INTERIOR CONSTRUCTION	-264,262	-264,262	-419,845	-419,845	-1,270,137
C20	STAIRCASES	0	0	0	0	-71,920
C30	INTERIOR FINISHES	0	0	0	0	-3,341
D10	CONVEYING SYSTEMS	0	0	0	0	788,800
D15	MECHANICAL	4,438,004	2,078,955	4,078,040	1,340,722	3,344,735
D50	ELECTRICAL	933,116	1,038,516	987,817	985,965	332,042
E10	EQUIPMENT	0	0	0	0	-612
E20	FURNISHINGS	-246,544	-246,544	-483,336	-483,336	108,521
F10	SPECIAL CONSTRUCTION	0	0	0	0	0
F20	SELECTIVE BUILDING DEMOLITION	0	0	0	0	0
G	BUILDING SITE WORK	0	0	0	0	0
	INCREMENTAL COST	**$5,824,953**	**$3,571,303**	**$6,471,673**	**$3,732,503**	**$17,906,530**
	POTENTIAL UTILITY INCENTIVE @ $4/SF	($2,099,608)	($2,099,608)	($2,098,840)	($2,098,840)	-
	RESULTING INCREMENTAL COST	**$3,725,345**	**$1,471,695**	**$4,372,833**	**$1,633,663**	-

Table 5.0: Analysis of cost results showing percent change and incremental premium reported in % (top) and dollar change with incremental premium reported in $ (bottom). Comparisons are made between Option 1 as a baseline to determine incremental costs for Options 2 and 3 within each Scheme. Additionally, a comparison between A1 and B1 is shown. Potential utility incentives are calculated and resulting total cost and cost per square foot are reported as the bottom-line figure.

Table 6.0: Detailed Comparison of Mechanical Systems, Scheme A.

MECHANICAL A1			
PLUMBING			
Allowance for plumbing (Includes instantaneous steam fired portable water heaters)	524,902	GFA	17,048,817
HVAC			
Wet Side -			
Energy supply;			
Boilers (steam) 300 bhp, total load 19,361 btu/hr	3	EA	887,478
Feedwater system	1	LS	130,163
Steam to HW Ht Exchanger	3	EA	532,487
Potable Water heater	7	EA	182,229
Associated equipment. 19no. Pumps, Tanks, Separators etc	1	LS	212,995
Chiller, 800 ton	3	EA	1,235,400
Cooling tower	3	EA	709,982
Associated equipment. Pumps, Tanks, Separators etc	1	LS	325,409
Distribution & Auxiliary equipment:			
Distribution piping including equipment connections (Approximate distribution quantity 50,000 LF)	524,902	GFA	5,205,978
Dry Side -			
Air handling systems	543,020	CFM	6,299,032
Packaged split A/C systems	1	LS	47,332
Terminal VAV boxes	1,100	EA	969,760
Exhaust systems	524,902	GFA	1,272,572
Miscellaneous systems	524,902	GFA	377,510
Distribution systems (1.85 lbs / sf)	524,902	GFA	13,130,633
Control , BMS & Sensing & monitoring (3360 control points)	524,902	GFA	4,140,427
HVAC related items-			
Balancing, Testing	524,902	GFA	608,886
Supervision associated with commissioning	524,902	GFA	273,999
HVAC, seismic, gen conditions, engineering, etc	524,902	GFA	608,886
FIRE PROTECTION			
Fire sprinklers, standpipe & specialties	524,902	GFA	2,739,988
MECHANICAL			**$56,939,964**
Wetside			4,216,143
Distribution Piping			5,205,978
Dryside			8,966,206
Ductwork			13,130,633
Controls			4,140,427

MECHANICAL A2			
PLUMBING			
Allowance for plumbing	524,902	GFA	17,048,817
Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separate waste & vent system also required from shower drains and selected hot water waste drains	524,902	GFA	290,357
HVAC			
Wet Side -			
Energy supply (Closed Loop);			
Geo thermal field, 416 bores @ 300 ft deep	124,800	LF	2,200,474
Geo thermal field, headers	26,500	LF	464,328
Utility from field to building (150 l/ft allowance)	1	LS	47,332
Heat pumps, 400 ton Approx ($900 per ton + GC markups)	3	EA	1,277,968
Chiller, 800 ton	1	EA	411,800
Cooling tower	1	EA	236,660
Associated Pumps 27 no., 482 hp total	1	LS	257,520
Associated equipment - Tanks, Separators etc	1	LS	35,499
Steam boiler (standby), 90 hp	2	EA	236,661
Associated equipment. Pumps, Tanks, Separators etc	1	LS	59,165
Distribution & Auxiliary equipment:			
Distribution piping including equipment connections (Approximate distribution quantity; 70,000 l/ft)	524,902	GFA	7,915,522
Dry Side -			
Air handling / heat recovery systems	373,600	CFM	4,734,633
Packaged split A/C systems	1	LS	47,332
Fan coil units, four pipe	727	EA	5,591,702
Terminal VAV boxes	269	EA	237,150
Exhaust systems (heat recovery ventilators to function as primary exhaust)	524,902	GFA	983,351
Miscellaneous systems	524,902	GFA	377,510
Distribution systems (Approximate duct poundage; 1.44 lb/sf)	524,902	GFA	9,194,183
Control , BMS & Sensing & monitoring (5221 control points)	524,902	GFA	5,053,756
HVAC related items-			
Balancing, Testing	524,902	GFA	761,108
Supervision associated with commissioning	524,902	GFA	273,999
HVAC, seismic, gen condition, engineering etc	524,902	GFA	901,152
FIRE PROTECTION			
Fire sprinklers	524,902	GFA	2,739,988
MECHANICAL			**$61,377,968**
Wetside			5,227,406
Distribution Piping			7,915,522
Dryside			11,971,679
Ductwork			9,194,183
Controls			5,053,756

MECHANICAL A3			
PLUMBING			
Allowance for plumbing	524,902	GFA	17,048,817
Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separate waste & vent system also required from shower drains and selected hot water waste drains	524,902	GFA	290,357
HVAC			
Wet Side -			
Boiler (condensing), 2,000 mbh	4	EA	162,400
Back up fuel storage - Propane system	1	EA	13,920
Chiller (multistack - ht harvester), 400 ton	2	EA	649,600
Chiller, 800 ton	1	EA	411,800
Heat pump, 400 ton ($900 per ton + GC markups)	1	EA	425,989
Cooling tower, @ 400 ton	2	EA	255,200
Cooling tower, @ 800 ton	1	EA	236,660
Associated Pumps 27 no., 482 hp total	1	LS	257,520
Associated equipment - Tanks, Separators etc	1	LS	35,499
Steam boiler (standby), 90 hp	2	EA	236,661
Associated equipment. Pumps, Tanks, Separators etc	1	LS	59,165
Distribution & Auxiliary equipment:			
Distribution piping including equipment connections (Approximate distribution quantity; 70,000 l/ft)	524,902	GFA	8,037,299
Dry Side -			
Air handling / heat recovery systems	373,600	CFM	4,736,800
Packaged split A/C systems	1	LS	47,332
Fan coil units, four pipe	727	EA	5,591,702
Terminal VAV boxes	269	EA	237,150
Exhaust systems (heat recovery ventilators to function as primary exhaust)	524,902	GFA	983,351
Miscellaneous systems	524,902	GFA	377,510
Distribution systems (Approximate duct poundage; 1.44 lb/sf)	524,902	GFA	9,194,183
Control , BMS & Sensing & monitoring (5221 control points)	524,902	GFA	5,053,756
HVAC related items-			
Balancing, Testing	524,902	GFA	761,108
Supervision associated with commissioning	524,902	GFA	273,999
HVAC, seismic, gen condition, engineering etc	524,902	GFA	901,152
FIRE PROTECTION			
Fire sprinklers	524,902	GFA	2,739,988
MECHANICAL			**$59,018,919**
Wetside			2,744,414
Distribution Piping			8,037,299
Dryside			11,973,846
Ductwork			9,194,183
Controls			5,053,756

Overall, the increase in cost for the entire Target 100 ground source heat pump concept (Option A2) results in an up-front increase in capital investment of $5.82M.

Option A3, the Target 100 Scheme with the heat recovery plant is the same at all levels as A2, except at the central plant. Thus, the cost results represent the similarities between A2 and A3. Differences in mechanical and electrical are due to the removal of the ground source system, and moving the heat recovery concept to the central plant level, rather than using the ground as a heat sink or heat source. Overall, the increase in cost for the Target 100 heat recovery plant concept (Option A3) results in an up-front increase in capital investment of $1.47M.

SCHEME B

For Scheme B, the baseline cost estimate is slightly higher than Scheme A, at $440/SF, and a total project cost of $230,970,000. Scheme B2, the Target 100 Option with ground source heat pump, is estimated to increase 3% from B1 to $453/SF, or $237,440,000 total, a premium of $6.47M over B1. Similar to Scheme A, Option B3, the Target 100 Option with heat recovery plant represents a mid-point between B1 and B2 at $447/SF or $234,700,000 total project cost – a premium over B1 of 2% or $3.73 million.

The areas that represent the increase in costs are similar to those that shift between Schemes A1 and A2: exterior enclosure and mechanical systems. Comparable decreases are also seen. Congruous to that discussion, a linear comparison of cost increases and decreases is very difficult to draw due to the integrated building and systems design concepts that are employed in the change from one model to the next. Thus, within the cost increase for the mechanical section, there are systems that have greatly reduced in cost, and some that have increased in cost with a net overall increase of $4.08M within that category, a 7% increase in this category from Scheme B1 to Scheme B2. Also akin to the discussion of A1 and A2 above, there are cost savings associated with the reduction of floor-to-floor heights on the patient floors, $1.6M from B1 to B2, reflecting less total structure, reduced surface area for the exterior walls and shorter interior partitions.

SIMPLE PAY-BACK AND LIFECYCLE COSTING

If viewed from a simple payback perspective, Option 2 for both Scheme A and B, pay back the initial incremental capital investment over eight years; Option 3 pays back in five years. In the Energy Results section above, Net Present Value (NPV) calculations showed the value of the energy saving Target 100 strategies equivalent to $30-$35 per square foot over a 30 year period (using a 3% discount rate and 2% escalation rate). For that same time-period, a 14-22% Internal Rate of Return (IRR) is seen depending on the Scheme. This is based on energy cost savings over a 30 year period (based on NPV) and initial capital investment required to implement those energy savings strategies. Full lifecycle costing such as maintenance, operations, or more complex analysis of positive contributions to the healing or work environment were not included in this calculation of IRR. These analyses could provide insight to cost savings attributed to better light and air quality for patients, and also productivity improvements due to better daylight availability in staff work environments. Nonetheless, it is very compelling to see the potential of up-front investments on energy strategies to save over the lifetime ownership of a hospital building. These strategies can lead to the potential for savings that can be applied to other aspects of the organization and contribute to long-term stability of the organization.

INCENTIVE PROGRAMS

All Pacific Northwest electric utilities offer incentives to owners for increased first-costs that are incurred in order to implement more energy efficient solutions. Many of these incentive programs focus on an incremental approach, where individual strategies are assessed for their first-cost and energy implications on the project. For example, if a strategy such as a more efficient boiler has increased energy efficiency, but will cost the owner more up-front, the increase in first cost may be incentivized by the utility if it is found to have a sufficient pay-back potential.

This project, and other building projects that hope to achieve significant energy savings, must rely on synergistic energy saving strategies in order to accomplish their goals. In the view of an incremental incentive program, it is difficult to analyze the exact impact of a single strategy in isolation from the others, and how it might pay back over time. In conversations with utility partners in the Pacific Northwest, potential whole-building utility incentives may provide a more holistic approach to incentivizing significant energy reduction goals. For this kind of project, the incentive is probably in the range of $4/SF, or 1% of the total project cost. This would decrease the overall premium for energy efficiency measures in Option 2 to 2% for and 1% for Option 3.

Recently, some organizations have implemented an initial budget line-item allocation to accommodate for energy efficiency and other sustainable strategies. This allocation is commonly 1.5% of the total project cost. This allocation enters the capital budget at the conception of the project and stays with it through construction. The allocated amount for increased efficiency or sustainability gets applied to the project if the solutions show a simple payback of less than 5 years. Structuring the budget with this strategy would accommodate the ground coupled Target 100 strategies (Option 2) for both Schemes; their simple payback is 5 years, with an incremental cost of 1.7% and 1.9% respectively with utility incentives applied. This kind of budget strategy would also successfully accommodate the increase in cost for the heat recovery plant Target 100 strategies (Option 3) for both Schemes A and B, with simple return on investments of 3 and 2 years respectively when incorporating a utility whole building type incentive program.

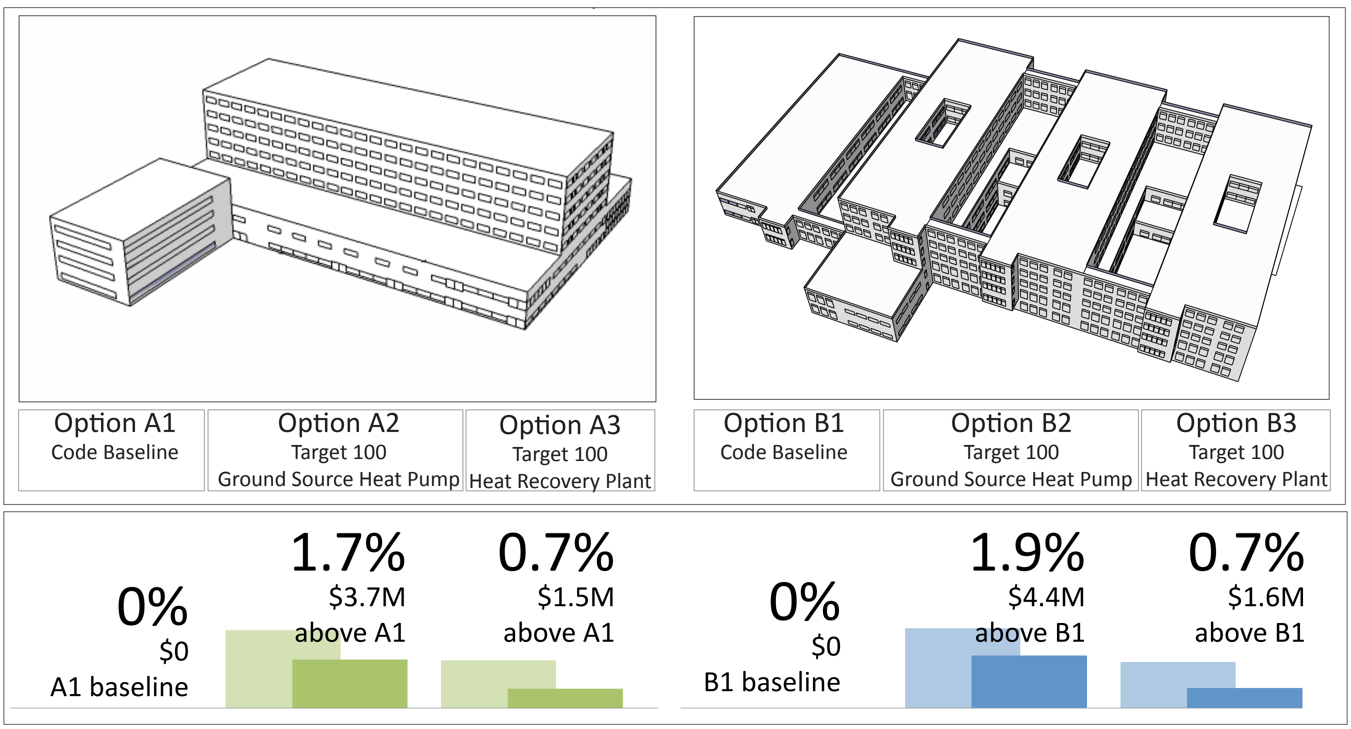

Figure 15.0: Incremental cost above baseline by percent and dollars with adjustments for utility incentives.

COMPARING SCHEMES A AND B

The analysis between A1 and B1 was primarily to determine the energy and cost implications of creating a more articulated building form, thus increasing the total building perimeter. Scheme B is transformation from a mid-20th century hospital form that came about in the post World War II era to a form that represents the opportunity for radically reduced energy use with much greater connection to the outside environment including access to daylight, the possibility for natural ventilation, and the implicit benefits of increased wellness and productivity associated to these architectural amenities. The cost difference between A1 and B1 is $17.9 million, or 8%, which is primarily for increased building skin and slight increases due to a more distributed model.

Overall, the difference in the estimate is mostly due to a 60% increase in surface area which is represented in the area of exterior closure; an increase of 58% ($9.5M) is seen in this category between Schemes A1 and B1. Just as in other aspects of this project, the increase in exterior skin also represents changes in other areas. For example, interior partitions decrease, due to the increased number of exterior walls in proportion to interior walls, representing an overall decrease from Scheme A1 to Scheme B1 of 4% ($1.27 million) within this category.

The more distributed architectural form increases the cost of multiple other systems. The interior conveyance systems are an increased cost of 30% within this category between Scheme A1 and B1, due to the more distributed nature of the architectural form. Similarly, the baseline mechanical design in Scheme B1 is inherently more distributed than in the more compact form of Scheme A1. This leads to slightly more equipment, distribution systems, piping, etc. compared to the baseline system in A1 (an increase of 6% or $3.3M).

It is important to keep in mind, however, that these analyses are based in a schematic representation of a hospital in its simplest form both architecturally, and at the code minimum performance mechanically. In some ways, the representation of Scheme A is an oversimplification architecturally, where an actualized model would have more skin to volume than this very simplistic model. As modeled, Scheme A1 has a perimeter to floor area ratio of 0.308, which is very low for this building type. As represented, this would be a building that is at its simplest to construct, and perhaps under-represents the reality of architectural complexities that would be actualized even in a "typical" prototype hospital today, therefore, this may artificially deflate the cost per square foot for Scheme A.

CONCLUSIONS, COMPARING SCHEME A TO SCHEME B

As a group, we had hoped that designing a hospital that meets the 2030 Challenge with a form that has the ability to connect to the outside environment would be a cost neutral proposition. The purpose of this research is to point out where there are differences in cost between a standard, or common form of a free-standing hospital building with typical code-compliant systems, and the re-envisioned hospital architecture with Target 100 systems that achieve the 2030 Challenge goals for 2010.

We are excited that there is as little difference as there is between the costs of Schemes A1 and B1, given the large potential benefits for patients and staff and the aligned opportunities for improved healing and productivity that can be associated with Scheme B. This difference of less than 10% between these two Schemes provides the opportunity for future study of why these differences occur and how to reconcile these increases in cost. Ultimately, we discovered through the energy and cost models that the increase in cost is modest to achieve significant savings, and depending on an organization's analysis, the benefit of implementing these strategies may outweigh the increased capital cost investment.

This study has primarily focused on the energy benefits of creating a high performance hospital. The added monetary benefit for creating opportunities for daylight, view, and access to nature have been shown to increase patient satisfaction, healing time, and decreased anxiety, and decreased use of pain medication. Similar attributes that are created by a more articulated form, such as Scheme B, have also been shown to improve productivity and satisfaction for staff. The interior environmental quality that the architectural form of Scheme B establishes is far superior to that of Scheme A. This study has not attempted to calculate a numerical value to creating better healing or work environments for staff and patients. Since staffing is one of the most expensive operational expenditures for hospitals, the benefits afforded by decreased staff turn over and increasing productivity and satisfaction are relevant areas to explore cost savings that can be incurred from creating superior interior environmental quality for staff as well as patients. It is by these measures that the cost differences for Scheme B as compared to Scheme A could be reconciled and determined to be beneficial investments for the long-term potential of a hospital organization.

SECTION V: CONCLUSIONS AND FUTURE WORK

CONCLUSIONS

How Can a Hospital Achieve the 2030 Challenge? In order to achieve a 60% reduction in energy use, an entire re-evaluation of many of the architectural systems, building systems and mechanical systems must take place. Additionally, a full integration of the design, ownership, engineering, and utility teams is necessary from the onset of the project through occupancy. Adhering to a code-compliant path, following relevant mechanical, architectural and health related guidelines, the following building and mechanical concepts were found to be one solution, integral to achieving a high performance, Target 100 hospital design that achieves the 2030 Challenge at little increased capital cost investment:

THE 2030 HOSPITAL INTEGRATES:

- Full **Project Team** and **Project Design Integration**.
- **Goal Setting**, **Energy Modeling**, and **Benchmarking**: Attention to designing to an energy goal, continuously verifying design performance through all stages of project schematic design through operations and maintenance.

Architectural Systems

- **Daylighting**: increase interior environmental quality and decrease electric lighting use.
- **Solar Control**: minimize peak loads for cooling and increase thermal comfort.
- **High Performance Envelope**: balance heat loss and radiant comfort with thermal performance.

Building Systems

- **De-centralized**, **De-coupled Systems**: separate thermal conditioning from ventilation air.
- Optimized **Heat Recovery** from space heat and large internal equipment sources.
- Advanced HVAC and lighting **Controls**: turn off what is not in use.

Plant Systems

- Advanced **Heat Recovery** at the central plant with **Heat Pumping** or enhanced heat recovery chillers and highly efficient boilers.

Some of these concepts are major departures from standard design practice, but must be addressed to achieve high quality, low energy healthcare designs that incur little upfront additional capital cost investment.

FUTURE WORK

The future research for the team is to focus on identifying areas where cost can be further reconciled to increase confidence in the ability to implement integrated solutions for energy efficiency and much improved interior environmental quality. Further, more depth in these systems' reliability from an energy perspective, cost perspective, and implementation perspective will be topics of exploration.

An area for study is to look at the Scandinavian experience where systems concepts lead to hospitals that use one half to one quarter the amount of energy use of typical U.S. hospital examples. These examples also have articulated forms that embody the ideals of connection to the outside environment with access to daylight and fresh air in most spaces. These hospitals provided a road-map for this research effort, and can continue to inform the trajectory of high performance, cost-effective hospital design. Several anecdotal explanations of differences between Scheme B in this study and Scandinavian examples include the amount of tempering that is necessary in patient rooms including an expanded comfort range and strategies of distributed systems. For example, some Scandinavian examples do use distributed systems concepts with tempering through radiant heat sources and supplemental cooling where needed. Some also use displacement ventilation. They do not, however, use individual fan coil units in each patient room, which was a significant cost increase in this study.

This research team undertook this project looking at the building and its various architectural, building mechanical and plant systems with an integrated approach. Thus, for energy modeling and costing we looked at the total result, rather than individual results of each incremental step. Future work to investigate the energy implications and cost associated with separate building and mechanical components would help guide an understanding of the strategies that achieve the most energy savings, and at what cost. This effort would be especially valuable for projects where additions, renovations and remodeling are the scope of the capital project. This would be a more in-depth study and will require an incremental step-by-step approach of de-coupling and energy modeling each strategy or strategy set. This would require a careful examination of the specific costs associated with each specific strategy.

This more incremental approach would help identify where the big energy savings are possible, how the savings can be achieved, and the cost associated with implementing energy savings. This would help in our understanding of the cost differential between the different schemes, and would help inform how to begin to reduce the difference in cost between the baseline Options and the Target 100 Options. Additionally, better understanding of energy end-uses in operational hospitals with focus on reheat loop loads, medical equipment loads, vacuum pump loads and operation, compressed air loads and operation, heating water and steam distribution system losses, fan motor loads and operation, pump loads and operation, potable hot water use patterns, sterilizer steam loads and use patterns, humidification loads, cooking loads and kitchen use patterns, and unique laboratory and surgery suite equipment loads and actual patterns of use would create a better understanding of how hospitals operate, and where the greatest targets of opportunity are.

In-depth life-cycle cost analysis of energy reduction strategies is a subject for future research, but was not the subject of this study. For example, the cost of operational maintenance, facility management knowledge and staffing needs are not evaluated in this study. The re-envisioned mechanical systems employed in this model are not the traditional systems implemented in typical hospitals today. Studies looking at the aspects of reduced maintenance costs in some areas, and increased maintenance in others over the lifetime of a building are very relevant topics for analysis when evaluating energy efficiency measures in hospitals. These aspects are the scope of future studies.

Lastly, with the support of the U.S. Department of Energy and the Northwest Energy Efficiency Alliance, the team looks forward to expanding this energy and cost analysis to the seven climate zones and six sub-zones in the U.S., and to developing a design guideline from that analysis.

RECOGNIZED AREAS TO EXPAND TO TARGET 50 EUI

The newest hospital projects in Scandinavia are approaching design EUI's of less than 50! The research documented in this report was implemented under code compliant conditions, adhering to all relevant state health code requirements and AIA guidelines for healthcare facilities. Areas for future research include identification and exploration of additional design strategies to achieve even greater energy savings. It is recognized that energy savings much beyond what was achieved in this study may require a change of current standards for ventilation rates, temperature requirements, and ventilation systems. These requirements are currently barriers to even more significant energy savings in hospitals today. Thus, to approach an EUI of 50 KBtu/SF·year would require new design thinking and a potential deviation from current healthcare codes under state and national regulation, but are commonly implemented in Scandinavia today. Ideas related to additional energy efficiency, identified by our team, include:

- Reduced air circulation rates in regulated spaces, allowing a dedicated outside air system to be installed in combination with radiant heating/cooling or chilled beams that do only sensible cooling.
- Dedicated outside air systems configured to introduce air in a displacement ventilation mode.
- Use of evaporative chilling and thermal energy storage to provide cool water to zone level cooling units (sensible cooling only).
- Continued crafting of heating and cooling loads so that heat recovery chillers in combination with heat pump-assisted heat recovery from the exhaust air stream is sufficient to meet most if not all of the heating needs (without the need for extensive ground-coupling).

- Multi-zone air-source heat pumping, i.e., variable refrigerant flow systems.
- Low flow plumbing fixtures, especially showers.
- Active solar thermal water heating.
- Continued refinement of efficient interior lighting concepts using dimming fluorescent or white LED throughout.
- Triple pane glazing, or other non-traditional high performance glazing products.

SECTION VI: CONTRIBUTORS

This research was conducted in a very collaborative team effort with contributions made in-kind by many individuals and companies including representatives from architectural design, mechanical design, construction, ownership, operation, and utility teams. Below is a synopsis of the core team and a list of key players who contributed to the quality and depth of this work.

CORE RESEARCH TEAM

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Phoebe Warren, Seattle City Light

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APPENDIXES

Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Appendix 1.0

Architectural Descriptions

University of Washington's Integrated Design Lab

with support from

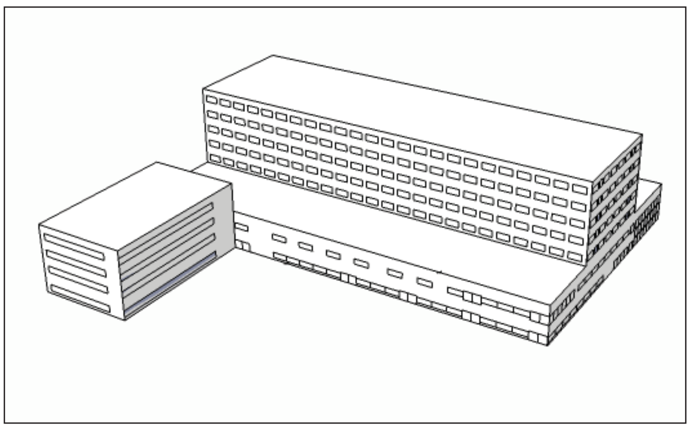
Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

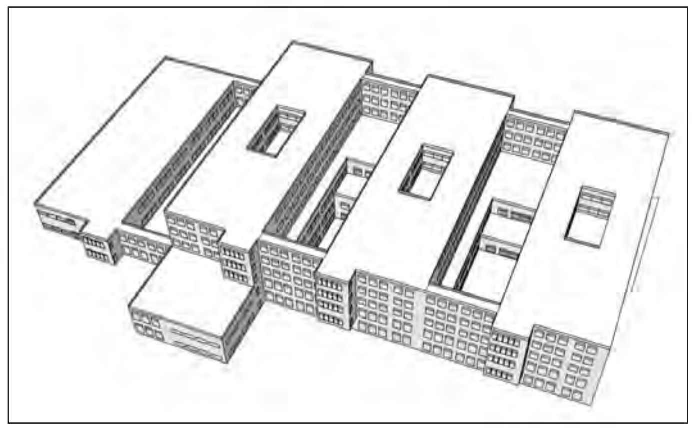
University of Washington's Integrated Design Lab
NBBJ Architects
Solarc Architecture and Engineering
TBD Consultants
Cameron MacAllister
Mahlum Architects
Mortenson Construction

Table of Contents

Architectural Description for Scheme A:
Typical Geometry

Scheme A	Scheme B



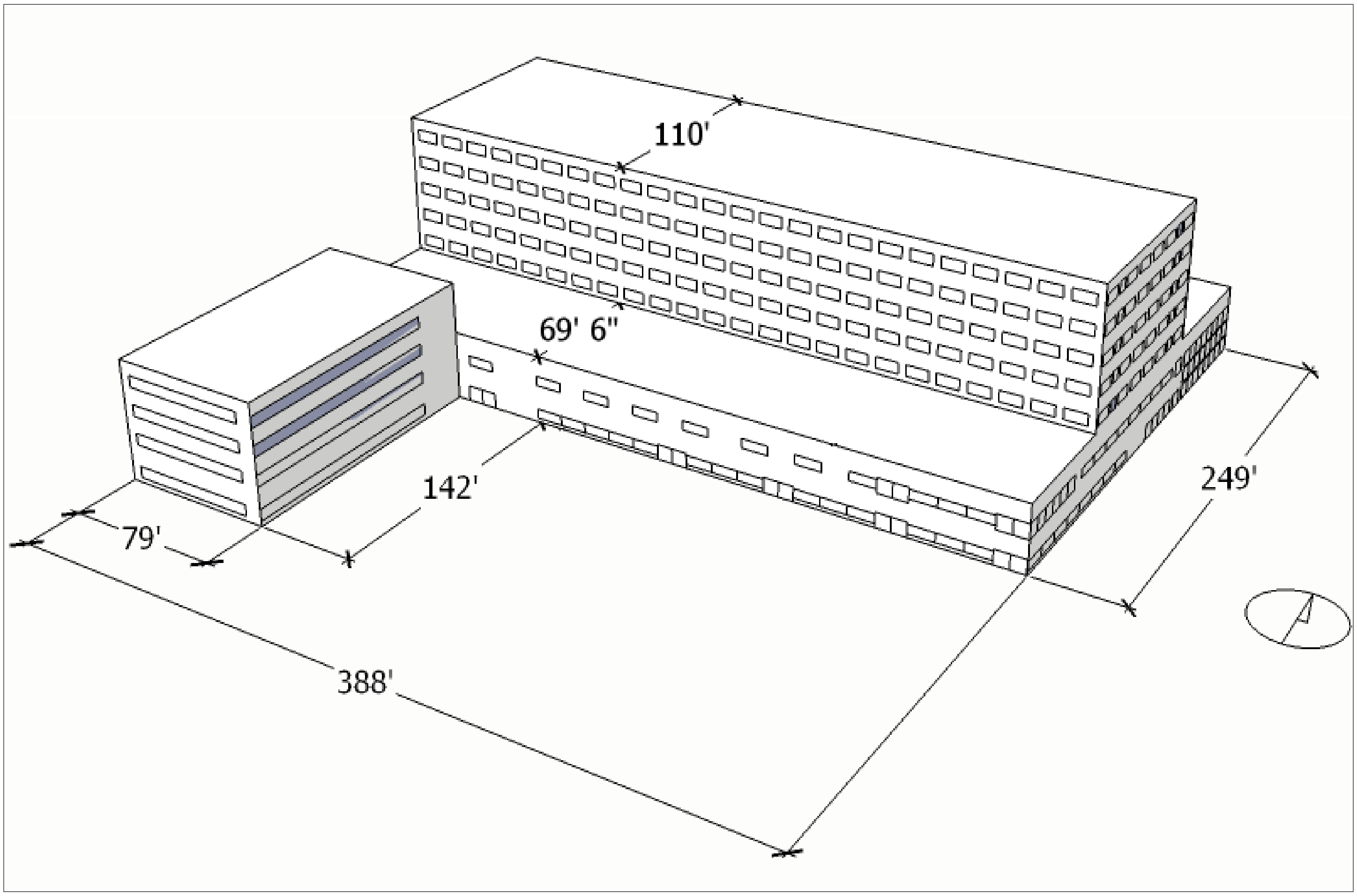


Option A1	Option A2	Option A3	Option B1	Option B2	Option B3
Code Baseline	Target 100 Ground Source Heat Pump	Target 100 Heat Recovery Plant	Code Baseline	Target 100 Ground Source Heat Pump	Target 100 Heat Recovery Plant

Typical Schemes A1, A2 & A3

Overall Building Massing

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



Overall Window to Wall Ratios From Energy Model

Baseline Energy Option A1

The LV-D report shows a summary of external surfaces as included in energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces.

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.517	0.058	0.194	13448.22	31991.28	45439.50
EAST	0.510	0.058	0.231	9828.71	15755.30	25584.00
SOUTH-EAST	0.000	0.058	0.058	0.00	100.00	100.00
SOUTH	0.519	0.058	0.180	12654.82	35053.18	47708.00
SOUTH-WEST	0.513	0.058	0.276	4138.18	4481.82	8620.00
WEST	0.516	0.058	0.162	3841.52	13122.49	16964.00
ROOF	0.000	0.032	0.032	0.00	107833.55	107833.55
ALL WALLS	0.515	0.058	0.197	43911.44	100504.05	144415.50
WALLS+ROOFS	0.515	0.044	0.126	43911.44	208337.59	252249.05
UNDERGRND	0.000	0.094	0.094	0.00	127153.95	127153.95
BUILDING	0.515	0.063	0.115	43911.44	335491.53	379402.97

Overall Window to Wall Ratios From Energy Model

Target 100 Energy Option A2 & A3

The LV-D report shows a summary of external surfaces as included in energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces.

```
High Performance Hospital – Scheme A2   Target 100 - Conventional               DOE-2.2-47b    4/14/2010    14:35:34  BDL RUN  1

REPORT- LV-D Details of Exterior Surfaces                                            WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------(CONTINUED)--------

                      AVERAGE              AVERAGE            AVERAGE U-VALUE        WINDOW          WALL           WINDOW+WALL
                  U-VALUE/WINDOWS       U-VALUE/WALLS        WALLS+WINDOWS           AREA           AREA              AREA
                  (BTU/HR-SQFT-F)      (BTU/HR-SQFT-F)      (BTU/HR-SQFT-F)         (SQFT)         (SQFT)            (SQFT)


NORTH                    0.349               0.044                0.152           15365.26       28134.23          43499.50

EAST                     0.337               0.044                0.154            9435.13       15608.87          25044.00

SOUTH-EAST               0.000               0.044                0.044               0.00         100.00            100.00

SOUTH                    0.350               0.044                0.143           14772.22       30995.79          45768.00

SOUTH-WEST               0.333               0.044                0.142            2932.36        5687.64           8620.00

WEST                     0.348               0.044                0.145            5460.40       10963.60          16424.00

ROOF                     0.000               0.032                0.032               0.00      107833.55         107833.55

ALL WALLS                0.346               0.044                0.148           47965.37       91490.14         139455.50

    WALLS+ROOFS          0.346               0.037                0.097           47965.37      199323.69         247289.05

    UNDERGRND            0.000               0.094                0.094               0.00      127153.95         127153.95

BUILDING                 0.346               0.059                0.096           47965.37      326477.66         374443.00
```

Insulation Values Per Washington State Energy Code

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

Energy Codes Comparison [a,b]:

	Code	Opaque Wall	% Glazing Area	Max. SHGC4	Vertical glazing	Overhead Glazing	Opaque Doors	Roofs	Floor Uncond.	Slab on Grade
Baseline	Washington State 2006 [c]	R-19 or U=0.062	30% or system analysis	0.45	U-0.55	U-0.7	U-0.6	R-21 or U=0.046	R-19	R-10
Target 100	Washington State 2009 [e]	R-13 + R-7.5 continuous insulation	40% max.	0.40 all	U-0.4	U-0.5 (sloped glazing) U-0.6 (individual unit)	U-0.6	R-30 continuous insulation or U=0.034	R-38 + R-4 continuous insulation	R-10 continuous insulation (with thermal break)

Notes:

a. Requirements ***only*** for metal framing, using heat pumps and VAV.
b.% Glazing are if using prescriptive path.
c. Per 2006 Washington State Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1
d. Per 2006 Seattle Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1
e. Per Draft of 2009 Washington State Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1

Wall and Roof Assembly Per Washington State Energy Code

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

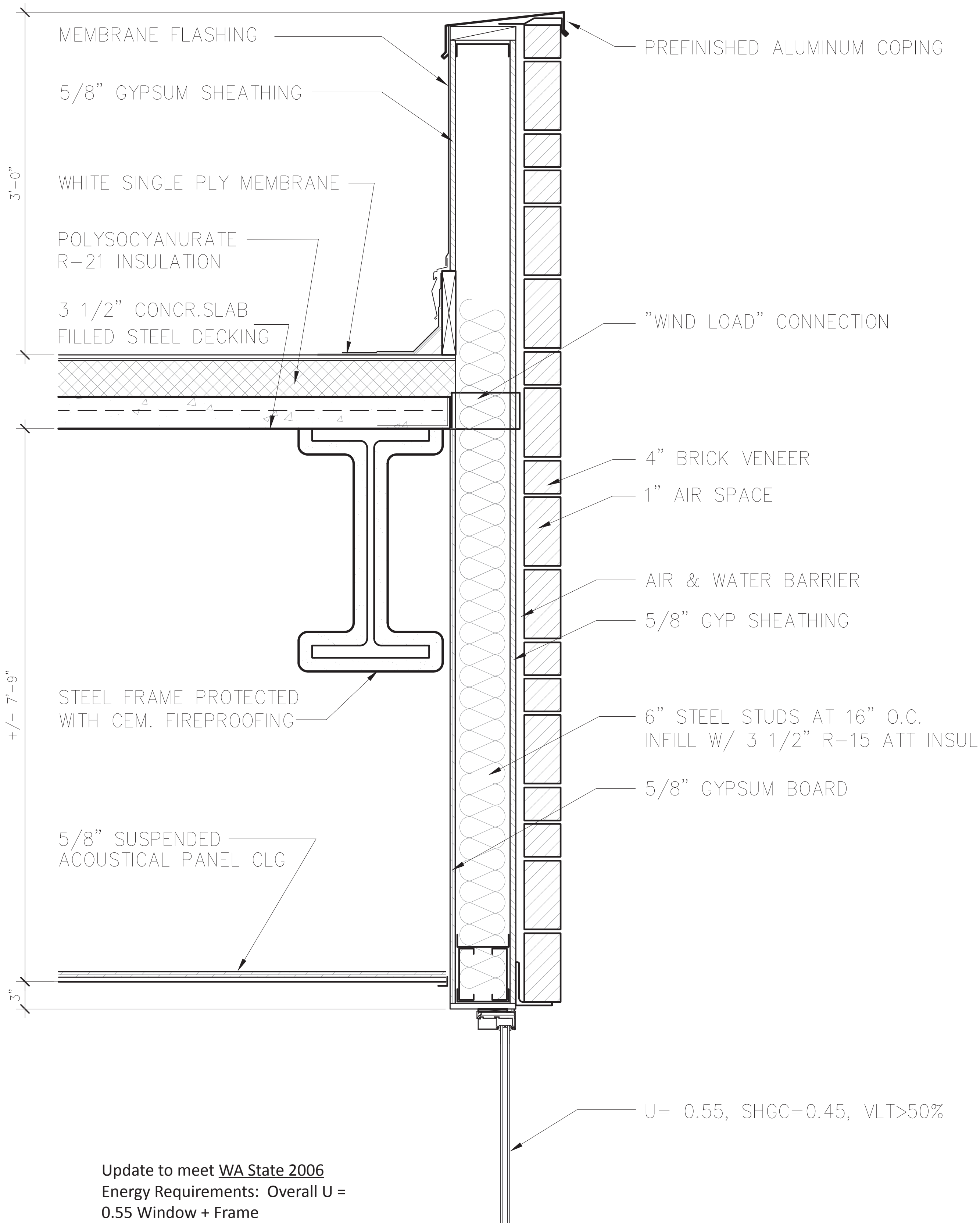
Wall Components	Baseline Option (R-19)	Target 100 Option (R-13+R-7.5)
4" Brick	0.80	0.80
1" Air Layer	0.89	0.89
2 1/2" R-7.5 Cont. Rigid Insul. (Target 100 only)	N/A	7.50
5/8" Gypsum Board	0.56	0.56
Air & water barrier	N/A	N/A
R-19 Batt ins. high density inside metal cavity (Baseline only)	19.00	N/A
R-13 Batt ins. high density inside metal cavity (Target 100 only)	N/A	13.00
5/8" Gypsum Board	0.56	0.56
Total Effective R-Value:		

Roof Components	Baseline (R-21)	Target 100 (R-30)
White single ply membrane	N/A	N/A
R-21 Polysocyanurate ins. (Baseline only)	21.00	N/A
R-30 Polysocyanurate ins. (Target 100 only)	N/A	30.00
3 1/2" Concrete slab	0.28	0.28
Total Effective R-Value:		

General Notes:
a. Baseline per 2006 Washington State Energy Code
b. Target 100 per 2009 Washington State Energy Code - Draft filed on August 19 2009

Detailed Building Section

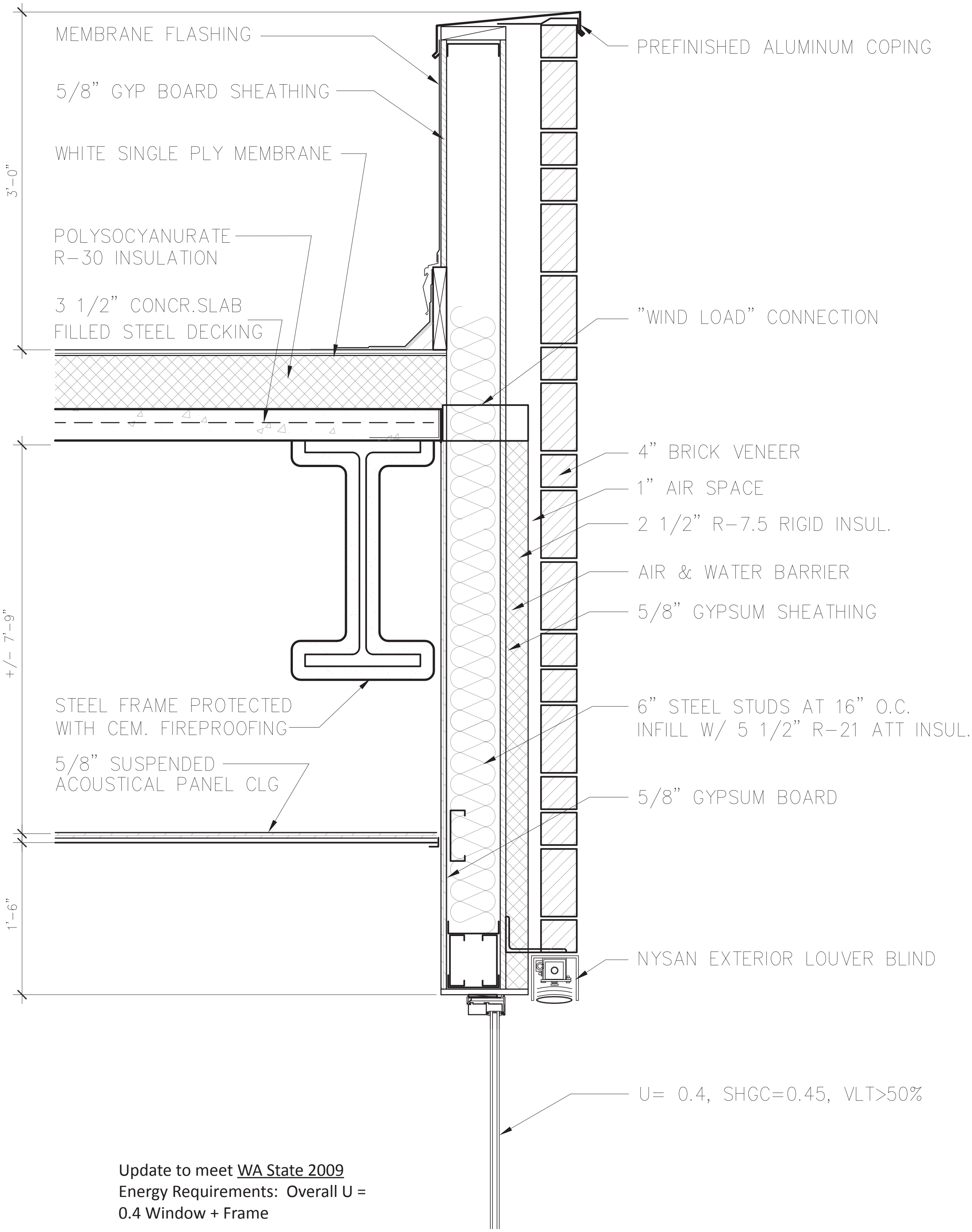
Baseline Energy Option A1



Update to meet WA State 2006
Energy Requirements: Overall U =
0.55 Window + Frame

Detailed Building Section

Target 100 Energy Option A2 & A3



Update to meet WA State 2009
Energy Requirements: Overall U =
0.4 Window + Frame

Program Summary

Schemes A and B

	Unit/Service	Beds	TOTAL SF TO ESTIMATE
Inpatient Nursing Services			
	Critical Care Unit (ICU/CCU)*	32	22,828
	Acute Care Med/Surg Unit - Ortho/Neuro*	24	13,824
	Acute Care Med/Surg Unit - Oncology*	24	9,004
	Acute Care Med/Surg Unit - Cardiac*	24	13,824
	Acute Care Med/Surg Unit - General Medicine*	24	9,004
	Acute Care Med/Surg Unit - General Surgery*	24	13,824
	Acute Care Med/Surg Unit	24	35,068
	Labor & Delivery*	12	13,824
	Acute Care Post Partum Unit*	16	8,767
	Newborn Nursery	12	9,004
	NICU Level II*	21	9,004
	Total beds:	**225**	
Ancillary Services			
	Clinical Laboratory		12,000
	Emergency Department	36	20,461
	Diagnostic Imaging		18,634
	Interventional Imaging		9,582
	Pathology		3,697
	Operating Rooms	10	31,025
	Procedure Rooms	4	4,000
	Recovery (PACU)	48	10,695
	Inpatient Pharmacy		4,800
	Respiratory Services		1,811
	Sterile Processing		6,400
Inpatient Support Services			
	EKG		480
	Hospital Based Physicians		841
	Rehabilitation Therapy		11,352
	Chapel/Meditation		513
	Provider Sleep Rooms		2,320
	Admitting		2,785
	Medical Records		800
Administrative Services			
	Hospital Conference Rooms		1,745
	Administration		2,320
	Lobby & Gift Shop		4,900
	Undefined Administration		2,386
Building General Services			
	Biomedical Engineering		1,600
	Cafeteria and Servery		5,955
	Nutritional Services & Dietary		11,319
	Linen Services		2,000
	Materials Management		6,600
	Loading Dock		400
	Environmental Services		2,100
	Bed Repair and Storage		400
	Staff Amenities		1,844
	Communications		670
Medical Office Building			44,872
Atrium			4,900
Indirect Support			
	Building Main Telecom		3,250
	Storage		6,400
	Building Circulation and Public Waiting Areas		88,150
	Mechanical		32,920
	TOTAL BUILDING GROSS SQUARE FEET		**524,902**

Program Analysis

Schemes A and B

Floor	Unit/Service	Beds	Scheme A	Perforated Plan	Scheme B (v. 4.0)	SF Difference Btwn A & B	% Difference Btwn A & B
-1	Bed Repair and Storage		400	Bed Repair and Storage	390	(10)	-3%
-1	Biomedical Engineering		1,600	Biomedical Engineering	1,470	(130)	-8%
-1	Bldg Main Telecom		3,250	Bldg Main Telecom	3,287	37	1%
-1	Clinical Laboratory		12,000	Clinical Laboratory	12,000	0	0%
-1	Communications		670	Communications	600	(70)	-10%
-1	Environmental Services		2,100	Environmental Services	2,200	100	5%
-1	Linen Services		2,000	Linen Services	1,920	(80)	-4%
-1	Loading Dock		400	Loading Dock	590	190	48%
-1	Materials Management		6,600	Materials Management	6,600	0	0%
-1	Mechanical Space (Ave per floor)		3,754	Mechanical Space (Ave per floor)	4,400	*	*
-1	Medical Records		800	Medical Records	1,000	200	25%
-1	Nutritional Services & Dietary		11,319	Nutritional Services & Dietary	11,320	1	0%
-1	Sterile Processing		6,400	Sterile Processing	6,120	(280)	-4%
-1	Storage		6,400	Storage	6,380	(20)	0%
-1	Undefined Administration		2,386	Undefined Administration	2,400	14	1%
			60,079		60,677	598	1%
			13,327		12,757	-570	-4%
		254'x289'	73,406		73,434	28	0%
1	Admitting		2,785	Admitting	2,700	(85)	-3%
1	Administration		2,320	Administration	*	*	*
1	Cafeteria and Servery		5,955	Cafeteria and Servery	5,910	(45)	-1%
1	Chapel/Meditation		513	Chapel/Meditation	480	(33)	-6%
1	Diagnostic Imaging		18,634	Diagnostic Imaging	18,260	(374)	-2%
1	Emergency Department	36	20,461	Emergency Department	20,156	(305)	-1%
1	EKG		480	EKG	*	*	*
1	Hospital Conference Rooms		*	Hospital Conference Rooms	480	*	*
1	Inpatient Pharmacy		4,800	Inpatient Pharmacy	4,896	96	2%
1	Lobby & Gift Shop		4,900	Lobby & Gift Shop	5,000	100	2%
1	Mechanical Space		2,246	Mechanical Space	5,700	*	*
1	Provider Sleep Rooms		2,320	Provider Sleep Rooms	1,200	*	*
1	Rehabilitation Therapy		11,352	Rehabilitation Therapy	11,400	48	0%
1	Respiratory Services		1,811	Respiratory Services	*	*	*
1	Staff Amenities		*	Staff Amenities	1,800	*	*
1	Staff Lounges		*	Staff Lounges	1,800	*	*
1	Medical Office Building		11,218		22,410	*	*
			78,577		79,782	1,205	2%
			18,035		16,776	(1,259)	-7%
		249'x388'	107,830		120,168	12,338	11%
			96,612		96,558	(54)	0%
2	Atrium		4,900	Atrium above Lobby (subtracted from circulation)	5,250	350	7%
2	Administration		*	Administration	1,500	*	*
2	Critical Care Unit (ICU/CCU)		*	Critical Care Unit (ICU/CCU)	8,780	*	*
2	Family Lounge		*	Family Lounge	900	*	*
2	Hospital Based Physicians		841	Hospital Based Physicians	*	*	*
2	Hospital Conference Rooms		1,745	Hospital Conference Rooms	0	*	*
2	Interventional Imaging		9,582	Interventional Imaging	9,637	55	1%
2	Mechanical Space		13,600	Mechanical Space	5,700	*	*
2	Operating Rooms	10	31,025	Operating Rooms	**30,622**	(403)	-1%
2	Pathology		3,697	Pathology	3,784	87	2%
2	Procedure Rooms	4	4,000	Procedure Rooms	4,000	0	0%
2	Recovery (PACU)	48	10,695	Recovery (PACU)	10,600	(95)	-1%
2	Staff Amenities		1,844	Staff Amenities	0	*	*
2	Staff Lounges		*	Staff Lounges	1,800	*	*
	Medical Office Building		11,218	Medical Office Building	22,410	*	*
			81,929		82,573	644	1%
			14,683		11,716	(2,967)	-20%
		249'x388'	107,830		117,900	10,070	9%
			96,612		94,289	(2,323)	-2%

Program Analysis, cont.

Schemes A and B

Floor	Unit/Service	Beds	Scheme A	Perforated Plan	Scheme B (v. 4.0)	SF Difference Btwn A & B	% Difference Btwn A & B
3	Mechanical		2,664		5,700		
3	Patient Rooms	CCU	13,824	Departmentally Grouped	24,210		
3	Critical Care Space	NICU	9,004		24,210		
3	Acute Care Space		8,767		24,210		
3	Medical Office Building		11,218				
			42,813		72,630		
			8,421		2,400		
		110'x388'	53,898		75,030	32,350	39%
			42,680				
4	Administration		*	Administration	500		
4	Hospital Based Physicians		*	Hospital Based Physicians	1,000		
4	Hospital Conferance Rooms		*	Hospital Conferance Rooms	583		
4	Provider Sleep Rooms		*	Provider Sleep Rooms	600		
4	Mechanical		2,664	Mechanical	5,700	*	*
4	Patient Rooms	Labor and Delivery	13,824	Departmentally Grouped	22,308		
4	Critical Care Space	Nursery	9,004		22,308		
4	Acute Care Space	Acute Care PPU	8,767		22,308		
4	Medical Office Building		11,218				
			42,813		66,924		
			8,421		2,165		
		110'x388'	53,898		69,089	26,409	28%
			42,680				
5	Administration		*	Administration	500		
5	EKG		*	EKG	480		
5	Hospital Conference Rooms		*	Hospital Conference Rooms	583		
5	Provider Sleep Rooms		*	Provider Sleep Rooms	600		
5	Respiratory Services		*	Respiratory Services	1,950		
5	Mechanical		2,664	Mechanical	5,700	*	*
5	Patient Rooms	Ortho	13,824	Departmentally Grouped	22,308		
5	Critical Care Space	Oncology	9,004		22,308		
5	Acute Care Space		8,767		22,308		
			31,595		66,924		
			8,421		2,165		
		110'x388'	42,680		69,089	26,409	62%
6	Mechanical		2,664				
6	Patient Rooms	Cardiac	13,824				
6	Critical Care Space	General Medicine	9,004				
6	Acute Care Space		8,767				
			31,595				
			8,421				
		110'x388'	42,680		0	-42,680	-100%
7	Mechanical		2,664				
7	Patient Rooms	General Surgery	13,824				
7	Critical Care Space	General Surgery	9,004				
7	Acute Care Space		8,767				
			31,595				
			8,421				
		110'x388'	42,680		0	-42,680	-100%
	Sub-Programatic Spaces		Scheme A		Scheme B	Scheme A to B	
	Mechanical Space		32,920	Mechanical Space	32,900	(20)	0%
	Administration		2,320	Administration	2,500	180	8%
	Hospital Conference Rooms		1,745	Hospital Conference Rooms	1,646	(99)	-6%
	Provider Sleep Rooms		2,320	Provider Sleep Rooms	2,400	80	3%

Program Analysis, cont.

Schemes A and B

Totals	Scheme A		Scheme B		SF	%
	44,872	Total MOB	44,820	Total MOB	(52)	0%
	73,406	Total Basement	73,434	Total Basement	28	0%
	32,920	Mechanical Space	32,900	Mechanical Space	(20)	0%
	220,585	Sum Diagnostic and Treatment Program Areas (no MOB)	223,032	Sum Diagnostic and Treatment Program Areas (no MOB)	2,447	1%
	266,630	Sum Diagnostic and Treatment Areas with department gross (no MOB)	266,682	Sum Diagnostic and Treatment Areas with department gross (no MOB)	52	0%
	160,506	Sum Diagnostic and Treatment Program Areas (no MOB)	162,355	Sum Diagnostic and Treatment Program Areas (no MOB)	1,849	1%
	193,224	Sum Diagnostic and Treatment Areas with department gross (no MOB)	193,248	Sum Diagnostic and Treatment Areas with department gross (no MOB)	24	0%
	157,975	Sum of Inpatient Depts. Program Areas ** This calculation DOES NOT include intradepartmental circulation!	206,478	Sum of Inpatient Depts. Program Areas ** This calculation DOES include intradepartmental circulation!	48,503	31%
	213,400	Sum of Inpatient Depts. with department gross (no MOB)	213,208	Sum of Inpatient Depts. with department gross	(192)	0%
	Total		Total			
	480,030	Sum all in-patient (No MOB)	479,890	Sum all in-patient (No MOB)	(140)	0%
	240,490	Sum all program areas	267,155	Sum all program areas	26,665	11%
	524,902	Sum footprint (architectural total SF) Increases from Phase I due to increase in size of MOB	**524,710**	Sum footprint (architectural total SF)	(192)	0%

Floor, Roof, Wall Areas

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

FLOORS, ROOFS, WALLS AREAS -- TYPICAL MODEL A

FLOORS											ARCHITECTURAL MODEL
					OPTION A1, A2, & A3						
	Width	Length	-1 Level	1 Level	2 Level	3 Level	4 Level	5 Level	6 Level	7 Level	Total
Basement	**289**	**254**	73406								
MOB	79	142		11,218	11,218	11,218	11,218	0	0	0	
D & T	388	249		96,612	96,612	0	0	0	0	0	
PT	388	110		0	0	42,680	42,680	42,680	42,680	42,680	
			73406	107,830	107,830	53,898	53,898	42,680	42,680	42,680	**524,902**

EXTERIOR PERIMETER	BASEMENT	MOB	D&T	TOWER	
Above Grade		1,610	2,386	4,980	
Below Grade (Excavated)	**1,086**				
TOTAL					**10,062**

FOOTPRINT		
MOB	11,218	
Hospital	96,612	
TOTAL		**107,830**

ROOFS	OPTION A1, A2, & A3		
	Width	Length	Total
MOB	79	142	11,218
D & T - PT	388	249	53,932
PT	388	110	42,680
			107,830

WALLS				A1						A2 & A3		
WALLS		Width	Height	Without Parapet	Parapet Only	Total w/ Parapet	Heather wind/ wall ratio	Mike Hatten E/Quest		Height	Without Parapet	Total w/ Parapet
MOB	N	79	27	2133	237	2370				27	2133	2370
	E	142	63	8946	426	9372				63	8946	9372
	S	79	63	4977	237	5214				63	4977	5214
	W	142	63	8946	426	9372				63	8946	9372
				25002							25002	
D & T	N	388	36	13968	1164	15132				36	13968	15132
	E	249	36	8964	747	9711				36	8964	9711
	S	309	36	11124	927	12051				36	11124	12051
	W	249	36	8964	747	9711				36	8964	9711
				43020							43020	
PT	N	388	75	29100	1164	30264				70	27160	28324
	E	110	75	8250	330	8580				70	7700	8030
	S	388	75	29100	1164	30264				70	27160	28324
	W	110	75	8250	330	8580				70	7700	8030
				74700							69720	
Total	N			45201	2565	47766	49710	49920			43261	45826
Total	E			26160	1503	27663	26556	25980			25610	27113
Total	S			45201	2328	47529	49710	49500			43261	45589
Total	W			26160	1503	27663	26556	25980			25610	27113
				142722		**150621**	152532	151380			**137742**	**145641**

Window Areas

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

WINDOWS

Option A1

Total Area Windows:

Type	Area		Percentage	W/W ratio
Total Area	43046		100	30

Area for louver shades (NONE):

Type	Area		Percentage
Total Area	0		0

Option A2 & A3

Total Area Windows:

Type	Area		Percentage	W/W ratio
Total Area	43046		100	31

Area for louver shades:

Type	Area		Percentage
Total Area	29034		67

Total Area windows by Type Option A1, A2, & A3:

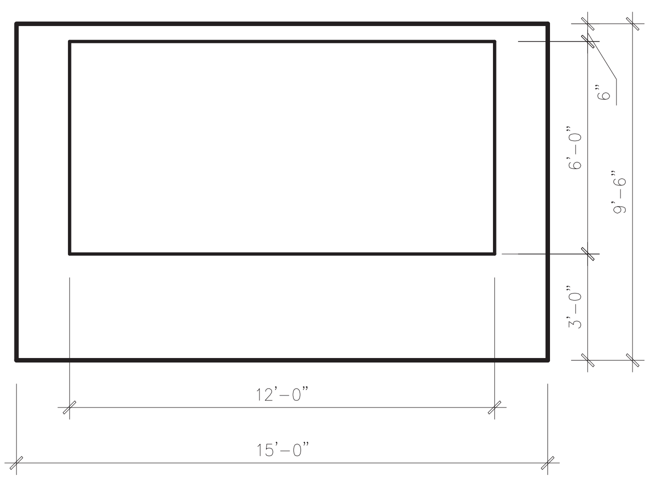
Type	Height	Width	Number	Area	Percentage	
A	6	65	6	2340	5	strip
B	6	115	8	5520	13	strip
C	6	12	310	22320	52	punch
D	5	14	107	7490	17	strip
E	8	8	84	5376	12	store front
Total Area			515	43046	100	

Area for louver shades (S, W, E Facades ONLY) for Options 2 & 3 ONLY:

Type			Number	Area	Percentage	
A	6	65	4	1560	4	strip
B	6	115	8	5520	13	strip
C	6	12	190	13680	32	punch
D	5	14	67	4690	11	strip
E	8	8	56	3584	8	store front
Total Area			325	29034	67	

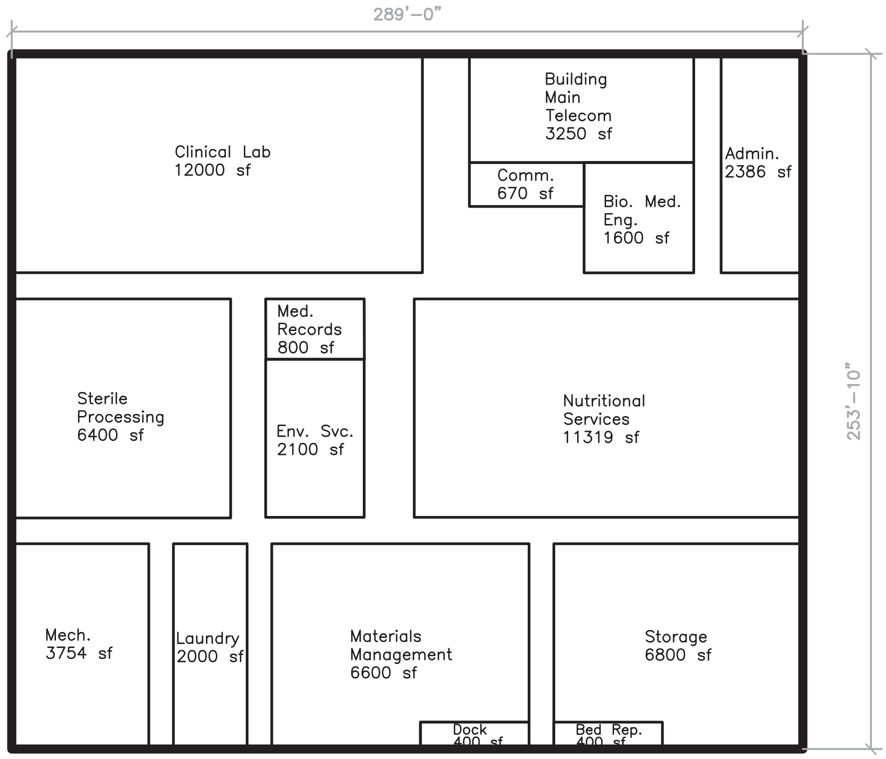
Example Patient Room Window

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



Schematic Plan Layout Basement as described in energy model

Baseline Energy Option A1; Target 100 Energy Option A2 & A3:
Not to Scale

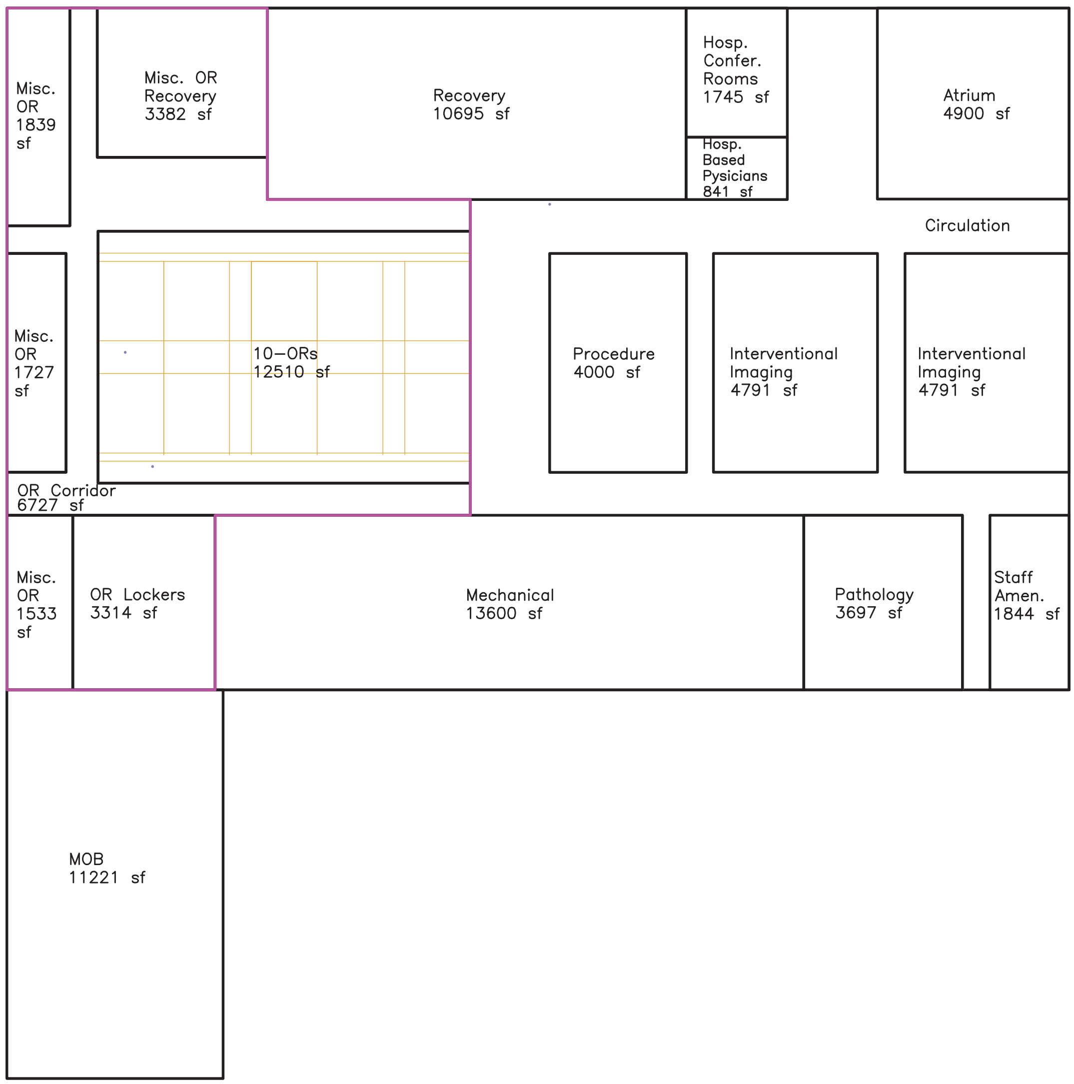


Schematic Plan Layout Floor 1 (Diagnostic and Treatment) as described in energy model

Baseline Energy Option A1; Target 100 Energy Option A2 & A3:
Not to Scale

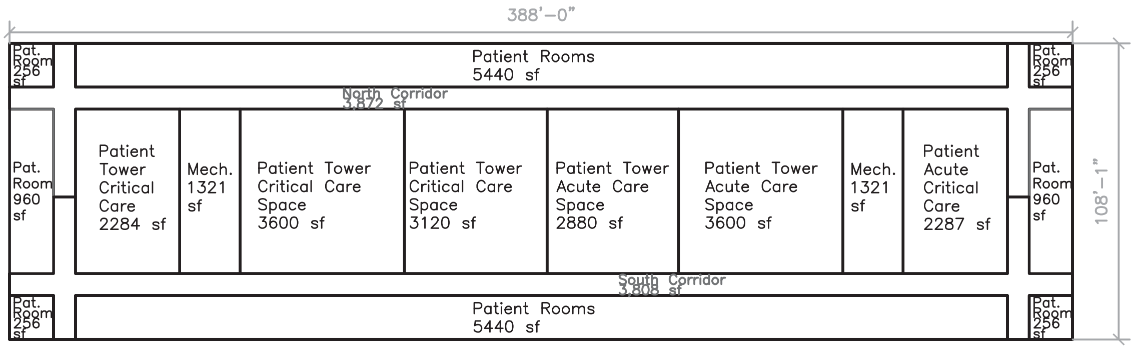
Schematic Plan Layout Floor 2 (Diagnostic and Treatment)

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



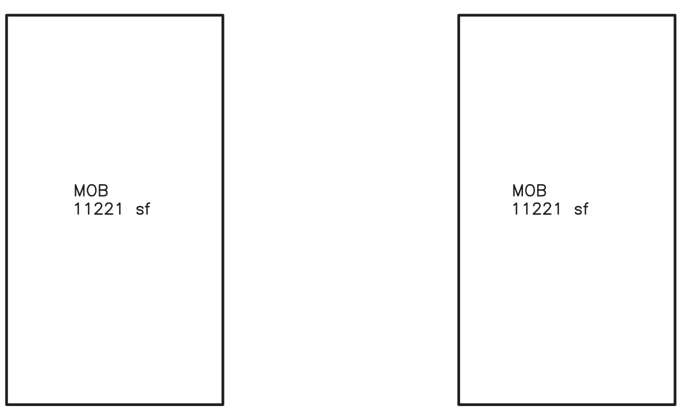
Schematic Plan Layout Floors 3-7 (Patient Tower)

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



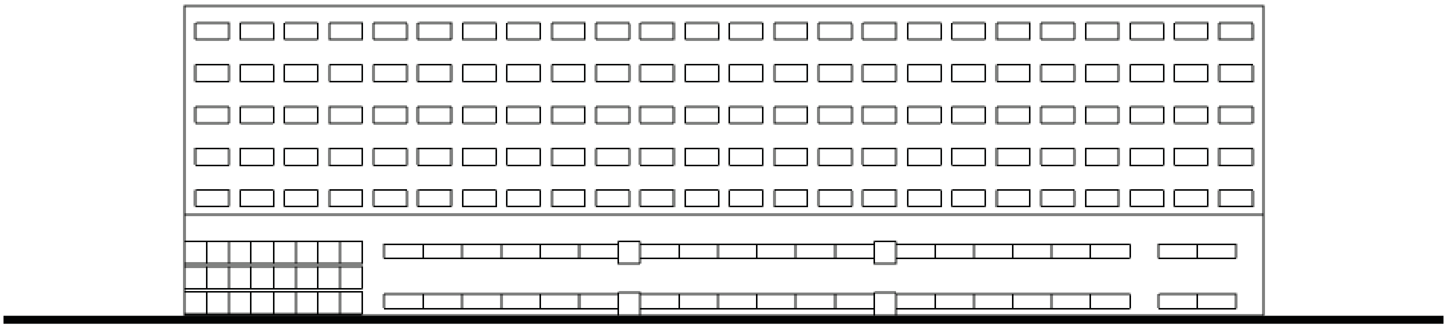
Schematic Plan Layout Floors 3-4 (MOB)

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale

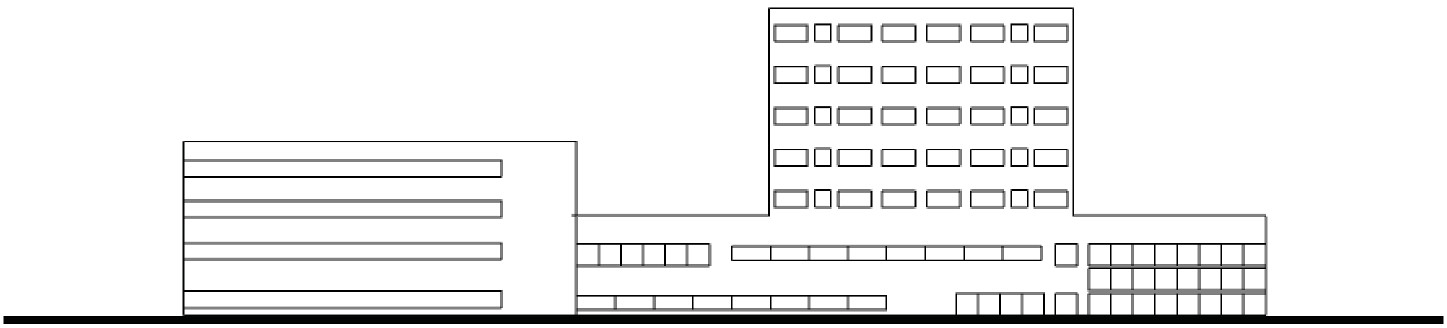


Example Window Distribution, Updated Version

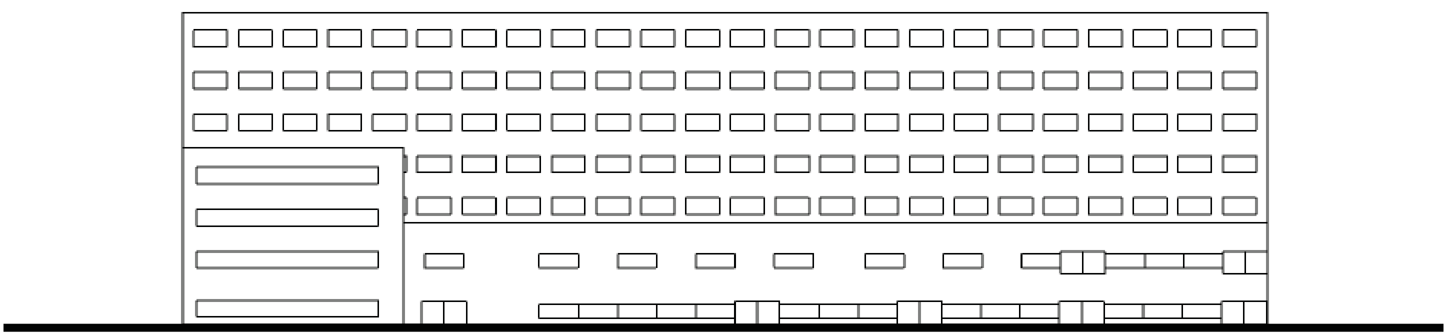
Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



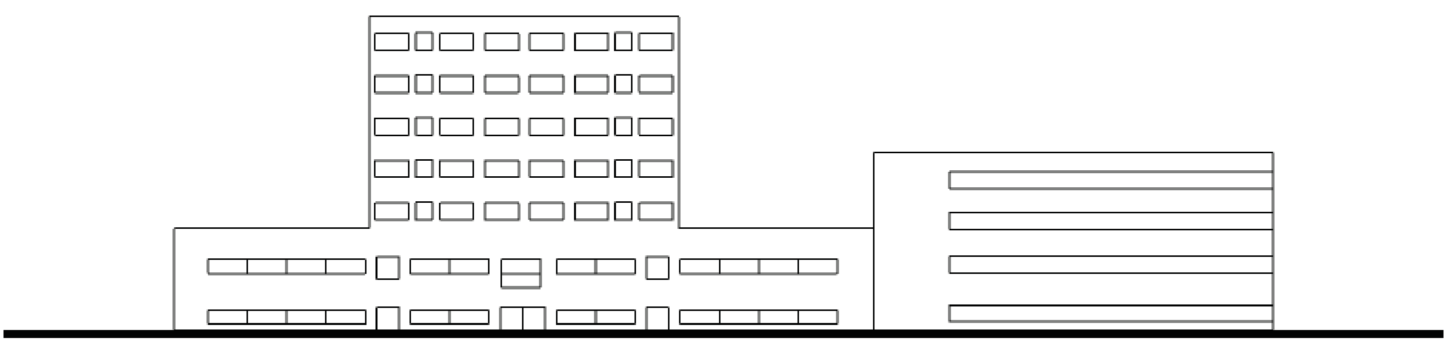
North Elevation



East Elevation



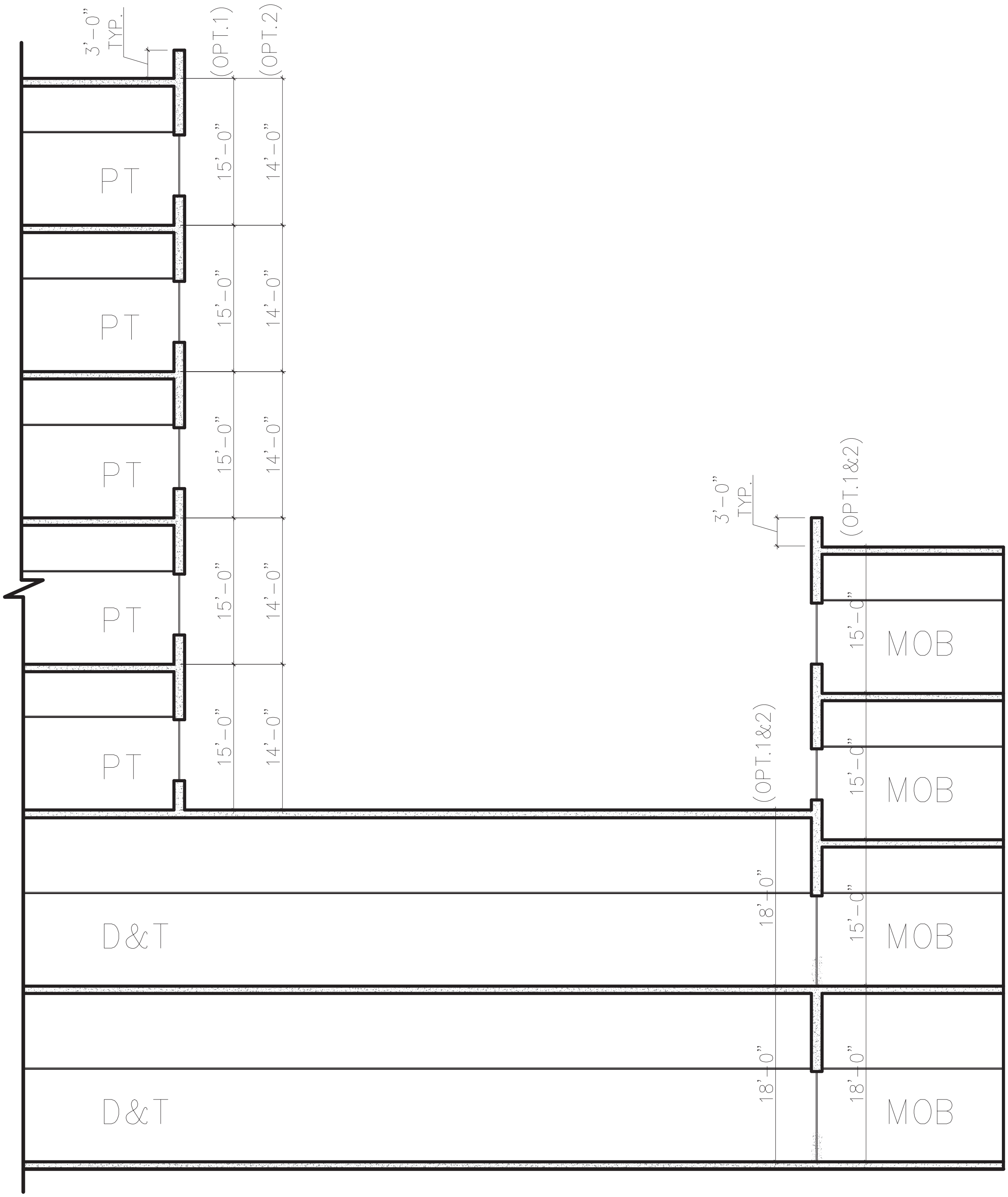
South Elevation



West Elevation

Building Section

Baseline Energy Option A1; Target 100 Energy Option A2 & A3
Not to Scale



Electric Lighting Summary

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

The electric lighting sees a 10% reduction from the baseline energy to the "target 100" energy. A space-by-space evaluation of lighting power density can be seen below. An additional 5% reduction is seen through occupancy sensor control systems in appropriate spaces. Spaces highlighted in blue below have been identified as not having occupancy sensors.

	Option 1	Option 2	
Space Name	Baseline W/sf connected load	Interior LPD 10% Reduction	Occ Sensor LPD Adjustment (5% reduction)
Critical LPD	1.2	1.08	1.08
Acute LPD	1.8	1.62	1.62
Labor LPD	1.5	1.35	1.35
Lab LPD	1.4	1.26	1.20
Emergency LPD	1.8	1.62	1.62
Imaging LPD	1.5	1.35	1.28
OR LPD	1.8	1.62	1.62
Procedure LPD	1.5	1.35	1.35
Recovery LPD	1	0.9	0.86
Pharmacy LPD	1.2	1.08	1.03
Sterile LPD	1.2	1.08	1.03
EKG LPD	1.5	1.35	1.28
PT LPD	0.9	0.81	0.77
Chapel LPD	1.3	1.17	1.11
Sleep LPD	1	0.9	0.86
Admitting LPD	1.2	1.08	1.03
Conference LPD	1.2	1.08	1.03
Office LPD	1	0.9	0.86
Lobby LPD	1.2	1.08	1.03
Cafeteria LPD	1.2	1.08	1.03
Kitchen LPD	1.5	1.35	1.28
Laundry LPD	1.5	1.35	1.28
Storage LPD	0.8	0.72	0.68
Dock LPD	0.8	0.72	0.68
Amenities LPD	0.8	0.72	0.68
Server LPD	0.8	0.72	0.68
IT LPD	1	0.9	0.86
Circulation LPD	0.7	0.63	0.63
Mechanical LPD	1.5	1.35	1.28
MOB LPD	1.5	1.35	1.28

Windows & Glazing

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

Target 100 Glazing Specs

WA Energy Code for vertical glazing, Zone 1, less than 30%, metal framing, no PF
2006: Max U = 0.55, Max SHGC = 0.45
2009: Max U = 0.40, Max SHGC = 0.40

Glass	VLT	U	SHGC
PPG Solarban 60 clear low-e	70	0.29	0.38
PPG Solarban 80 clear low-e	47	0.29	0.24
Viracon Solarscreen VE-1-2M	70	0.29	0.37
Viracon Solarscreen VE-2-85	65	0.31	0.38
Typical double-pane clear	79	0.47	0.70* (not code compliant)

Framing	% Glass	Glass U	Assembly U
Kawneer Trifab VG 451T	86	0.29	0.40
Kawneer Trifab VG 451T	86	0.31	0.42
Kawneer System 2250	85	0.29	0.42
Kawneer System 2250	85	0.31	0.43
EFCO System 433	86	0.30	0.43
EFCO System 960	88	0.30	0.41

We decided as a team to establish two glass and frame combinations; one for baseline and one for the Target 100 schemes. These specific products allowed a basis for costing purposes, but are only one path to the goal as discussed below.

Discussion of glass assumptions:
Either the PPG Solarban 60 glass or the Viracon Solarscreen VE-1-2M glass could be used as the basis for both the base case and the Target 100 case. We can't step down to regular (non-low-e) glass for the base case because it doesn't meet the SHGC criteria, and it is not known if there is any clear glass cheaper than the PPG product that would meet current code.

For comparison, all of the framing systems were normalized to a 4 X 6-foot shape with no intermediate mullions, per the NFRC test procedure. It looks as though the Kawneer Trifab VG 451T with Solarban 60 just barely meets the 0.40 U-value standard for the Target 100 case, while the others are all a little above it. We hoped to find a framing system that was closer to the 0.55 U-value, but it seems as though the systems jump up to the 0.60 U-value range when they are not thermally broken.

This is a somewhat simplified approach, and using the same framing system for storefront glazing, ribbon windows and punched windows is going to be the most sensible way to go.

Decision on glass types:
For Options A1 and B1, we could use Kawneer System 2250 w/ Solarban 60 glass (U = 0.43)
For Options A2, A3, B2 and B3, we could use Kawneer Trifab 451 with Solarban 60 (U = 0.40)

Exterior Louver Blinds

Target 100 Energy Option A2 & A3

Windows shall have exterior automated, 4" retractable louver blinds that are controlled with an intelligent solar tracking system (see next page). These louvers will be on the East, West, and and South facades only, and not on the North facade. For the energy model, typically a SHGC of 0.09 is used for the windows with dynamic shading devices.

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Daylight Enhancing - System Description

External specialty venetian blinds are the most effective shading device in as much as:

- They can be retracted when not required
- They can be lowered when sun comes onto the building elevation
- The slats can be tilted between open and closed to cope with varying sun angles
- The slats can be perforated to provide some outward vision, even when in the closed position, and
- They provide effective control of both daylight/glare and solar gain.

An external specialty venetian blind is similar to the ½" and 1" blinds that are commonly installed internally, with a number of key exceptions: a) The slats are larger – generally being between 2" (50mm) and 4" (100mm) b) The blinds are generally motorized for ease of raising / lowering and tilting c) The main components (headrail, bottom rail and tilt mechanism) are more robust to cope with external weather conditions, and d) The slats are held on side guide wires or extrusions so that the blinds are not too significantly affected by wind. That said, external venetian blinds are often used with a control system which will automatically raise the blinds if the wind speed exceeds a pre-set level.

The standard method of operation is motorized, although a manual (gearbox and crank handle) version is also available for blinds that are installed internally. A number of standard venetian blind motors, manufactured by Elero are used. Key technical details relating to these are as follows:

Speed:	**35 rpm**
Power:	**110 – 120 watts**
Current draw:	**1.15 – 1.35 amps**
Voltage:	**110 volts**
Torque:	**6, 12 Nm**
Max. lift capacity:	**160 lbs.**
Max. no. of turns	**85**

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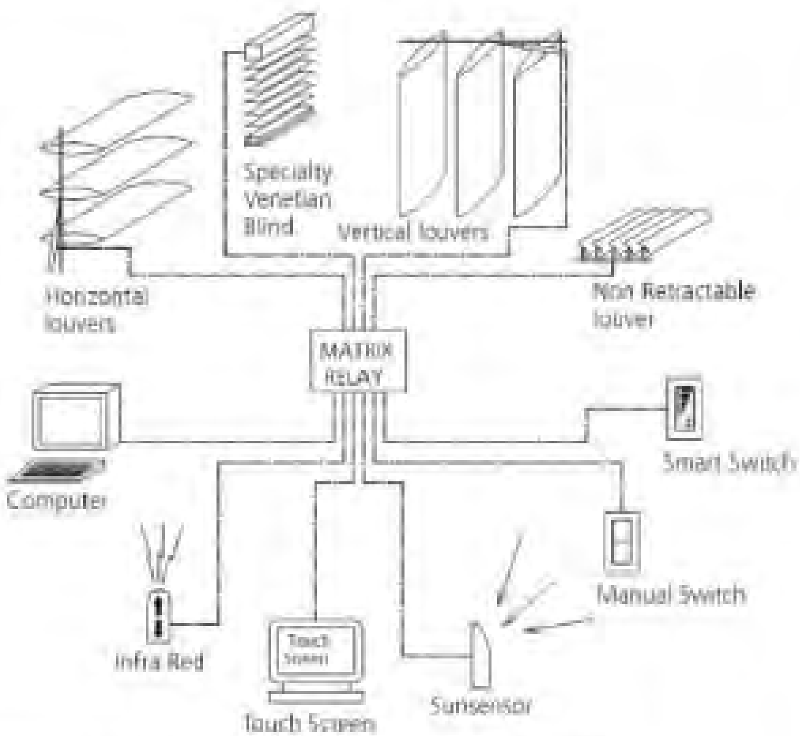
Nysan Intelligent Controls - Control Diagram

MATRIX RELAY DIAGRAM

Motorized operable systems can be controlled by switch (either singly or in groups) or can be connected to an automatic control system. Depending upon the specific project requirements, a wide range of different control features might be required. These can be provided through the intelligent Matrix relay.

The Matrix relay can operate any type of blind system and can be programmed to provide a wide range of control options, as shown in the diagram below:



Specific control functions that are available through the Matrix relay include:

- Group operation by switch
- Flexibility of control groups – future changes in office layouts do not require re-wiring
- Automatic control by reference to actual daylight conditions
- Automatic control by reference to predicted sun position
- Time clock override
- Remote access via RS232 or 485 ports
- Communication by bus line technology
- PC interface
- Offsite re-configuration
- Infrared remote control
- Interface with proprietary touch screen control systems
- Pre-programmable multiple stop positions/louver angles
- Intelligent switch interface

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Architectural Elements

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

Overall interior & exterior specifications were based on the recently completed Phoenix Banner Gateway hospital as a representative example of contemporary hosptial design, unless otherwise specified.

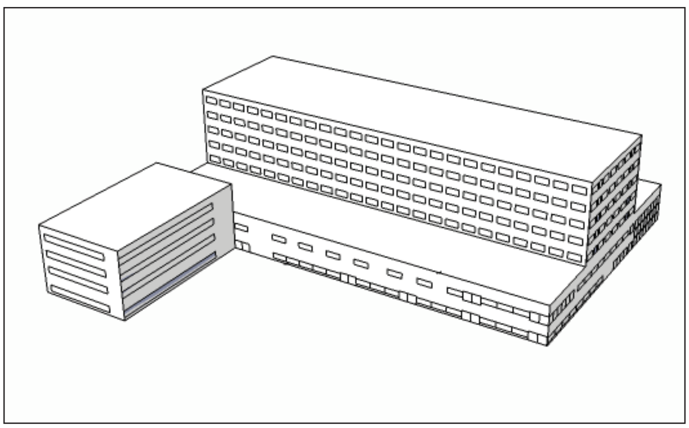
Mechanical Systems

Baseline Energy Option A1; Target 100 Energy Option A2 & A3

Please see Appendix 2.0

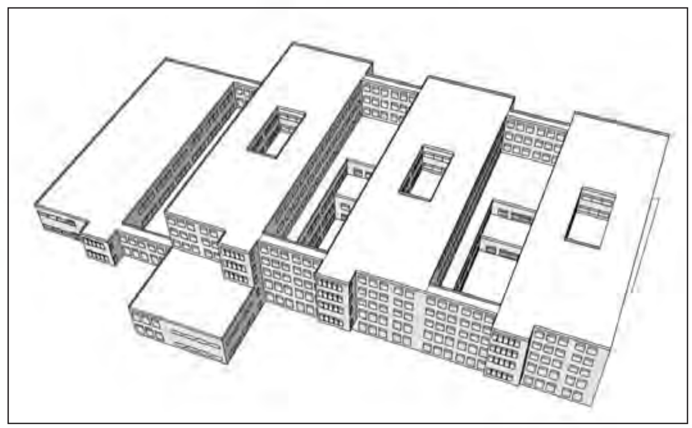
Architectural Description for Scheme B: Perforated Geometry

Scheme A



Option A1	Option A2	Option A3
Code Baseline	Target 100 Ground Source Heat Pump	Target 100 Heat Recovery Plant

Scheme B

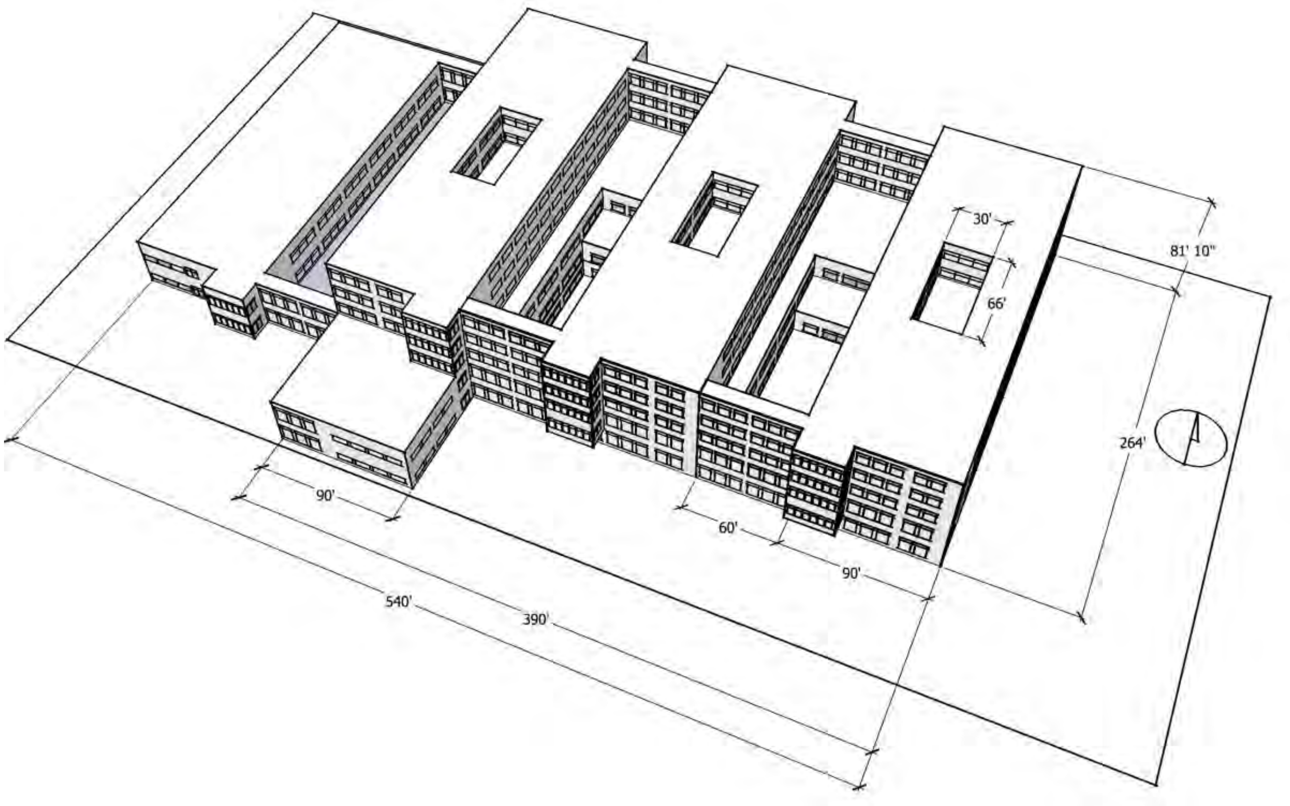


Option B1	Option B2	Option B3
Code Baseline	Target 100 Ground Source Heat Pump	Target 100 Heat Recovery Plant

Perforated Schemes B1, B2 & B3

Overall Building Massing

Baseline Energy Option B1; Target 100 Energy Option B2 & B3
Not to Scale



Overall Window to Wall Ratios From Energy Model

Baseline Energy Option B1

The LV-D report shows a summary of external surfaces as included in energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces.

```
High Performance Hospital – Scheme B1   Baseline - Perforated                  DOE-2.2-47b    4/12/2010    18:54:49  BDL RUN  1

REPORT- LV-D Details of Exterior Surfaces                                                WEATHER FILE- Seattle      WA TMY2
------------------------------------------------------------------------------------------------------(CONTINUED)--------
```

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.521	0.058	0.187	14787.43	38252.56	53040.00
EAST	0.512	0.058	0.185	21493.88	55533.62	77027.50
SOUTH	0.523	0.058	0.229	19508.50	33543.50	53052.00
WEST	0.511	0.058	0.188	22241.91	55164.59	77406.50
FLOOR	0.000	0.056	0.056	0.00	1350.00	1350.00
ROOF	0.000	0.032	0.032	0.00	124966.75	124966.75
ALL WALLS	0.516	0.058	0.195	78031.78	182494.25	260526.00
WALLS+ROOFS	0.516	0.047	0.142	78031.78	307461.03	385492.78
UNDERGRND	0.000	0.097	0.097	0.00	140866.00	140866.00
BUILDING	0.516	0.063	0.130	78031.78	449677.03	527708.75

Overall Window to Wall Ratios From Energy Model

Target 100 Energy Option B2 & B3

The LV-D report shows a summary of external surfaces as included in energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces.

```
High Performance Hospital – Scheme B2   Target 100 - Perforated              DOE-2.2-47b    4/14/2010     9:57:51  BDL RUN  1

REPORT- LV-D Details of Exterior Surfaces                                               WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------(CONTINUED)--------
```

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.361	0.044	0.134	14787.43	37052.57	51840.00
EAST	0.348	0.044	0.131	21493.88	53543.62	75037.50
SOUTH	0.364	0.044	0.164	19508.50	32303.50	51812.00
WEST	0.347	0.044	0.133	22241.91	53174.19	75416.10
FLOOR	0.000	0.056	0.056	0.00	1350.00	1350.00
ROOF	0.000	0.032	0.032	0.00	124966.75	124966.75
ALL WALLS	0.354	0.044	0.139	78031.78	176073.86	254105.59
WALLS+ROOFS	0.354	0.039	0.104	78031.78	301040.63	379072.38
UNDERGRND	0.000	0.097	0.097	0.00	140866.00	140866.00
BUILDING	0.354	0.057	0.102	78031.78	443256.63	521288.38

Insulation Values Per Washington State Energy Code

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

Energy Codes Comparison [a,b]:

	Code	Opaque Wall	% Glazing Area	Max. SHGC4	Vertical glazing	Overhead Glazing	Opaque Doors	Roofs	Floor Uncond.	Slab on Grade
Baseline	Washington State 2006 [c]	R-19 or U=0.062	30% or system analysis	0.45	U-0.55	U-0.7	U-0.6	R-21 or U=0.046	R-19	R-10
Target 100	Washington State 2009 [e]	R-13 + R-7.5 continuous insulation	40% max.	0.40 all	U-0.4	U-0.5 (sloped glazing) U-0.6 (individual unit)	U-0.6	R-30 continuous insulation or U=0.034	R-38 + R-4 continuous insulation	R-10 continuous insulation (with thermal break)

Notes:

a. Requirements ***only*** for metal framing, using heat pumps and VAV.
b.% Glazing are if using prescriptive path.
c. Per 2006 Washington State Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1
d. Per 2006 Seattle Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1
e. Per Draft of 2009 Washington State Energy Code Table 13-1 Building Envelope Requirements For Climate Zone 1

Wall and Roof Assembly Per Washington State Energy Code

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

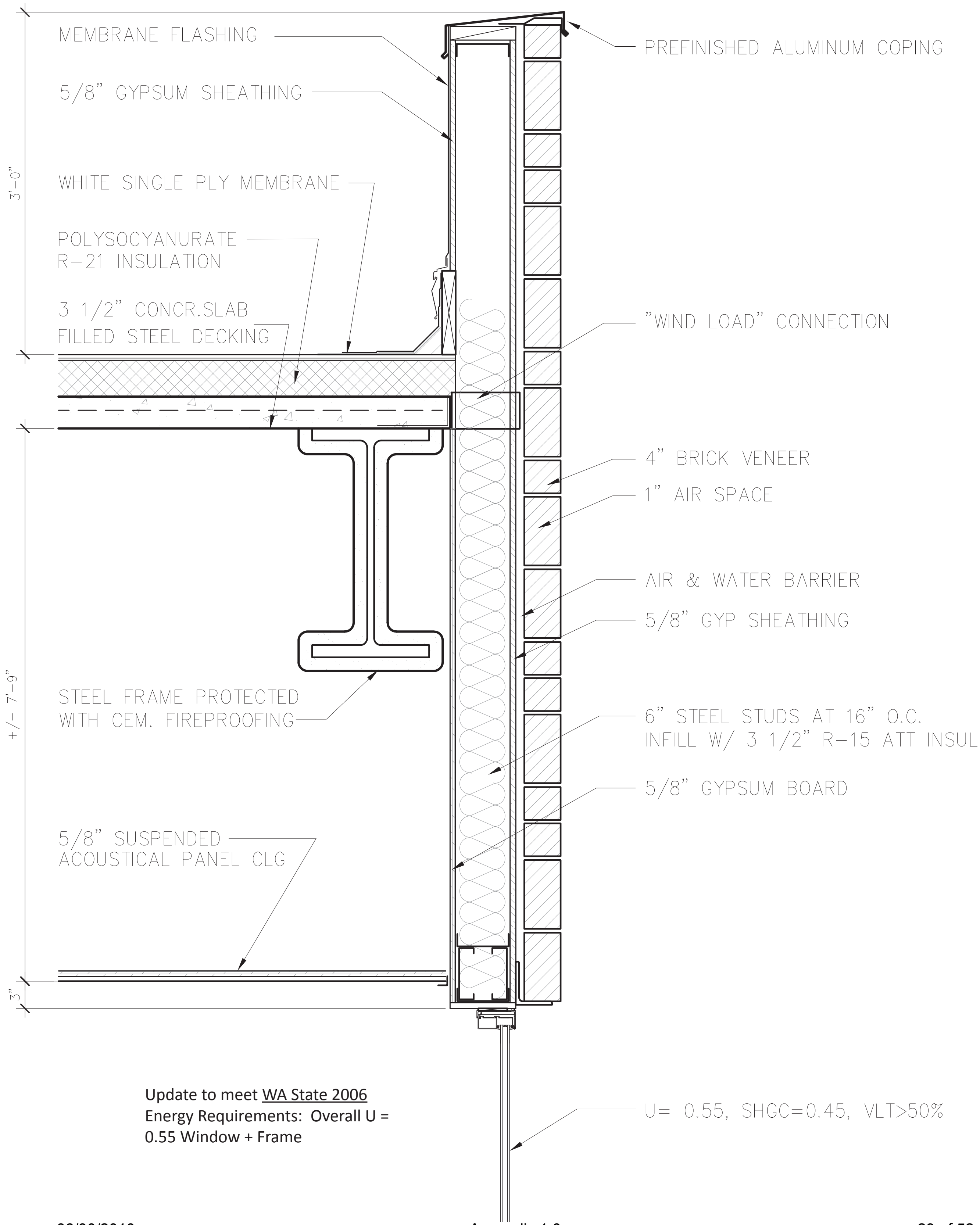
Wall Components	Baseline Option (R-19)	Target 100 Option (R-13+R-7.5)
4" Brick	0.80	0.80
1" Air Layer	0.89	0.89
2 1/2" R-7.5 Cont. Rigid Insul. (Target 100 only)	N/A	7.50
5/8" Gypsum Board	0.56	0.56
Air & water barrier	N/A	N/A
R-19 Batt ins. high density inside metal cavity (Baseline only)	19.00	N/A
R-13 Batt ins. high density inside metal cavity (Target 100 only)	N/A	13.00
5/8" Gypsum Board	0.56	0.56
Total Effective R-Value:		

Roof Components	Baseline (R-21)	Target 100 (R-30)
White single ply membrane	N/A	N/A
R-21 Polysocyanurate ins. (Baseline only)	21.00	N/A
R-30 Polysocyanurate ins. (Target 100 only)	N/A	30.00
3 1/2" Concrete slab	0.28	0.28
Total Effective R-Value:		

General Notes:
a. Baseline per 2006 Washington State Energy Code
b. Target 100 per 2009 Washington State Energy Code - Draft filed on August 19 2009

Detailed Building Section

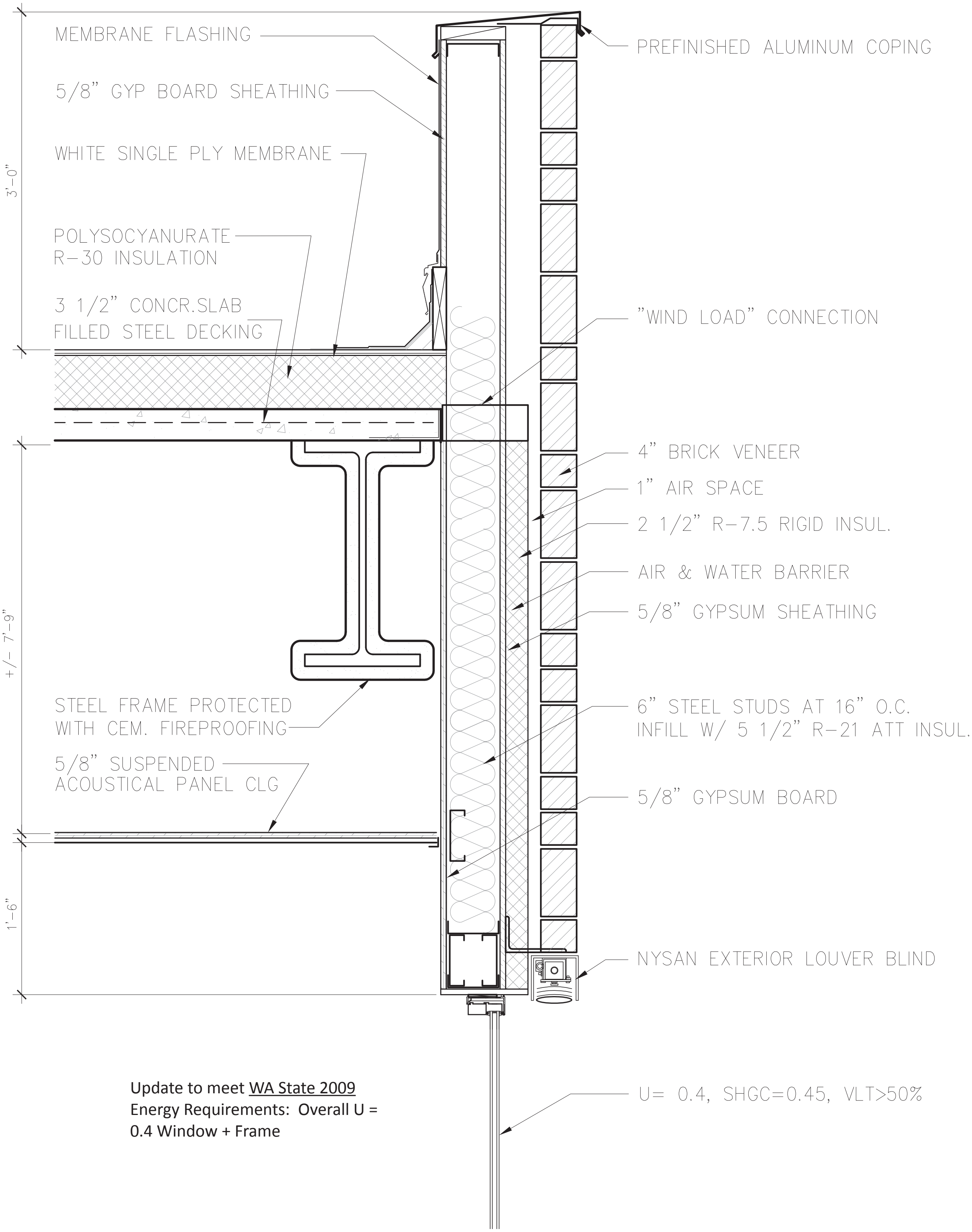
Baseline Energy Option B1



Update to meet WA State 2006 Energy Requirements: Overall U = 0.55 Window + Frame

Detailed Building Section

Target 100 Energy Option B2 & B3



Update to meet <u>WA State 2009</u>
Energy Requirements: Overall U =
0.4 Window + Frame

Program Summary

Schemes A and B

	Unit/Service	Beds	TOTAL SF TO ESTIMATE
Inpatient Nursing Services			
	Critical Care Unit (ICU/CCU)*	32	22,828
	Acute Care Med/Surg Unit - Ortho/Neuro*	24	13,824
	Acute Care Med/Surg Unit - Oncology*	24	9,004
	Acute Care Med/Surg Unit - Cardiac*	24	13,824
	Acute Care Med/Surg Unit - General Medicine*	24	9,004
	Acute Care Med/Surg Unit - General Surgery*	24	13,824
	Acute Care Med/Surg Unit	24	35,068
	Labor & Delivery*	12	13,824
	Acute Care Post Partum Unit*	16	8,767
	Newborn Nursery	12	9,004
	NICU Level II*	21	9,004
	Total beds:	**225**	
Ancillary Services			
	Clinical Laboratory		12,000
	Emergency Department	36	20,461
	Diagnostic Imaging		18,634
	Interventional Imaging		9,582
	Pathology		3,697
	Operating Rooms	10	31,025
	Procedure Rooms	4	4,000
	Recovery (PACU)	48	10,695
	Inpatient Pharmacy		4,800
	Respiratory Services		1,811
	Sterile Processing		6,400
Inpatient Support Services			
	EKG		480
	Hospital Based Physicians		841
	Rehabilitation Therapy		11,352
	Chapel/Meditation		513
	Provider Sleep Rooms		2,320
	Admitting		2,785
	Medical Records		800
Administrative Services			
	Hospital Conference Rooms		1,745
	Administration		2,320
	Lobby & Gift Shop		4,900
	Undefined Administration		2,386
Building General Services			
	Biomedical Engineering		1,600
	Cafeteria and Servery		5,955
	Nutritional Services & Dietary		11,319
	Linen Services		2,000
	Materials Management		6,600
	Loading Dock		400
	Environmental Services		2,100
	Bed Repair and Storage		400
	Staff Amenities		1,844
	Communications		670
Medical Office Building			44,872
Atrium			4,900
Indirect Support			
	Building Main Telecom		3,250
	Storage		6,400
	Building Circulation and Public Waiting Areas		88,150
	Mechanical		32,920
	TOTAL BUILDING GROSS SQUARE FEET		**524,902**

Program Analysis

Schemes A and B

Floor	Unit/Service	Beds	Scheme A	Perforated Plan	Scheme B (v. 4.0)	SF Difference Btwn A & B	% Difference Btwn A & B
-1	Bed Repair and Storage		400	Bed Repair and Storage	390	(10)	-3%
-1	Biomedical Engineering		1,600	Biomedical Engineering	1,470	(130)	-8%
-1	Bldg Main Telecom		3,250	Bldg Main Telecom	3,287	37	1%
-1	Clinical Laboratory		12,000	Clinical Laboratory	12,000	0	0%
-1	Communications		670	Communications	600	(70)	-10%
-1	Environmental Services		2,100	Environmental Services	2,200	100	5%
-1	Linen Services		2,000	Linen Services	1,920	(80)	-4%
-1	Loading Dock		400	Loading Dock	590	190	48%
-1	Materials Management		6,600	Materials Management	6,600	0	0%
-1	Mechanical Space (Ave per floor)		3,754	Mechanical Space (Ave per floor)	4,400	*	*
-1	Medical Records		800	Medical Records	1,000	200	25%
-1	Nutritional Services & Dietary		11,319	Nutritional Services & Dietary	11,320	1	0%
-1	Sterile Processing		6,400	Sterile Processing	6,120	(280)	-4%
-1	Storage		6,400	Storage	6,380	(20)	0%
-1	Undefined Administration		2,386	Undefined Administration	2,400	14	1%
			60,079		60,677	598	1%
			13,327		12,757	-570	-4%
		254'x289'	73,406		73,434	28	0%
1	Admitting		2,785	Admitting	2,700	(85)	-3%
1	Administration		2,320	Administration	*	*	*
1	Cafeteria and Servery		5,955	Cafeteria and Servery	5,910	(45)	-1%
1	Chapel/Meditation		513	Chapel/Meditation	480	(33)	-6%
1	Diagnostic Imaging		18,634	Diagnostic Imaging	18,260	(374)	-2%
1	Emergency Department	36	20,461	Emergency Department	20,156	(305)	-1%
1	EKG		480	EKG	*	*	*
1	Hospital Conference Rooms		*	Hospital Conference Rooms	480	*	*
1	Inpatient Pharmacy		4,800	Inpatient Pharmacy	4,896	96	2%
1	Lobby & Gift Shop		4,900	Lobby & Gift Shop	5,000	100	2%
1	Mechanical Space		2,246	Mechanical Space	5,700	*	*
1	Provider Sleep Rooms		2,320	Provider Sleep Rooms	1,200	*	*
1	Rehabilitation Therapy		11,352	Rehabilitation Therapy	11,400	48	0%
1	Respiratory Services		1,811	Respiratory Services	*	*	*
1	Staff Amenities		*	Staff Amenities	1,800	*	*
1	Staff Lounges		*	Staff Lounges	1,800	*	*
1	Medical Office Building		11,218		22,410	*	*
			78,577		79,782	1,205	2%
			18,035		16,776	(1,259)	-7%
		249'x388'	107,830		120,168	12,338	11%
			96,612		96,558	(54)	0%
2	Atrium		4,900	Atrium above Lobby (subtracted from circulation)	5,250	350	7%
2	Administration		*	Administration	1,500	*	*
2	Critical Care Unit (ICU/CCU)		*	Critical Care Unit (ICU/CCU)	8,780	*	*
2	Family Lounge		*	Family Lounge	900	*	*
2	Hospital Based Physicians		841	Hospital Based Physicians	*	*	*
2	Hospital Conference Rooms		1,745	Hospital Conference Rooms	0	*	*
2	Interventional Imaging		9,582	Interventional Imaging	9,637	55	1%
2	Mechanical Space		13,600	Mechanical Space	5,700	*	*
2	Operating Rooms	10	31,025	Operating Rooms	**30,622**	(403)	-1%
2	Pathology		3,697	Pathology	3,784	87	2%
2	Procedure Rooms	4	4,000	Procedure Rooms	4,000	0	0%
2	Recovery (PACU)	48	10,695	Recovery (PACU)	10,600	(95)	-1%
2	Staff Amenities		1,844	Staff Amenities	0	*	*
2	Staff Lounges		*	Staff Lounges	1,800	*	*
	Medical Office Building		11,218	Medical Office Building	22,410	*	*
			81,929		82,573	644	1%
			14,683		11,716	(2,967)	-20%
		249'x388'	107,830		117,900	10,070	9%
			96,612		94,289	(2,323)	-2%

Program Analysis, cont.

Schemes A and B

Floor	Unit/Service	Beds	Scheme A	Perforated Plan	Scheme B (v. 4.0)	SF Difference Btwn A & B	% Difference Btwn A & B
3	Mechanical		2,664		5,700		
3	Patient Rooms	CCU	13,824	Departmentally Grouped	24,210		
3	Critical Care Space	NICU	9,004		24,210		
3	Acute Care Space		8,767		24,210		
3	Medical Office Building		11,218				
			42,813		72,630		
			8,421		2,400		
		110'x388'	53,898		75,030	32,350	39%
			42,680				
4	Administration		*	Administration	500		
4	Hospital Based Physicians		*	Hospital Based Physicians	1,000		
4	Hospital Conferance Rooms		*	Hospital Conferance Rooms	583		
4	Provider Sleep Rooms		*	Provider Sleep Rooms	600		
4	Mechanical		2,664	Mechanical	5,700	*	*
4	Patient Rooms	Labor and Delivery	13,824	Departmentally Grouped	22,308		
4	Critical Care Space	Nursery	9,004		22,308		
4	Acute Care Space	Acute Care PPU	8,767		22,308		
4	Medical Office Building		11,218				
			42,813		66,924		
			8,421		2,165		
		110'x388'	53,898		69,089	26,409	28%
			42,680				
5	Administration		*	Administration	500		
5	EKG		*	EKG	480		
5	Hospital Conference Rooms		*	Hospital Conference Rooms	583		
5	Provider Sleep Rooms		*	Provider Sleep Rooms	600		
5	Respiratory Services		*	Respiratory Services	1,950		
5	Mechanical		2,664	Mechanical	5,700	*	*
5	Patient Rooms	Ortho	13,824	Departmentally Grouped	22,308		
5	Critical Care Space	Oncology	9,004		22,308		
5	Acute Care Space		8,767		22,308		
			31,595		66,924		
			8,421		2,165		
		110'x388'	42,680		69,089	26,409	62%
6	Mechanical		2,664				
6	Patient Rooms	Cardiac	13,824				
6	Critical Care Space	General Medicine	9,004				
6	Acute Care Space		8,767				
			31,595				
			8,421				
		110'x388'	42,680		0	-42,680	-100%
7	Mechanical		2,664				
7	Patient Rooms	General Surgery	13,824				
7	Critical Care Space	General Surgery	9,004				
7	Acute Care Space		8,767				
			31,595				
			8,421				
		110'x388'	42,680		0	-42,680	-100%
	Sub-Programatic Spaces		Scheme A		Scheme B	Scheme A to B	
	Mechanical Space		32,920	Mechanical Space	32,900	(20)	0%
	Administration		2,320	Administration	2,500	180	8%
	Hospital Conference Rooms		1,745	Hospital Conference Rooms	1,646	(99)	-6%
	Provider Sleep Rooms		2,320	Provider Sleep Rooms	2,400	80	3%

Program Analysis, cont.

Schemes A and B

Totals	Scheme A		Scheme B		SF	%
	44,872	Total MOB	44,820	Total MOB	(52)	0%
	73,406	Total Basement	73,434	Total Basement	28	0%
	32,920	Mechanical Space	32,900	Mechanical Space	(20)	0%
	220,585	Sum Diagnostic and Treatment Program Areas (no MOB)	223,032	Sum Diagnostic and Treatment Program Areas (no MOB)	2,447	1%
	266,630	Sum Diagnostic and Treatment Areas with department gross (no MOB)	266,682	Sum Diagnostic and Treatment Areas with department gross (no MOB)	52	0%
	160,506	Sum Diagnostic and Treatment Program Areas (no MOB)	162,355	Sum Diagnostic and Treatment Program Areas (no MOB)	1,849	1%
	193,224	Sum Diagnostic and Treatment Areas with department gross (no MOB)	193,248	Sum Diagnostic and Treatment Areas with department gross (no MOB)	24	0%
	157,975	Sum of Inpatient Depts. Program Areas ** This calculation DOES NOT include intradepartmental circulation!	206,478	Sum of Inpatient Depts. Program Areas ** This calculation DOES include intradepartmental circulation!	48,503	31%
	213,400	Sum of Inpatient Depts. with department gross (no MOB)	213,208	Sum of Inpatient Depts. with department gross	(192)	0%
	Total		Total			
	480,030	Sum all in-patient (No MOB)	479,890	Sum all in-patient (No MOB)	(140)	0%
	240,490	Sum all program areas	267,155	Sum all program areas	26,665	11%
	524,902	Sum footprint (architectural total SF) Increases from Phase I due to increase in size of MOB	**524,710**	Sum footprint (architectural total SF)	(192)	0%

Floor, Roof, Wall Areas

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

FLOORS, ROOFS, WALLS AREAS -- PERFORATED MODEL B

FLOORS

	OPTION B1, B2, B3						ARCHITECTURAL MODEL	PROGRAM DGSF
	Underground (-1)	**1 Level**	**2 Level**	**3 Level**	**4 Level**	**5 Level**	**TOTAL**	
Per Floor Plans	73434	120168	117900	75030	69089	69089		
							524,710	510,966
Total Hospital	73434	97758	95490	75030	69089	69089		
Total MOB	0	22410	22410	0	0	0		
TOTAL	73434	120168	117900	75030	69089	69089		

EXTERIOR PERIMETER

	BASEMENT	1	2	3	4	5	
Above Grade Hospital	498.5	2398	2589	2613	3189	3189	
Above Grade MOB		678	678	0	0	0	
Below Grade (Excavated)	1253						
TOTAL	1751.5	3076	3267	2613	3189	3189	17,086

Total walls extruded	7477.5	55368	58806	39195	47835	47835	256,517	**Use to Calculate COST

FOOTPRINT

MOB	22,410	
Hospital	121,950	
TOTAL		144,360

ROOFS

	OPTION B1, B2 & B3
Towers	69089
MOB	23610
Lobby	6750
Courtyards	20484
Total	119933

WALLS

B1

WALLS		Width	Height	Without Parapet	Parapet Only	Total w/ Parapet	Heather wind/ wall ratio	Mike Hatten E/Quest
Façade Towers	N	270	81	21870	810	22680		
Façade Bridges	N	120	81	9720	360	10080		
Façade Bridge to MOB	N	60	33	1980	180	2160		
Facade MOB	N	90	33	2970	270	3240		
Courtyard Bridge to MOB	N	60	33	1980	180	2160		
Courtyard Towers	N	90	30	2700	270	2970		
Courtyard Big (Upper)	N	120	45	5400	360	5760		
Courtyard Big (Lower 1)	N	48	36	1728	0	1728		
Courtyard Big (Lower 2)	N	48	51	2448	0	2448		
Basement Courtyard	S	47.5	15	712.5	142.5	855		
Façade Towers (w/o lobby)	S	180	81	14580	540	15120		
Façade Tower (w/lobby)	S	90	45	4050	270	4320		
Façade Lobby	S	90	36	3240	270	3510		
Façade Bridges	S	120	81	9720	360	10080		
Façade Bridge to MOB	S	60	33	1980	180	2160		
Facade MOB	S	90	33	2970	270	3240		
Courtyard Bridge to MOB	S	60	33	1980	180	2160		
Courtyard Big (Upper)	S	120	45	5400	360	5760		
Courtyard Big (Lower 1)	S	48	36	1728	0	1728		
Courtyard Big (Lower 2)	S	48	51	2448	0	2448		
Courtyard Towers	S	90	30	2700	270	2970		
Façade Tower	W	264	48	12672	792	13464		
Façade Towers (NW corners)	W	40	81	3240	120	3360		
Façade Lobby	W	75	36	2700	225	2925		
Façade PT waiting areas	W	30	63	1890	90	1980		
PT waiting area above lobby	W	15	45	675	45	720		
Façade MOB	W	244	33	8052	732	8784		
Façade MOB PT waiting	W	15	33	495	45	540		
Courtyard Towers	W	198	30	5940	594	6534		
Courtyards Big (Upper)	W	448	45	20160	1344	21504		
Courtyards Big (Mid)	W	290	18	5220	0	5220		
Courtyards Big (Lower 1)	W	112	18	2016	0	2016		
Courtyards Big (Lower 2)	W	112	33	3696	0	3696		
Courtyards (MOB)	W	244	33	8052	0	8052		
Basement Courtyard	E	87	15	1305	261	1566		
Façade Tower	E	264	81	21384	792	22176		
Façade Tower (NE corners)	E	40	81	3240	120	3360		
Façade Lobby	E	60	36	2160	180	2340		
Façade PT waiting areas	E	30	63	1890	90	1980		
PT waiting area above lobby	E	15	81	1215	45	1260		
Facade MOB Courtyard	E	224	33	7392	672	8064		
Façade MOB pt waiting	E	15	33	495	45	540		
Courtyard Towers	E	198	30	5940	594	6534		
Courtyards Big (Upper)	E	448	45	20160	1344	21504		
Courtyards Big (Mid)	E	290	18	5220	0	5220		
Courtyards Big (Lower 1)	E	112	18	2016	0	2016		
Courtyards Big (Lower 2)	E	112	33	3696	0	3696		
Total	N			50,796		53,226	50,796	52,152
Total	S			51,509		54,351	50,796	53,052
Total	W			74,808		78,795	74,808	77,413
Total	E			76,113		80,256	74,808	77,401
** USE for W|W calculation**				253,226		266,628	251,208	260,018

B2 & B3

WALLS		Width	Height	Without Parapet	Parapet Only	Total w/ Parapet
Façade Towers	N	270	78	21060	810	21870
Façade Bridges	N	120	78	9360	360	9720
Façade Bridge to MOB	N	60	33	1980	180	2160
Facade MOB	N	90	33	2970	270	3240
Courtyard Bridge to MOB	N	60	33	1980	180	2160
Courtyard Towers	N	90	28	2520	270	2790
Courtyard Big (Upper)	N	120	42	5040	360	5400
Courtyard Big (Lower 1)	N	48	51	2448	0	2448
Courtyard Big (Lower 2)	N	48	36	1728	0	1728
Basement Courtyard -- NEW	E	87	15	1305	261	1566
Façade Towers (w/o lobby)	S	180	78	14040	540	14580
Façade Tower (w/lobby)	S	90	42	3780	270	4050
Façade Lobby	S	90	36	3240	270	3510
Façade Bridges	S	120	78	9360	360	9720
Façade Bridge to MOB	S	60	33	1980	180	2160
Facade MOB	S	90	33	2970	270	3240
Courtyard Bridge to MOB	S	60	33	1980	180	2160
Courtyard Big (Upper)	S	120	42	5040	360	5400
Courtyard Big (Lower 1)	S	48	51	2448	0	2448
Courtyard Big (Lower 2)	S	48	36	1728	0	1728
Courtyard Towers	S	90	28	2520	270	2790
Façade Tower	W	264	45	11880	792	12672
Façade Towers (NW corners)	W	40	78	3120	120	3240
Façade Lobby	W	75	36	2700	225	2925
Façade PT waiting areas	W	30	60	1800	90	1890
PT waiting area above lobby	W	15	42	630	45	675
Façade MOB	W	244	33	8052	732	8784
Façade MOB PT waiting	W	15	33	495	45	540
Courtyard Towers	W	198	28	5544	594	6138
Courtyards Big (Upper)	W	448	42	18816	1344	20160
Courtyards Big (Mid)	W	290	18	5220	0	5220
Courtyards Big (Lower 1)	W	112	33	3696	0	3696
Courtyards Big (Lower 2)	W	112	18	2016	0	2016
Courtyards (MOB)	W	244	33	8052	0	8052
Basement Courtyard -- NEW	E	87	15	1305	261	1566
Façade Tower	E	264	78	20592	792	21384
Façade Tower (NE corners)	E	40	78	3120	120	3240
Façade Lobby	E	60	36	2160	180	2340
Façade PT waiting areas	E	30	60	1800	90	1890
PT waiting area above lobby	E	15	78	1170	45	1215
Facade MOB Courtyard	E	224	33	7392	672	8064
Façade MOB pt waiting	E	15	33	495	45	540
Courtyard Towers	E	198	28	5544	594	6138
Courtyards Big (Upper)	E	448	42	18816	1344	20160
Courtyards Big (Mid)	E	290	18	5220	0	5220
Courtyards Big (Lower 1)	E	112	33	3696	0	3696
Courtyards Big (Lower 2)	E	112	18	2016	0	2016
Total	N			49,086		51,516
Total	S			50,391		53,352
Total	W			72,021		76,008
Total	E			73,326		77,469
				244,824		258,345

Window Areas

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

WINDOWS

Option B1

Total Area Windows:

Type	Area		Percentage	W/W ratio
Total Area	**76415**		100	30

Area for louver shades (NONE):

Type	Area		Percentage
Total Area	0		0

Option B2 & B3

Total Area Windows:

Type	Area		Percentage	W/W ratio
Total Area	**76415**		100	31

Area for louver shades:

Type	Area		Percentage
Total Area	**60417**		79

Total Area by Type:

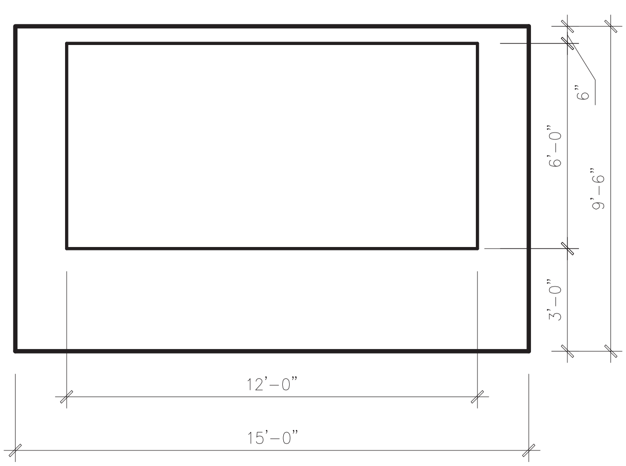
Type	Height	Width	Number	Area	Percentage
A	8	4	115	3680	5
B	6	12	228	16416	21
C	-	-	-	-	-
D	8	9	194	13968	18
E	7	9	108	6804	9
F	5	10	123	6150	8
G	9	4	63	2268	3
H	9	4	30	1080	1
I	12	7	134	11172	15
J	9	7	231	14877	19
Total Area			**1226**	76415	100

Area for louver shades (all but North façade):

Type	Height	Width	Number	Area	Percentage
A	8	4	36	1152	2
B	6	12	228	16416	21
C	-	-	-	-	-
D	8	9	194	13968	18
E	7	9	90	5670	7
F	5	10	81	4050	5
G	9	4	63	2268	3
H	9	4	30	1080	1
I	12	7	78	6552	9
J	9	7	147	9261	12
Total Area			947	60417	79

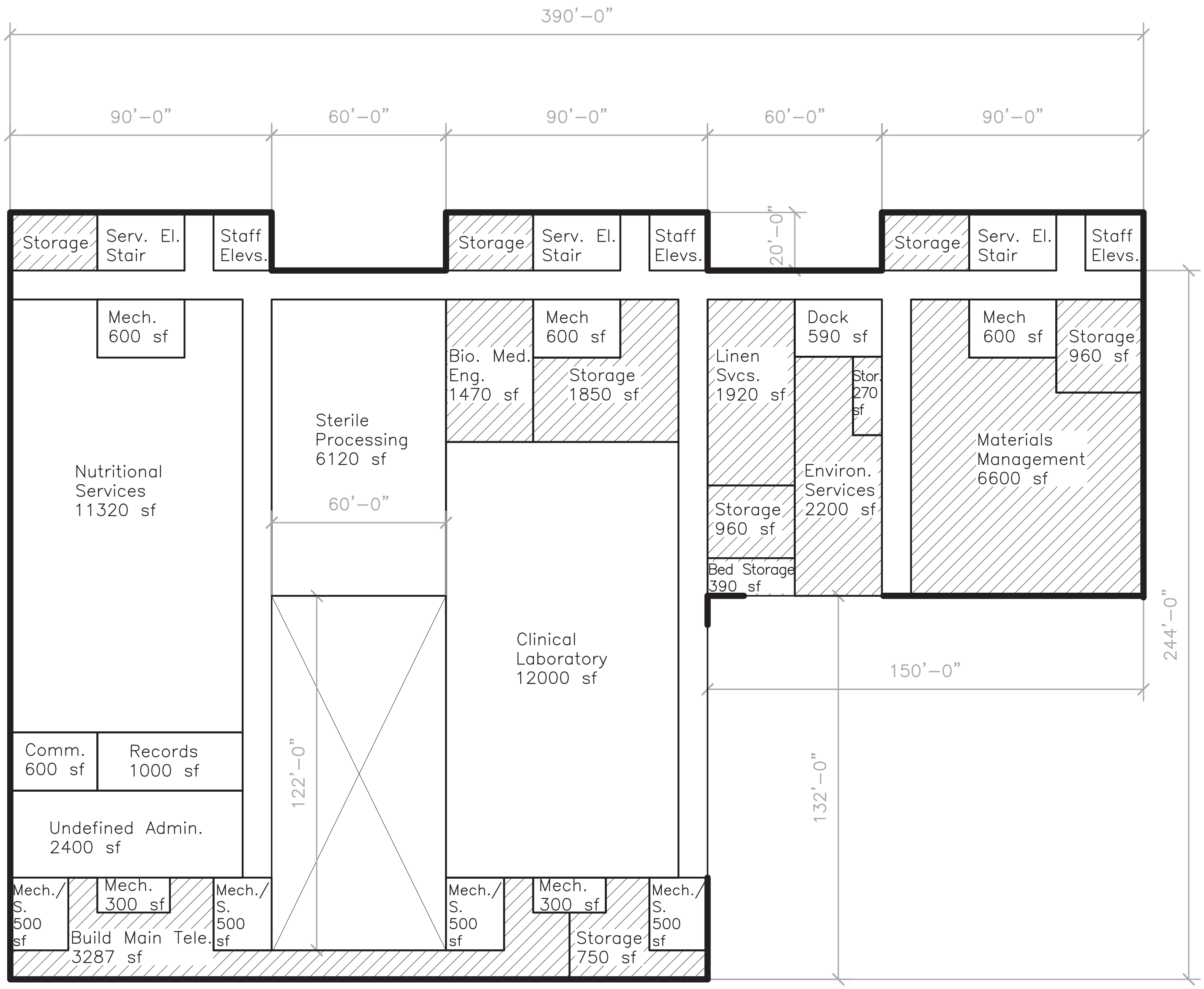
Example Patient Room Window

Baseline Energy Option B1; Target 100 Energy Option B2 & B3
Not to Scale



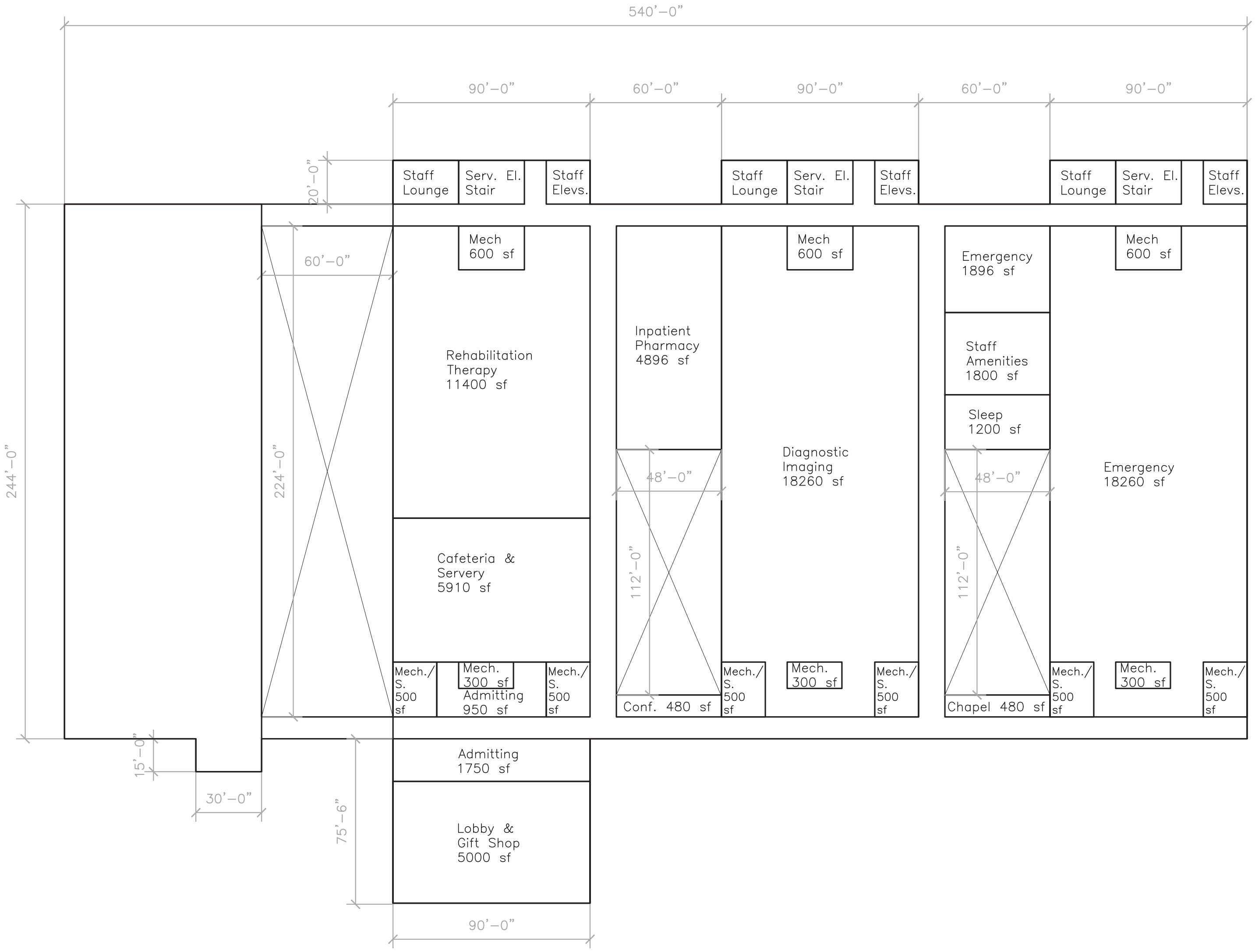
Schematic Plans Basement Level

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



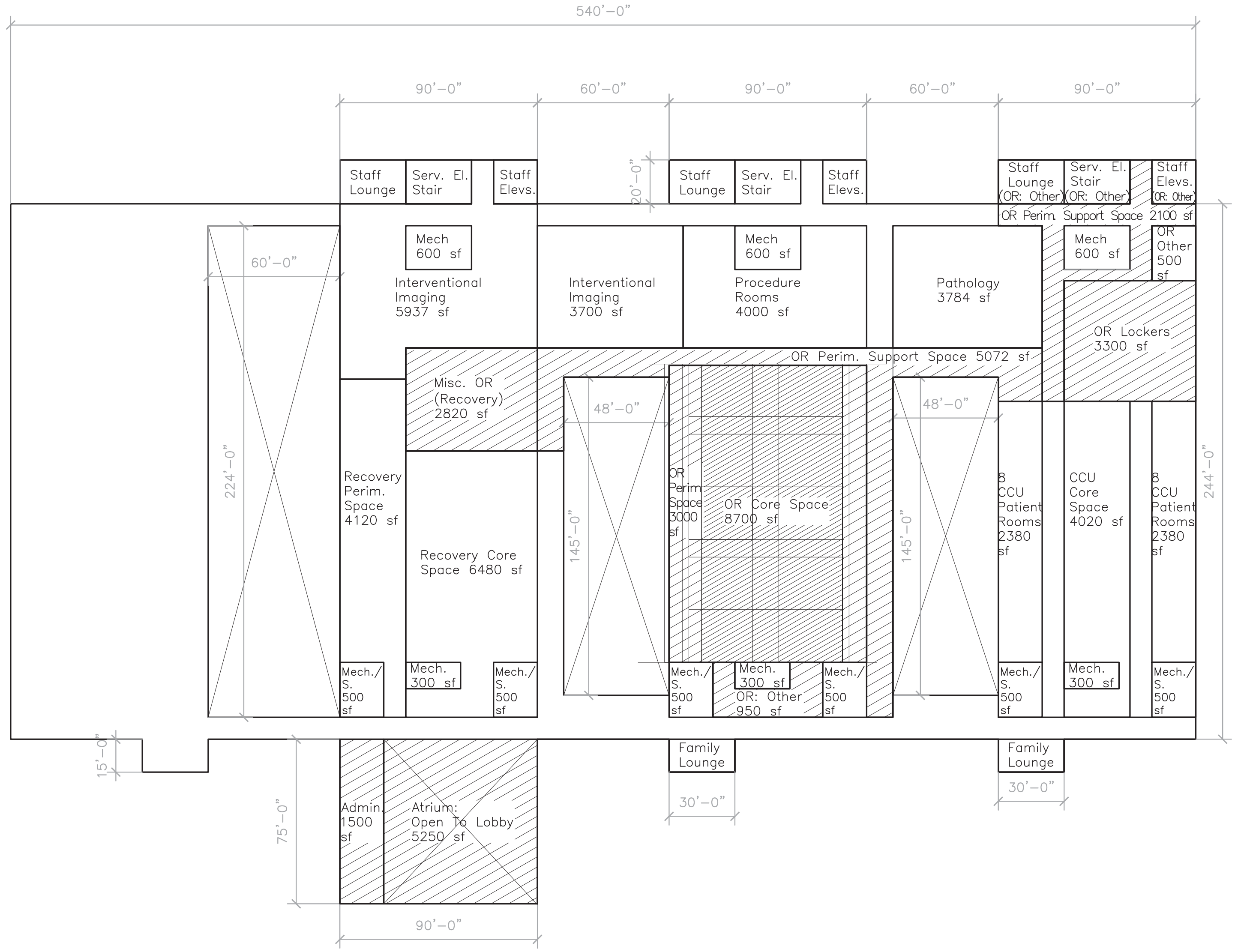
Schematic Plans Level 1

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



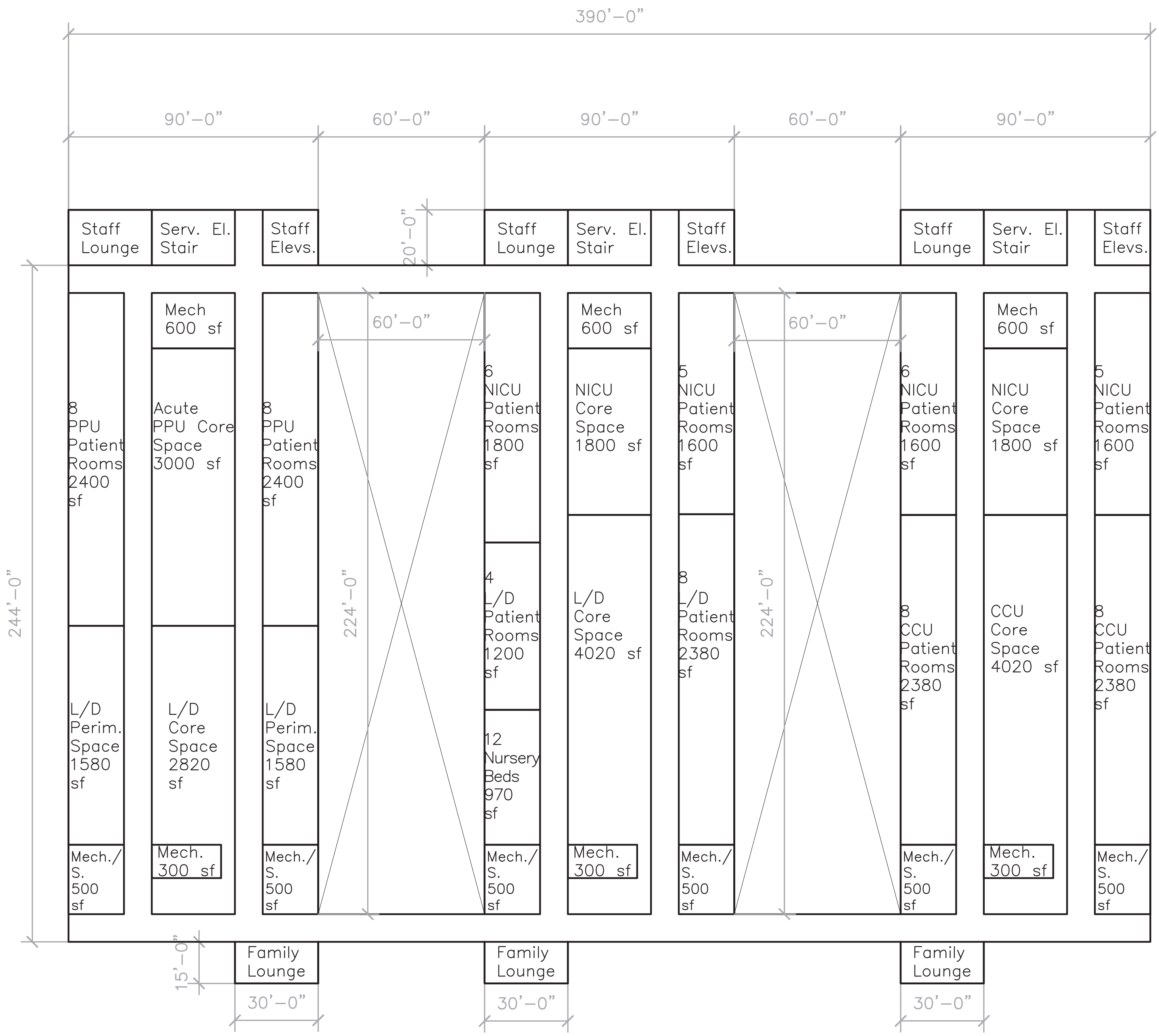
Schematic Plans Level 2

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



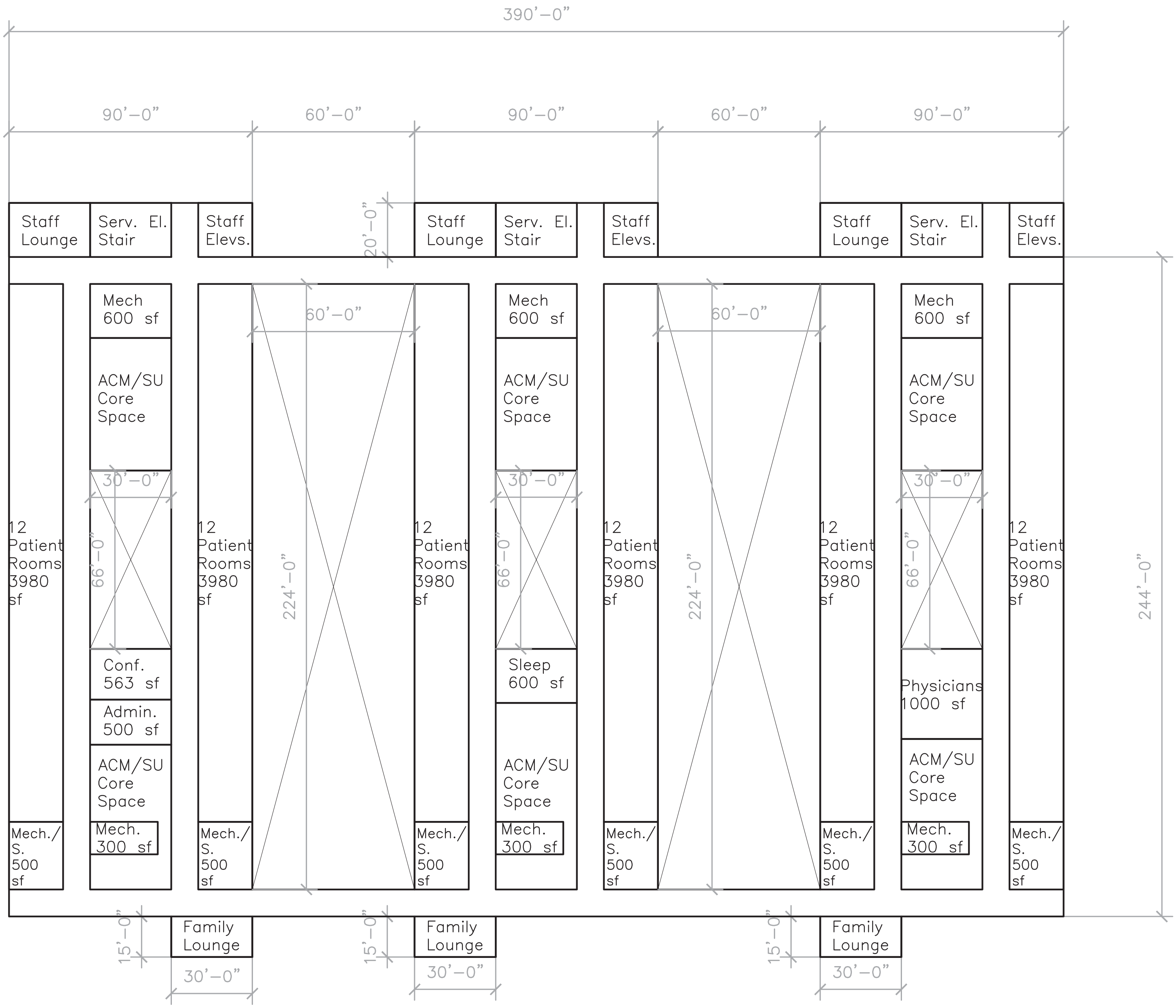
Schematic Plans Level 3

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



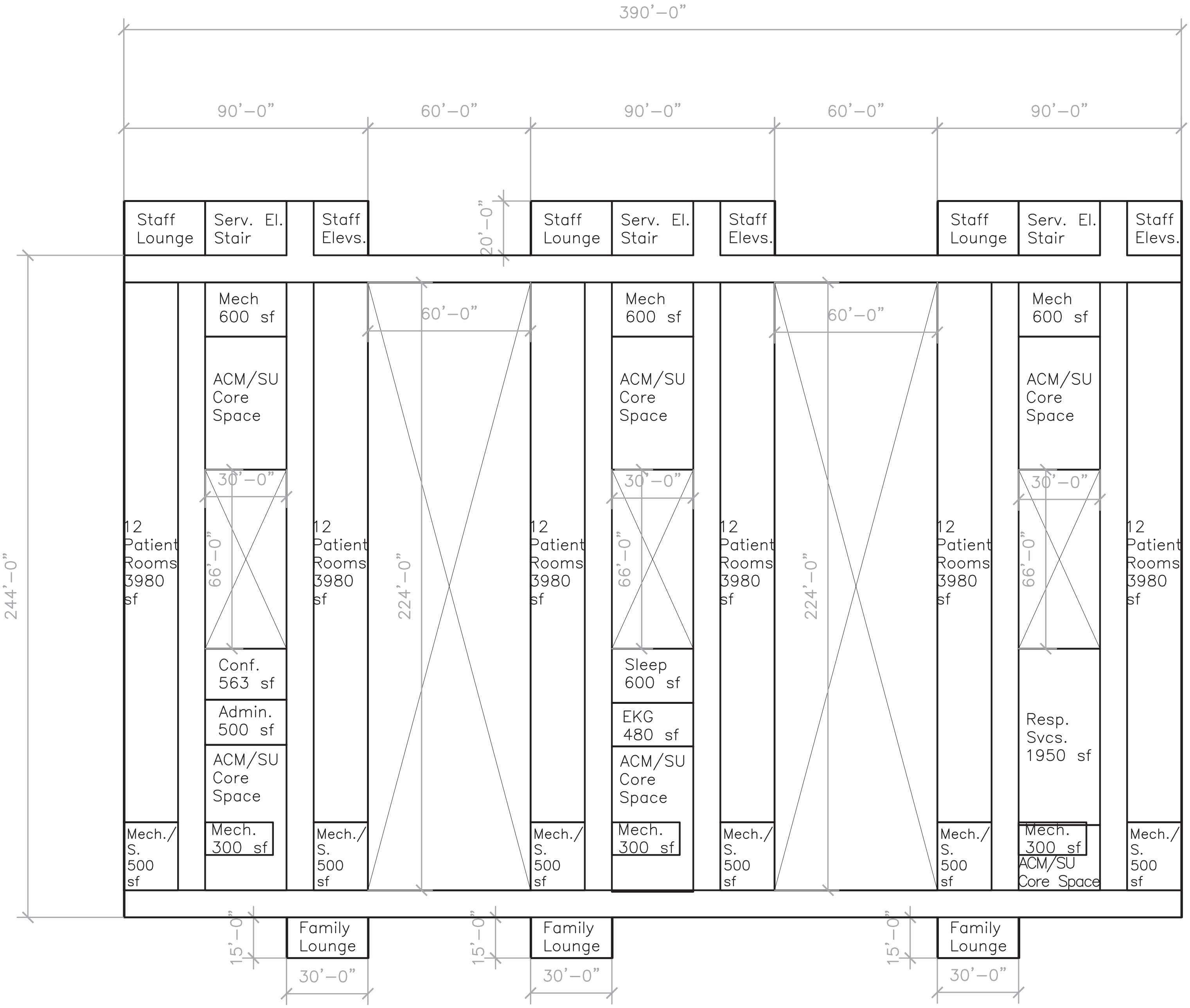
Schematic Plans Level 4

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



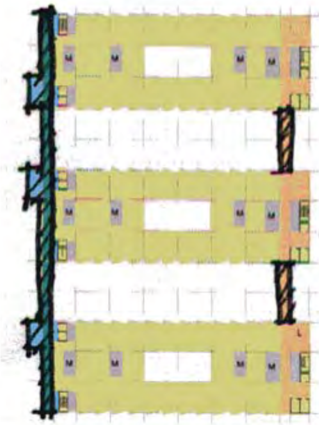
Schematic Plans Level 5

Baseline Energy Option B1; Target 100 Energy Option B2 & B3



Proposed Natural Ventilation Patterns

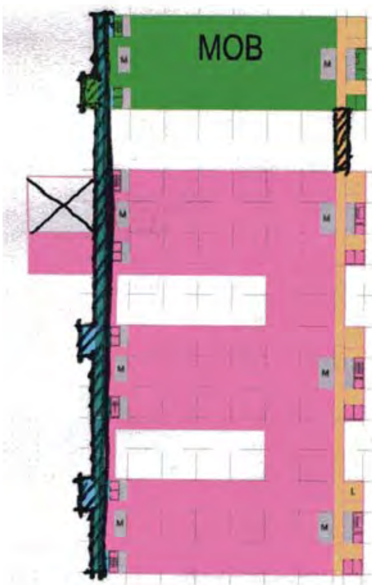
Target 100 Energy Option B2 & B3
Not to Scale, 30' x 33' grid.



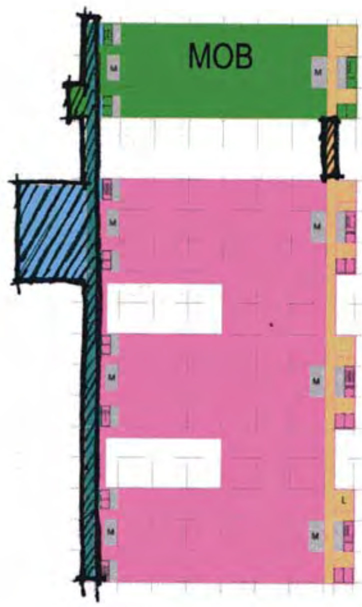
LEVEL 5 - SPECIALTY
69000 SF

LEVEL 4 - GENERAL
69000 SF

LEVEL 3 - CCU NICU
75000 SF



LEVEL 2
115000 SF

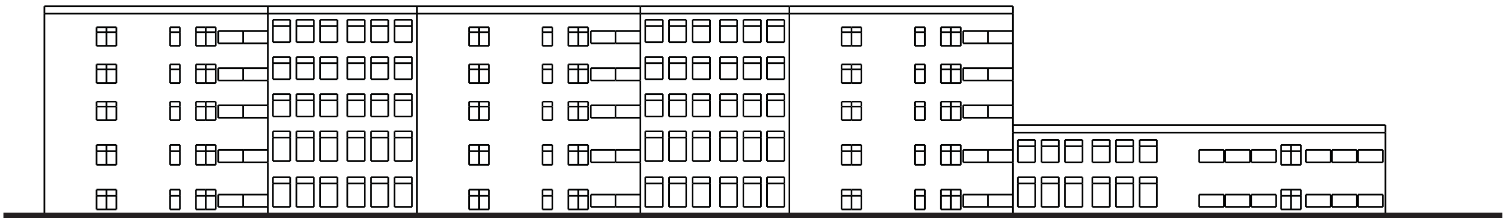


LEVEL 1
118000 SF

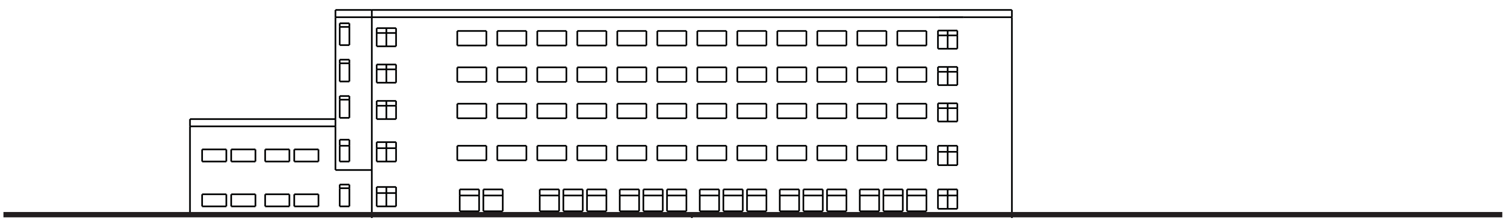

Denotes areas that are naturally ventilated

Example Window Distribution

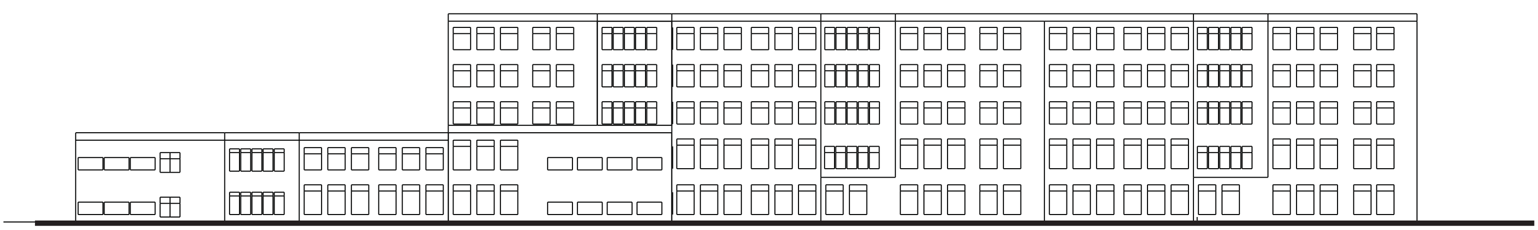
Baseline Energy Option B1; Target 100 Energy Option B2 & B3
Not to Scale



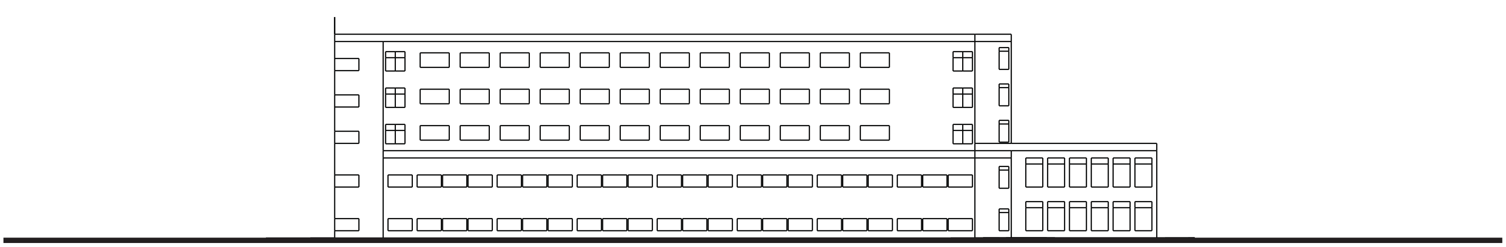
North Elevation



East Elevation



South Elevation

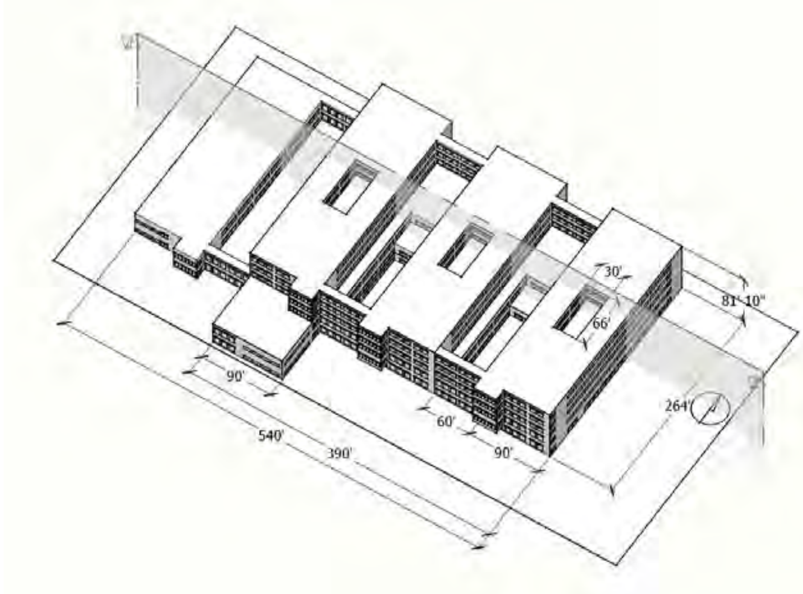


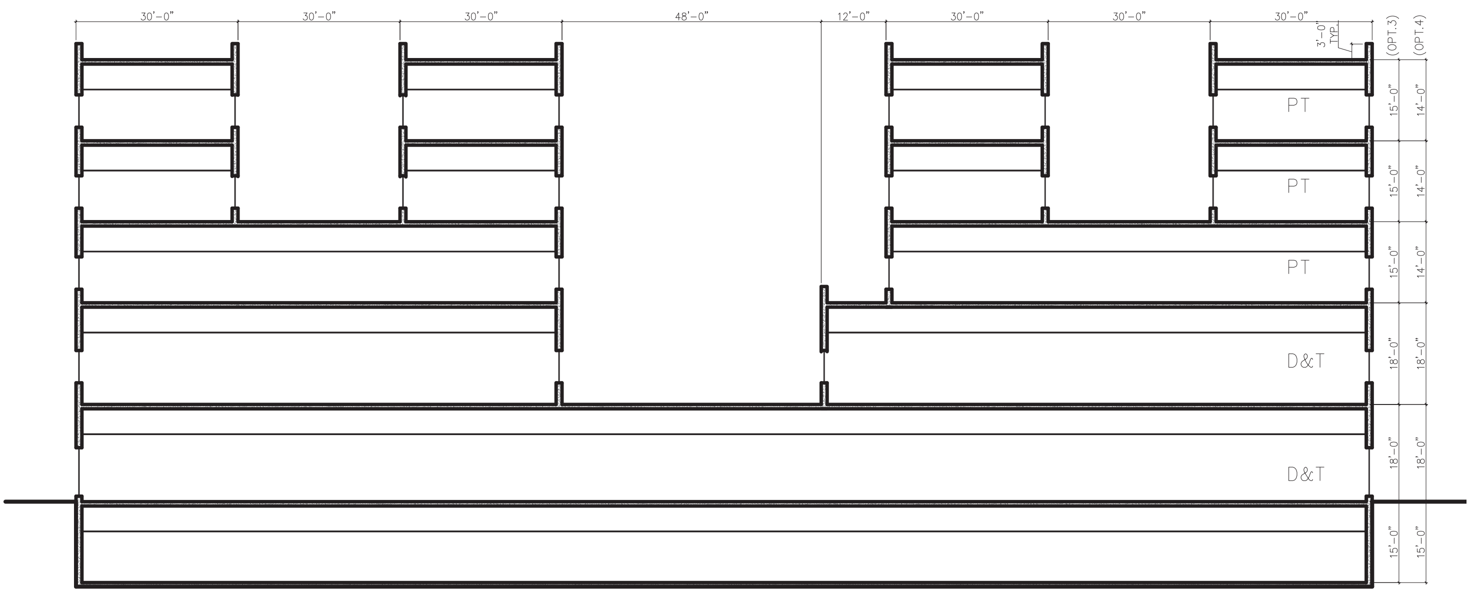
West Elevation

Overall Building Section

Baseline Energy Option B1; Target 100 Energy Option B2 & B3
Not to Scale

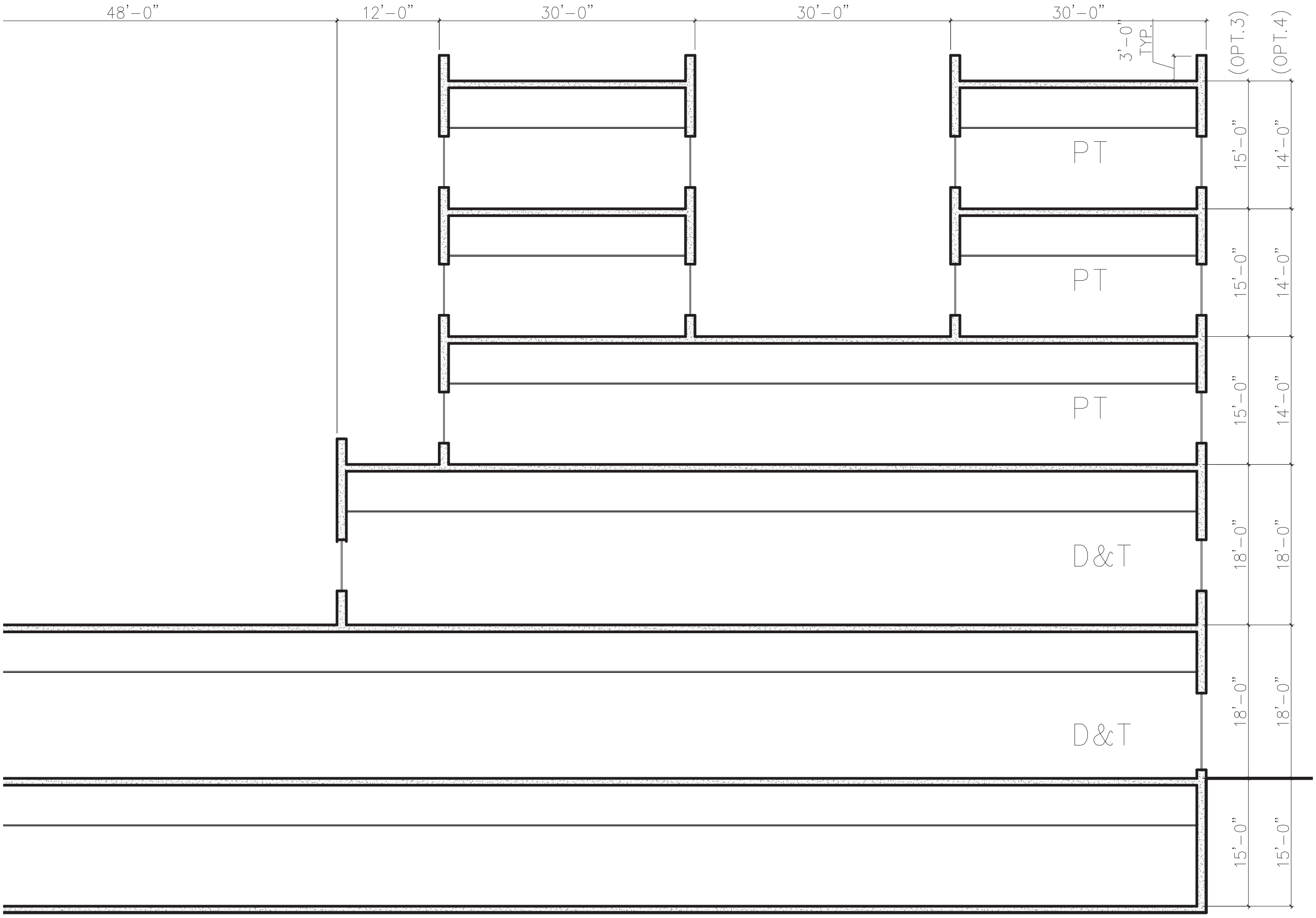
Location of Section Cut:





Building Section

Baseline Energy Option B1; Target 100 Energy Option B2 & B3
Not to Scale



Exterior Louver Blinds

Target 100 Energy Option B2 & B3

Windows shall have exterior automated, 4” retractable louver blinds that are controlled with an intelligent solar tracking system (see next page). These louvers will be on the East, West, and and South facades only, and not on the North facade. For the energy model, typically a SHGC of 0.09 is used for the windows with dynamic shading devices.

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Daylight Enhancing - System Description

External specialty venetian blinds are the most effective shading device in as much as:

- They can be retracted when not required
- They can be lowered when sun comes onto the building elevation
- The slats can be tilted between open and closed to cope with varying sun angles
- The slats can be perforated to provide some outward vision, even when in the closed position, and
- They provide effective control of both daylight/glare and solar gain.

An external specialty venetian blind is similar to the ½" and 1" blinds that are commonly installed internally, with a number of key exceptions: a) The slats are larger – generally being between 2" (50mm) and 4" (100mm) b) The blinds are generally motorized for ease of raising / lowering and tilting c) The main components (headrail, bottom rail and tilt mechanism) are more robust to cope with external weather conditions, and d) The slats are held on side guide wires or extrusions so that the blinds are not too significantly affected by wind. That said, external venetian blinds are often used with a control system which will automatically raise the blinds if the wind speed exceeds a pre-set level.

The standard method of operation is motorized, although a manual (gearbox and crank handle) version is also available for blinds that are installed internally. A number of standard venetian blind motors, manufactured by Elero are used. Key technical details relating to these are as follows:

Speed:	35 rpm
Power:	110 – 120 watts
Current draw:	1.15 – 1.35 amps
Voltage:	110 volts
Torque:	6, 12 Nm
Max. lift capacity:	160 lbs.
Max. no. of turns	85

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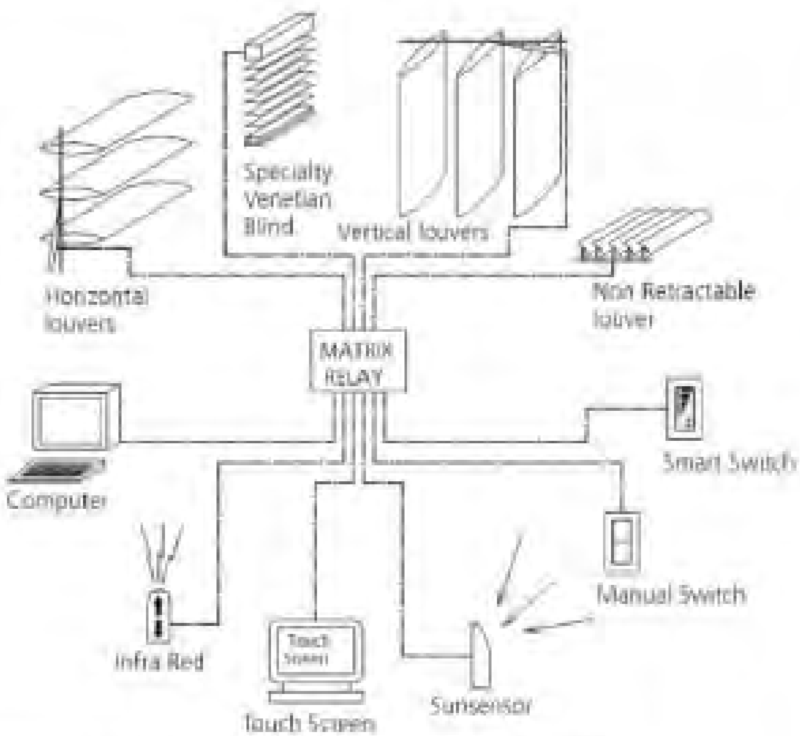
Nysan Intelligent Controls - Control Diagram

MATRIX RELAY DIAGRAM

Motorized operable systems can be controlled by switch (either singly or in groups) or can be connected to an automatic control system. Depending upon the specific project requirements, a wide range of different control features might be required. These can be provided through the intelligent Matrix relay.

The Matrix relay can operate any type of blind system and can be programmed to provide a wide range of control options, as shown in the diagram below:



Specific control functions that are available through the Matrix relay include:

- Group operation by switch
- Flexibility of control groups – future changes in office layouts do not require re-wiring
- Automatic control by reference to actual daylight conditions
- Automatic control by reference to predicted sun position
- Time clock override
- Remote access via RS232 or 485 ports
- Communication by bus line technology
- PC interface
- Offsite re-configuration
- Infrared remote control
- Interface with proprietary touch screen control systems
- Pre-programmable multiple stop positions/louver angles
- Intelligent switch interface

Electric Lighting Summary

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

The electric lighting sees a 10% reduction from the baseline energy to the "target 100" energy. A space-by-space evaluation of lighting power density can be seen below. An additional 5% reduction is seen through occupancy sensor control systems in appropriate spaces. Spaces highlighted in blue below have been identified as not having occupancy sensors.

	Option 1	Option 2	
Space Name	Baseline W/sf connected load	Interior LPD 10% Reduction	Occ Sensor LPD Adjustment (5% reduction)
Critical LPD	1.2	1.08	1.08
Acute LPD	1.8	1.62	1.62
Labor LPD	1.5	1.35	1.35
Lab LPD	1.4	1.26	1.20
Emergency LPD	1.8	1.62	1.62
Imaging LPD	1.5	1.35	1.28
OR LPD	1.8	1.62	1.62
Procedure LPD	1.5	1.35	1.35
Recovery LPD	1	0.9	0.86
Pharmacy LPD	1.2	1.08	1.03
Sterile LPD	1.2	1.08	1.03
EKG LPD	1.5	1.35	1.28
PT LPD	0.9	0.81	0.77
Chapel LPD	1.3	1.17	1.11
Sleep LPD	1	0.9	0.86
Admitting LPD	1.2	1.08	1.03
Conference LPD	1.2	1.08	1.03
Office LPD	1	0.9	0.86
Lobby LPD	1.2	1.08	1.03
Cafeteria LPD	1.2	1.08	1.03
Kitchen LPD	1.5	1.35	1.28
Laundry LPD	1.5	1.35	1.28
Storage LPD	0.8	0.72	0.68
Dock LPD	0.8	0.72	0.68
Amenities LPD	0.8	0.72	0.68
Server LPD	0.8	0.72	0.68
IT LPD	1	0.9	0.86
Circulation LPD	0.7	0.63	0.63
Mechanical LPD	1.5	1.35	1.28
MOB LPD	1.5	1.35	1.28

Windows & Glazing

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

Target 100 Glazing Specs

WA Energy Code for vertical glazing, Zone 1, less than 30%, metal framing, no PF
2006: Max U = 0.55, Max SHGC = 0.45
2009: Max U = 0.40, Max SHGC = 0.40

Glass	VLT	U	SHGC
PPG Solarban 60 clear low-e	70	0.29	0.38
PPG Solarban 80 clear low-e	47	0.29	0.24
Viracon Solarscreen VE-1-2M	70	0.29	0.37
Viracon Solarscreen VE-2-85	65	0.31	0.38
Typical double-pane clear	79	0.47	0.70* (not code compliant)

Framing	% Glass	Glass U	Assembly U
Kawneer Trifab VG 451T	86	0.29	0.40
Kawneer Trifab VG 451T	86	0.31	0.42
Kawneer System 2250	85	0.29	0.42
Kawneer System 2250	85	0.31	0.43
EFCO System 433	86	0.30	0.43
EFCO System 960	88	0.30	0.41

We decided as a team to establish two glass and frame combinations; one for baseline and one for the Target 100 schemes. These specific products allowed a basis for costing purposes, but are only one path to the goal as discussed below.

Discussion of glass assumptions:
Either the PPG Solarban 60 glass or the Viracon Solarscreen VE-1-2M glass could be used as the basis for both the base case and the Target 100 case. We can't step down to regular (non-low-e) glass for the base case because it doesn't meet the SHGC criteria, and it is not known if there is any clear glass cheaper than the PPG product that would meet current code.

For comparison, all of the framing systems were normalized to a 4 X 6-foot shape with no intermediate mullions, per the NFRC test procedure. It looks as though the Kawneer Trifab VG 451T with Solarban 60 just barely meets the 0.40 U-value standard for the Target 100 case, while the others are all a little above it. We hoped to find a framing system that was closer to the 0.55 U-value, but it seems as though the systems jump up to the 0.60 U-value range when they are not thermally broken.

This is a somewhat simplified approach, and using the same framing system for storefront glazing, ribbon windows and punched windows is going to be the most sensible way to go.

Decision on glass types:
For Options A1 and B1, we could use Kawneer System 2250 w/ Solarban 60 glass (U = 0.43)
For Options A2, A3, B2 and B3, we could use Kawneer Trifab 451 with Solarban 60 (U = 0.40)

Architectural Elements

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

Overall interior & exterior specifications were based on the recently completed Phoenix Banner Gateway hospital as a representative example of contemporary hospital design, unless otherwise specified.

Mechanical Systems

Baseline Energy Option B1; Target 100 Energy Option B2 & B3

Please see Appendix 2.0

Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Appendix 2.0

Mechanical Narrative

Solarc Architecture and Engineering

with support from

Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

University of Washington's Integrated Design Lab
NBBJ Architects
Solarc Architecture and Engineering
TBD Consultants
Cameron MacAllister
Mahlum Architects
Mortenson Construction

Appendix 2.0

Final Mechanical Narrative - 06.15.2010

This narrative is a compilation and update of three narrative documents including schematic diagrams that were prepared at various times over the course of the research work. The primary purpose of these narrative documents was to form the basis of the cost models for the mechanical systems. Narrative documents that have been incorporated into this final document include:

- Mechanical Narrative, dated 11.18.2009
- Alternate Plant Option Narrative, dated 03.22.2010
- Updated Air Handling Unit Schedules, dated 03.31.2010

Table of Contents

1.0 Executive Summary

This narrative is intended to provide sufficient concept description and system component sizing information to allow a reasonable cost model to be developed for mechanical systems in each of two hospital design scenarios.

- Design Option A1: Prototypical Code Compliant Design for a Hospital of Conventional Geometry and Massing
- Design Option A2: High Performance Design (Target "100") for a Hospital of Conventional Geometry and Massing
- Design Option A3: High Performance Design (Target "100") with Enhanced Heat Recovery Plant for a Hospital of Conventional Geometry and Massing
- Design Option B1: Prototypical Code Compliant Design for a Hospital for "Perforated" Geometry and Massing
- Design Option B2: High Performance Design (Target "100") for a Hospital for "Perforated" Geometry and Massing
- Design Option B3: High Performance Design (Target "100") with Enhanced Heat Recovery Plant for a Hospital for "Perforated" Geometry and Massing

The program and architecture associated with "conventional" and "perforated" geometry and massing is described in separate documents, and will not be explained within this narrative. Figures 1.1 and 1.2 show 3-dimensional representations of each massing option.

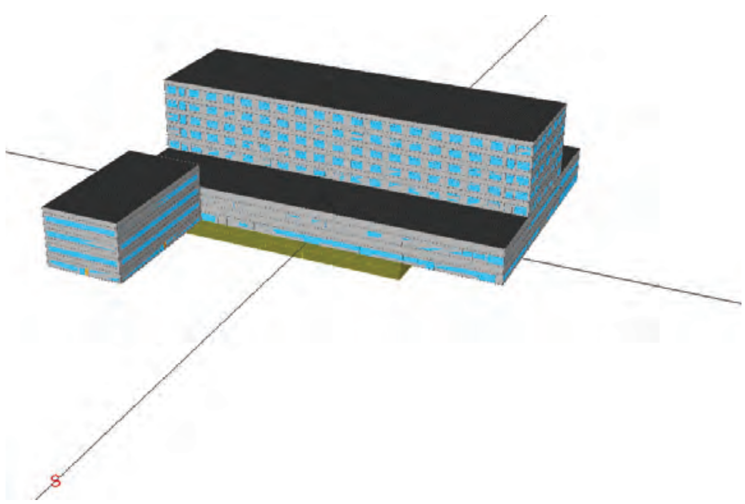


Figure 1.1. Conventional Geometry – Options A1 and A2.

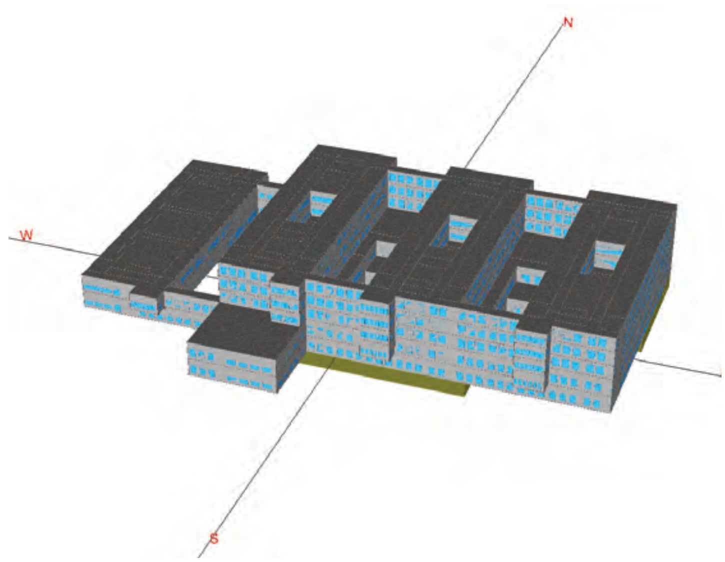


Figure 1.2. Perforated Geometry – Options B1 and B2.

The remainder of this narrative focuses on secondary and primary mechanical systems that will serve each of the design concepts. The differences between the design options are described in some detail in Sections 2 and 3. Loads and energy models for all Options are intended to be consistent with the Washington State Energy Code (WSEC), and have been run with Seattle weather.

1.1 Impacts on Other System Costs

In addition to mechanical system costs, the proposed mechanical systems will potentially affect costs related to:

- site work and construction coordination and scheduling
- site area required for mechanical systems
- space required for central energy plant equipment
- space required for secondary HVAC equipment
- floor-to-floor height in the patient tower
- capacity of emergency generators

Site Work and Construction Coordination

The ground coupled heat pump plant, in its closed loop form, will require coordination with site preparation and foundation work. Typically, well water drilling rigs are required to develop each of the vertical bores. Once a drilling rig and crew have developed a pattern of work, assuming that air rotary drilling is viable, each 300 foot deep bore takes about a day to complete. With hundreds of potential bores to develop, site work will require multiple drilling rigs working on site at the same time. With four to five rigs, it is conceivable that the borefield will require 3 months of time on site to complete. While not fully added to the critical path of the project schedule, it is appropriate to assume that half of this time will need to be added to the site work schedule resulting in an extra 6 weeks of site work to be scheduled within the overall project duration.

If an open loop system proves possible to develop, site work will involve drilling and development of at least four wells – two for supply and two for re-injection. It is not anticipated that well development will cause any undue extension to the site construction schedule, however, various state regulations may require coordination between well water piping location and site sewer (storm and sanitary) piping locations. This typically requires some extra coordination work during design between mechanical and civil engineers, and may increase the piping runs associated with sanitary or storm sewers by a modest factor.

Site Area Required for Mechanical Systems

For Options A1 and B1, three 800-ton cooling towers need to be located outside of the building enclosure but in close proximity to the chiller room. Using the SPX Marley NC-8412S-1 as a basis of sizing and costing, the required exterior tower yard footprint is estimated to be about 45' by 56' or 2,520 sq.ft.

With the ground-coupled plant, only one 400-ton cooling tower is required to be located on the site, requiring a footprint of 22' by 42' or about 924 sq.ft. With the open-loop option, there is no cooling tower requirement.

Space Required for Central Energy Plant Equipment.

For Options A1 and B1, an enclosed central plant will be required to housing boilers, chillers, heat exchangers, pumps, and associated auxiliary equipment. The minimum area required is estimated to be about 3,330 SF. As indicated in Figure 1.3 (on the next page but not to scale), the area required for the Target "100" central plant is less, at about 3,023 SF. It appears that the Target 100 plant (Options A2/A3 and B2/B3) requires about 10% less mechanical area.

Space Required for Secondary HVAC Equipment.

Fans systems planned for the various Options are assumed to be located both within indoor mechanical rooms and on the roof. Space requirements for these systems are discussed below for the air handling units associated with Options A1, A2, and A3.

Indoor Fan Rooms (Options A1, A2, and A3).

Air handling units serving area on the two Diagnostics and Treatment levels are assumed to be located within indoor mechanical rooms. There are (7) VAV fan systems and (4) constant volume fan systems identified to serve these areas in the baseline prototype design.

In the Target "100" design two of the large VAV systems (at just under 50,000 cfm each) are replaced with fan coil units and two 5,000 cfm heat recovery units. The heat recovery units will be located outdoors and the fan coil units will be located above the ceiling. Thus, indoor fan room requirements will be reduced in the Target "100" design, by about 20%.

Rooftop Area Requirements (Options A1, A2, and A3).

For Option A1, six air handling units (serving the patient tower and medical office building) are assumed to be located on the roof. In the Target "100" design, those units are eliminated, but five heat recovery units (HRUs) will need to be located on the roof. The HRUs are significantly smaller (per unit) that the baseline air handling units, thus it is expected that the overall roof area required for fan systems will be reduced by at least 25%.

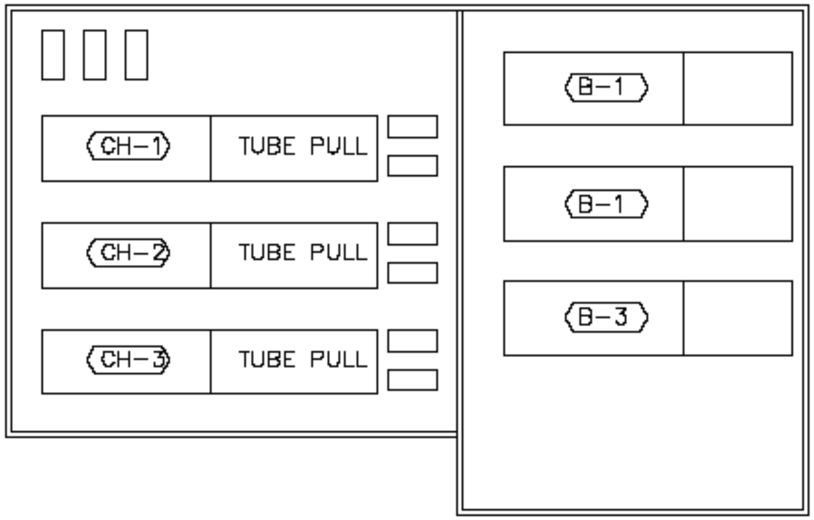
Floor to Floor Height in Patient Tower

As can be seen in Figure 1.3, sectional studies indicate that the duct height requirement can be reduced by up to 15 inches above the ceiling on each of the patient tower floors, due to the elimination of centralized return ducts and the reduction in overall size of the ventilation supply ducts.

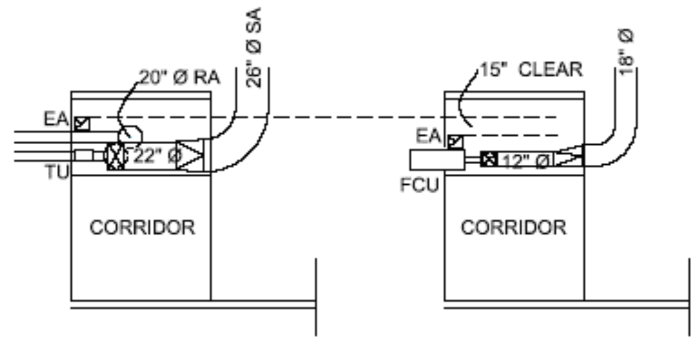
Capacity of Emergency Generators

If emergency generators are sized to only include air and heating system loads, the Target 100 design is projected to increase the capacity of the emergency generator plant by about 500 kW – from 1500 kW to 2000 kW (nominal capacity). This is primarily due to the significant increase in electrical load associated with generating heating water in the Target 100 design.

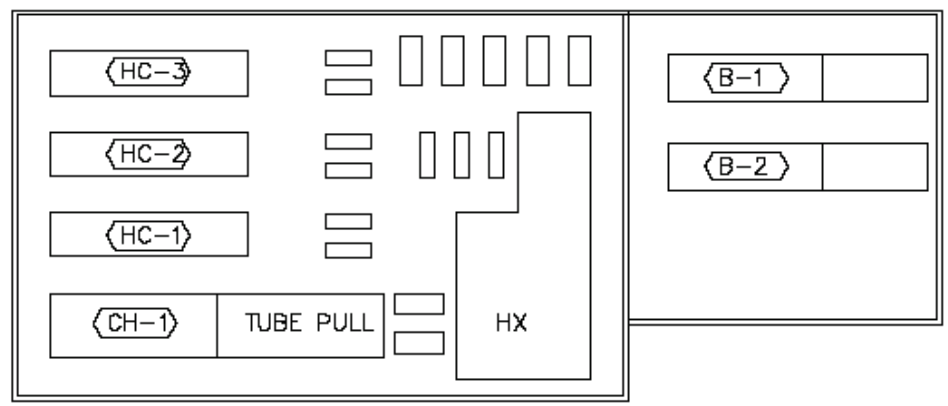
Though not strictly required by code, conventional practice for many hospital designs is to include some amount of the central cooling equipment in the emergency generator loads. If this practice were followed, then there would essentially no difference in the size of the emergency generator systems between the two design options.



PROTOTYPE BASELINE CENTRAL PLANT LAYOUT: 3330 SF
3/32"=1 FOOT



SECTIONS - DUCT CLEARANCE ABOVE CEILING
1/8"=1 FOOT



TARGET 100 CENTRAL PLANT LAYOUT: 3023 SF
3/32" = 1 FOOT

FIGURE 1.3. AREA AND HEIGHT STUDIES.

2.0 Baseline Systems: Options A1 and B1

2.1 Secondary HVAC Systems

Secondary systems are a mix of return air capable variable air volume (VAV) and constant volume 100% outside air systems. VAV systems serve all of the diagnostics and treatment areas, patient towers, and medical office building. Constant volume (CV) systems serve dietary (kitchen and dining), labs (clinical and pathology), and a small laundry.

Option A1 - Air Handling Units

Air handling units (AHUs) for Option A1 are defined in Table 2.1.

Table 2.1. Summary of Baseline Secondary Fan Systems – Options A1.

Tag	Area Served	GSF Served	CFM	Fan Qty	SF HP	RF/EF HP
S-1	Emergency Rooms	21,500	43,200	1	75	25
S-2	DT1 and DT2 required ventilation spaces	42,412	43,500	1	75	25
S-3	DT1 and DT2 general spaces	58,609	48,900	1	75	25
S-4	DT1 and DT2 office spaces	84,354	50,000	1	75	25
S-5	Surgery suite	15,512	37,000	1	60	20
S-6	Surgery suite	15,512	37,000	1	60	20
S-7	Not used	0	0	0	0	0
S-8	Patient tower core	70,000	39,500	1	60	20
S-9	Patient tower core	70,000	36,800	1	60	20
S-10	Patient tower perimeter	33,600	48,200	1	75	25
S-11	Patient tower perimeter	35,500	50,000	1	75	25
S-12	Kitchen (100% OSA)	11,317	25,000	1	40	25
S-13	Laundry (100% OSA)	2,021	3,500	1	5	2
S-14	Clinical lab (100% OSA)	11,979	20,000	1	30	20
S-15	Pathology lab (100% OSA)	3,697	5,000	1	10	2
S-16	MOB general	22,400	27,200	1	50	15
S-17	MOB general	22,400	27,200	1	50	15
AC-1	Server room	671	1,020	1	2	0
Total		**521,484**	**543,020**		**877**	**309**

Average air flow rate is approximately 1.04 CFM/SF. (Typical existing hospitals in the Pacific Northwest average about 1.2 to 1.3 cfm/sf across the entire facility). Total installed fan power is defined at 1,186 hp (nominal)

Each of the VAV air handlers is equipped with variable frequency drives (VFDs) for capacity control of both supply and return fans. VAV unit configuration includes a single row pre-heat coil, single row central heating coil, and a 6 row central chilled water coil. A pre-filter and final filter section is also included in each unit. Face velocities at coils and filters are 500 fpm.

Each of the CV systems is equipped with a central heating coil and central cooling coil, as well as pre- and final filter sections. The units serving kitchen and clinical labs are equipped with heat recovery coils with a minimum effectiveness of 50%.

AHUs are sized to accommodate units located inside mechanical rooms, or weatherproof units located on the roof. For purposes of costing, assume the following:

- S-1, S-2, S-3, S-4, S-13, and S-14: Interior units located in mechanical rooms on the 1st or 2nd level.

- AC-1: Split system with indoor units located in the server room(s) and outdoor units on ground level.

- All other units: Located on the roof.

Option B1 - Air Handling Units.

Table 2.2 shows a summary of the secondary system sizing for Option B1. Note that there are two additional air handling units compared to Option A1. Total air flow rate, in cfm/SF, is 6% greater than Option A1, primarily due to increased peak cooling loads that translate to larger air flow rate requirements. Total fan horsepower is defined at 1,291 hp (nominal) which is about 9% greater than Option A1.

Table 2.2. Summary of Air Handling Units – Option B1.

Tag	Area Served	GSF Served	CFM	Fan Qty	SF HP	RF/EF HP
S-1 (VAV)	Emergency Rooms	20,132	40,300	1	60	20
S-2 (VAV)	D1 and D2 required ventilation spaces	49,271	52,700	1	100	25
S-3 (VAV)	D1, D2, and basement general spaces	25,257	35,900	1	60	20
S-4A (VAV)	D1 and D2 office spaces	63,856	51,800	1	75	25
S-4B (VAV)	D1 and D2 office spaces	38,714	31,300	1	50	15
S-5 (VAV)	Surgery suite	30,624	36,000	1	60	20
S-6 (VAV)	Not used	0	36,000	0	60	20
S-7 (VAV)	Patient towers core	48,510	41,100	1	60	20
S-8 (VAV)	Patient towers core	48510	41,100	1	60	20
S-9 (VAV)	Patient towers core	48,510	41,100	1	60	20
S-10 (VAV)	Patient towers perimeter	25,467	26,300	1	50	15
S-11 (VAV)	Patient towers perimeter	25,469	26,300	1	50	15
S-11B (VAV)	Patient towers perimeter	25,469	26,300	1	50	15
S-12 (CV 100% OSA)	Kitchen	12,810	25,000	1	40	25
S-13 (CV 100% OSA))	Laundry	1,600	3,500	1	5	2
S-14 (CV 100% OSA)	Clinical lab	13,800	20,000	1	30	20
S-15 (CV 100% OSA)	Pathology lab	3,734	5,000	1	10	2
S-16 (VAV)	MOB general	23,756	18,900	1	40	15
S-17 (VAV)	MOB general	24,210	21,000	1	40	15
AC-1	Server room	600	1,100	1	2	0
Total		**530,299**	**580,700**		**962**	**329**
CFM/SF			**1.10**			

Variable air volume (VAV) units and constant volume (CV) units are internally configured in a manner similar to the Option A1 units.

Air Distribution and Terminal Units

Air distribution and terminal units will be located above a suspended ceiling. Supply duct mains (out to terminal units) shall be designed to withstand pressures up to 8 inches wc, and shall be round duct sealed to leakage class 3. Terminal units shall be VAV type, capable of dual maximum air flow setpoints and occupancy sensor interface, and shall be equipped with hydronic reheat coils (1 row). Ductwork downstream of terminal unit to room inlets/outlets shall be low pressure rectangular. For purposes of costing, typical VAV unit air distribution shall be assumed to be as follows, based on a typical patient room perimeter unit (S-10, S-11 in Option A1):

Table 2.3. Typical Air System Distribution Elements.

		Fittings	
Element	**Length, ft.**	**Description**	**Quan.**
Riser system (S/R)			
64" dia.	20	Reducer fitting	1
		Elbow	1
60" dia	20	Reducer fitting	1
		Elbow	1
58" dia	15	Reducer fitting	1
52" dia.	15	Reducer fitting	1
50" dia.	15	Reducer fitting	1
46" dia.	15	Reducer fitting	1
40" dia	15	Reducer fitting	1
38" dia.	15	Reducer fitting	1
28" dia.	40	Elbows	1
		Rect-to-round	5
26" dia.	40	Elbows	1
		Rect-to-round	5
Horizontal ducts (S/R)			
20" dia.	320		
18" dia.	760	Elbow	20
16" dia.	820		
14" dia.	300	Elbow	10
12" dia.	100		
10" dia.	460	Elbow	5
8" dia.	130		
6" dia.	960	Elbow	10
		Conical take-offs	130
Terminal Units			
400 to 500 cfm TUs			130
400-500 cfm diffusers			130
300-400 cfm RA grilles			130
75 cfm exhaust air grilles			130

A typical floor layout is shown in Figure 2.1 (next page). Exhaust air ductwork is shown in Figure 2.1 as rectangular, low pressure type. All duct construction shall be galvanized steel. It is anticipated that costs associated with air distribution systems for the other prototype baseline air systems, as listed in Tables 2.1 and 2.2, can be estimated by using the information listed in Table 2.3. This is consistent with the duct lay-out indicated in Figure 2.1.

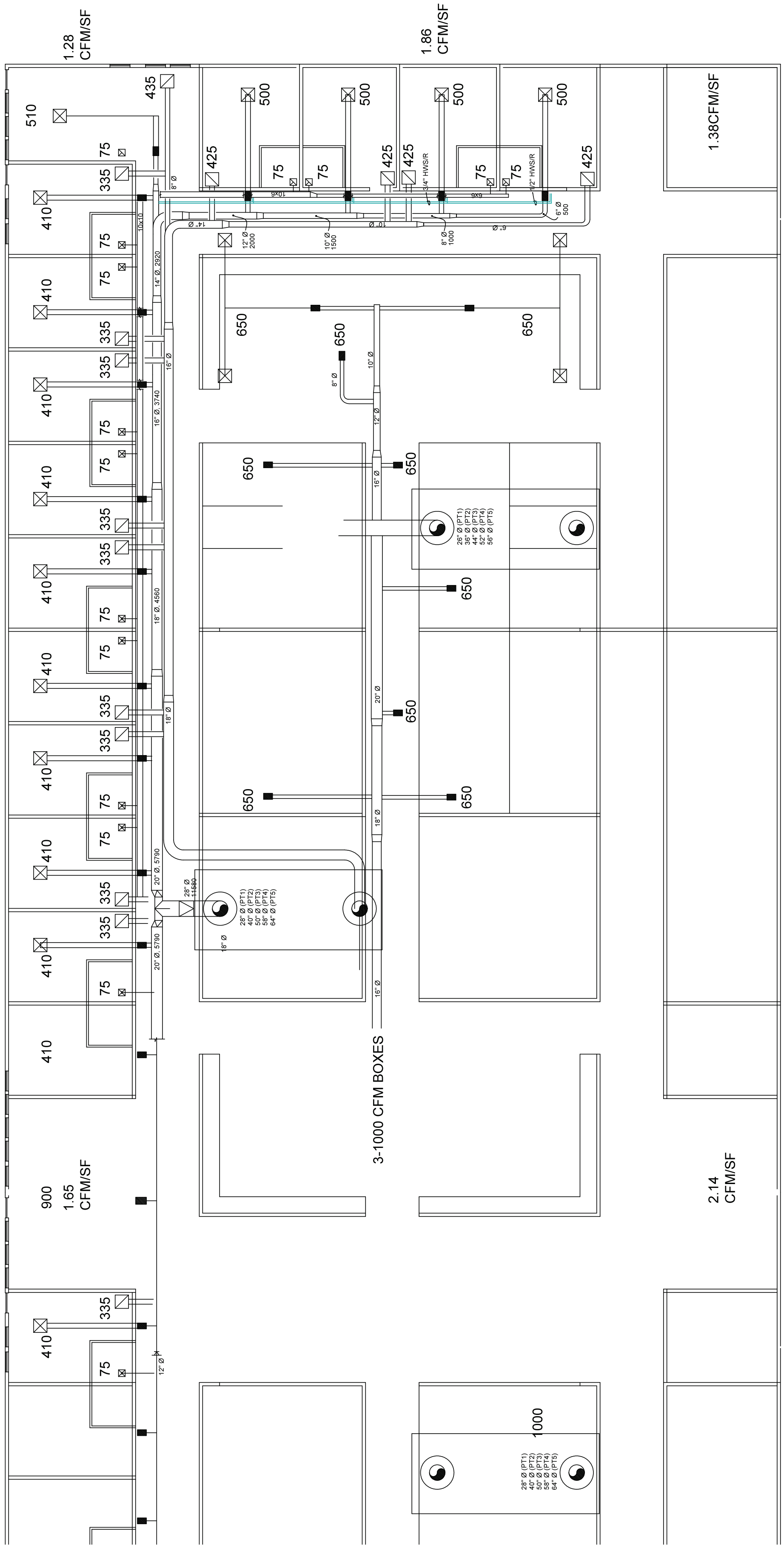


Figure 2.1. Partial Plan – Typical Patient Floor Duct Layout – Option A1 (Not to Scale)

Option B1 has a more horizontally-configured massing with more individual air handling units and a modestly greater air flow rate. It is anticipated that the amount of sheet metal work associated with ducting will increase, compared to Option A1. For purposes of costing Option B1, the following assumptions can be made:

- Cost of air handling units: Increase by 10%, based on two additional units.
- Cost of air distribution system: Increase by 7%, to account for additional ductwork serving a similar number of thermal zones.

2.2 Central Energy Plant

The baseline central energy plant consists of central steam and chilled water generation. Steam is used directly for process loads (laundry, dietary, sterilization, and humidification), and is converted to hot water for potable hot water, preheat and central heating coils in air handling units, and reheat coils at zone terminal units. A few convectors are likely to be attached to one or more of the heating water loops.

Steam Boiler Plant.

Boiler plant will be a medium pressure steam plant delivering steam at 125 psig. Three 300 bhp fire-tube boilers will comprise the plant that will deliver plant steam to the laundry, 60 psig steam to sterilizers and kitchen equipment, and 15 psig steam to potable water heaters, heating water converters (central heating coils and reheat coils), and clean steam generators for surgery suite AHU humidifiers. Figure 2.2 (next page) is a schematic diagram showing the steam plant and basic load configuration with basic component and pipe sizes, along with the central chiller plant.

Boiler sizing was adapted from predicted peak diversified loads developed from "in-progress" energy and loads DOE2 models. Load components used for sizing are as follows, extracted from the models for Option A1.

- Reheat loop: 6,475 MBH (diversified peak)
- Central heat/pre-heat loop: 2,699 MBH (diversified peak)
- Potable hot water: 3,444 MBH (diversified peak)
- Process: 1,125 MBH
- Humidification: 1,150 MBH

Total diversified peak: 14,893 MBH x 1.30 oversize = 19,361 MBH

Lead and lag boilers were sized to meet 50% of the peak, or 9680 MBH (approx. 300 boiler horsepower). A third 300 bhp boiler was added as back-up. Blowers for each dual-fuel burner (natural gas – diesel) are equipped with a constant speed 20 hp blower motor. Total installed boiler capacity is just under 60 Btuh/SF, (This is a reasonable match with existing regional hospitals). Basis of costing specifications are listed below:

- Boilers: Cleaver Brooks CB-LE-300
- Feedwater system: 600 gallons, 2@1 hp condensate pump, 2@7.5 hp feedwater pumps

Steam Boiler Plant Sizing for Option B1

Using the sizing criteria outlined for Option A1 above, the steam boiler plant for Option B1 is about 8% larger than Option A1. This translates to a total diversified peak load of 20,860 Btu/hr (compared to 19,361 Btu/hr for Option A1). The boilers and feedwater system specified as the basis of costing for Option A1 will meet the modestly increased load associated with Option B1. Therefore, the cost of the heating plant for Option 3 is assumed to be the same as Option 1.

Steam to Water Heat Exchangers (Converters)

Three steam to water converters are assumed for purposes of developing a cost model for the baseline plant. Each converter is a shell and tube type, sized based on the sum of the component capacities served by each heat exchanger, with a modest diversity (of 80% applied). Sizing criteria is summarized below:

HX-1: Serving heating coils in 100% OSA units and pre-heat coils in VAV units. Sum of coil capacities is 11,497 MBH. Heat exchanger capacity is established at 80% of that sum, or 9200 MBH. Two 20-hp constant speed heating water pumps are installed in a lead-standby configuration. Design heating water temperatures are 180F LWT / 140F EWT.

HX-2: Serving central heating coils in VAV units. Sum of coil capacities is 5,707 MBH. Heat exchanger capacity is established at 80% of that sum, or 4600 MBH. Two 10-hp constant speed heating water pumps are installed in a lead-standby configuration. Design heating water temperatures are 180F LWT / 140F EWT.

HX-3: Serving reheat coils in VAV terminal units throughout the facility. Undiversified load is estimated to be about 19,740 MBH. Heat exchanger capacity is established at 80% of that sum, or 15800 MBH. Two 30-hp constant speed heating water pumps are installed in a lead-standby configuration. Design heating water temperatures are 180F LWT / 140F EWT.

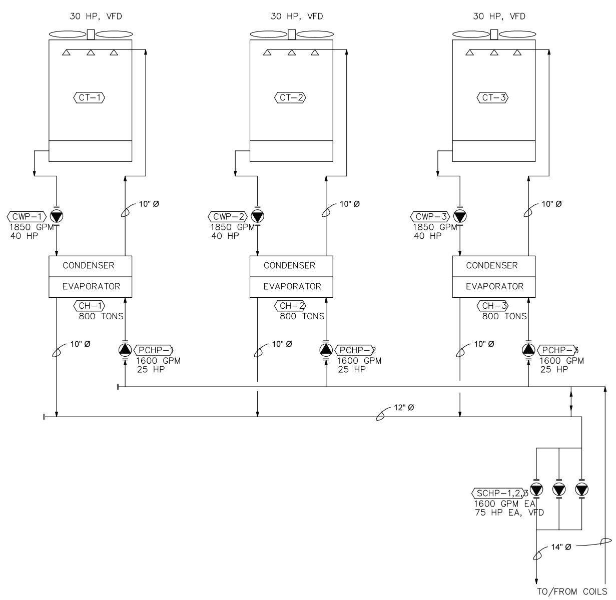
Total installed capacity for the converters is 29,600 MBH. This is 33% greater than the output of the boiler plant (sans back-up). This is typical for distributed component sizing.

Instantaneous Potable Water Heaters

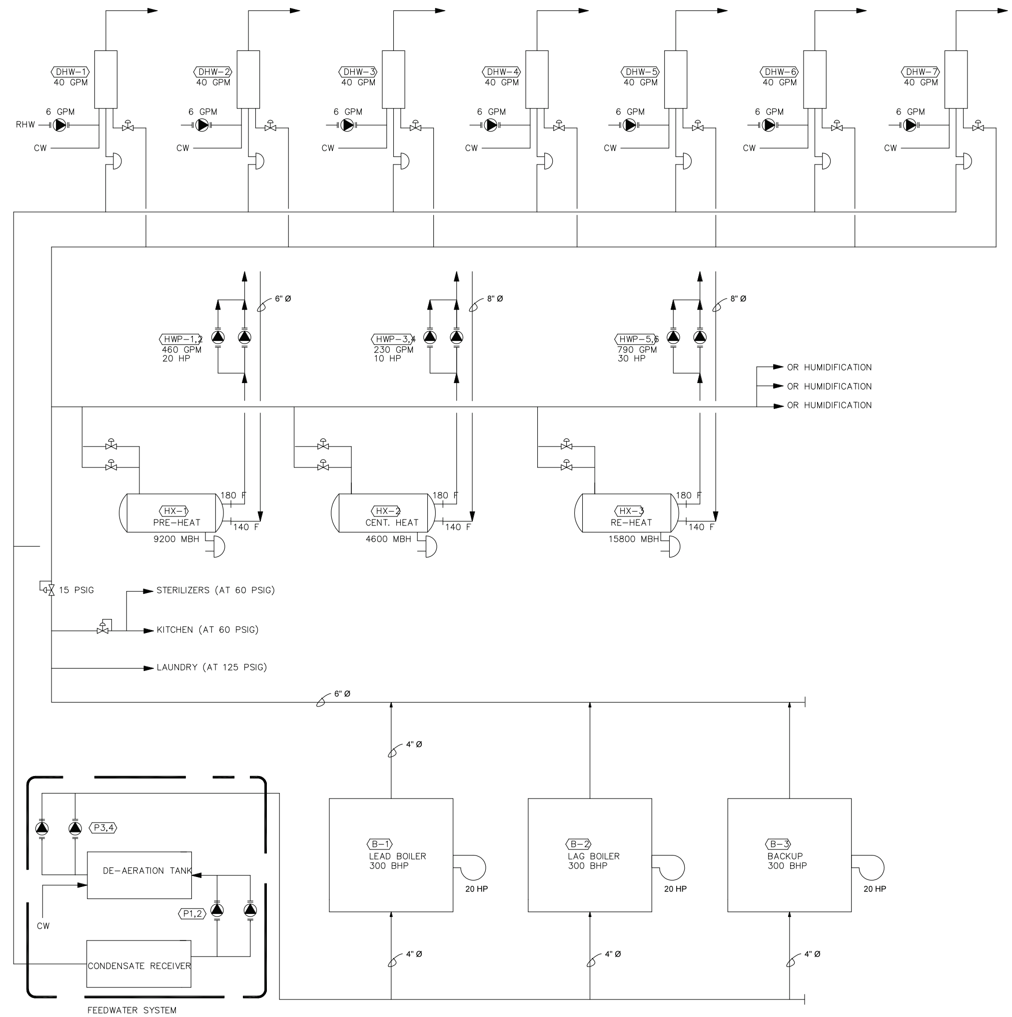
Seven instantaneous steam-fired potable water heaters are assumed for purposes of developing a cost model for the baseline plant. Each heater is sized at 40 gpm (1200 MBH), and is planned to serve loads on each level, as follows:

- DHW-1: DT level 1 and MOB
- DHW-2: DT level 2
- DHW-3/7: Individual patient tower floors (dominated by shower loads)

Basis of design: Aerco DW-24, 6 gpm recirculation pump (1/6 hp)



Central Chiller Plant



Central Boiler Plant

Figure 2.2. Schematic Diagram – Central Energy Plants – Option A1

Undiversified capacity for potable hot water heating is 8400 MBH. Diversified peak load, for plant sizing, is estimated at about 3500 MBH (42% of undiversified capacity). Without storage in the system, this implies that about 42% of the hot water-using plumbing fixtures would be in use during a peak load hour. This seems reasonable.

Condensate Return

All steam-using components will be equipped with steam traps (assume float and thermostatic type), compatible with steam pressure delivered to device. Condensate return on each level will be via gravity, back to a local receiver. Condensate will be pumped from each receiver back to the plant feedwater system.

Central Chiller Plant

The chiller plant will include three water-cooled centrifugal chillers, each sized at 800 tons of refrigeration capacity. Plant equipment configuration is based on peak load derived from “in-progress” energy and loads models, with 30% oversize factor. That load is met by two equally sized chillers. A third chiller, sized for 50% of peak load, is included in the plant as a back-up chiller. Total installed chiller plant capacity is just under 220 SF/ton, which is consistent with typical hospitals across the Pacific Northwest.

Chilled water system performance basis is as follows:

- Chilled water supply temperature: 44 F
- Chilled water return temperature: 56 F
- Condenser water supply temperature: 74 F
- Condenser water return temperature: 86 F
- Chiller full load efficiency: 6.10 COP
- Chiller integrated part load value: 6.10 COP

Each chiller will be equipped with a dedicated cooling tower, each equipped with VFD control of the tower axial fan. Condenser water loops are constant flow, with constant speed pumps. Chilled water hydronic system is a primary-secondary system with variable flow secondary loop. Primary evaporator pumps are constant speed, constant volume. Secondary chilled water pumps are variable speed, variable volume. Pump speed and staging is controlled on differential pressure at the farthest significant chilled water coil.

Basis of costing specifications are listed below:

- Chillers: York Max E series
- Cooling Towers: SPX (Marley) NC Series, 30 hp axial fan
- Pumps: Based-mounted end-suction, Bell & Gossett Series 1510.

Central Chiller Plant Sizing for Option B1.

Using the sizing criteria outlined for Option A1, the chiller plant for Option B1 requires three chillers with a net peak capacity of 785 tons. This is essentially identical to the three (3) 800-ton centrifigual chillers with associated cooling towers and pumps that were defined as the basis for costing of Option A1. The chilled water plant, specified as the basis of costing for Option A1, is appropriate to use as the basis of costing for Option B1.

Hydronic Systems

The secondary chilled water system serves about (17) central chilled water coils in the air handling units. Riser piping is estimated to be 14-inch supply and return. Return piping design is direct return. Coils are equipped with 2-way modulating flow control valves. A bypass valve and piping arrangement is assumed to be installed at a point in the system, with a differential pressure sensor installed to control secondary pump capacity (staging and speed). Primary chilled water pumps and condenser water pumps are directly linked to each chiller and will operate when that chiller is enabled. Automatic flow control valves (2-way, 2-position) are assumed to be installed on each chiller to isolate the chiller from the primary chilled loop when not in operation. Significant pumps are defined in Table 2.4.

Table 2.4. Hydronic System Pumps for Baseline Central Plant.

Tag	Flow, GPM	Head, Ft H2O	Mech. Eff.	BHP	Nom. HP	Service	Status	VFD
P-1					1	Condensate pump	Lead	N
P-2					1	Condensate pump	Stand-by	N
P-3					7.5	Feedwater pump	Lead	N
P-4					7.5	Feedwater pump	Stand-by	N
HWP-1	460	100	0.75	15.49	20	Pre-heat coil loop pump	Lead	N
HWP-2	460	100	0.75	15.49	20	Pre-heat coil loop pump	Stand-by	N
HWP-3	230	100	0.7	8.30	10	Central heat coil loop pump	Lead	N
HWP-4	230	100	0.7	8.30	10	Central heat coil loop pump	Stand-by	N
HWP-5	790	100	0.8	24.94	30	Reheat loop pump	Lead	N
HWP-6	790	100	0.8	24.94	30	Reheat loop pump	Stand-by	N
PCHP-1	1600	40	0.75	21.55	25	Primary chilled water pump	Lead	N
PCHP-2	1600	40	0.75	21.55	25	Primary chilled water pump	Lag	N
PCHP-3	1600	40	0.75	21.55	25	Primary chilled water pump	Stand-by	N
CWP-1	1850	50	0.75	31.14	40	Condenser water pump	Lead	N
CWP-2	1850	50	0.75	31.14	40	Condenser water pump	Lag	N
CWP-3	1850	50	0.75	31.14	40	Condenser water pump	Stand-by	N
SCHP-1	1600	125	0.8	63.13	75	Secondary chilled water pump	Lead	Y
SCHP-2	1600	125	0.8	63.13	75	Secondary chilled water pump	Lag	Y
SCHP-3	1600	125	0.8	63.13	75	Secondary chilled water pump	Stand-by	Y
Total				**444.92**	**557**			

Heating Water and Potable Hot Water Hydronic System Sizing for Option B1

While the boiler plant capacity is of similar size to Option A1, the piping associated with the heating water and potable hot water systems are expected to be modestly more expensive due to the distributed nature of the Option B1 massing. Piping costs should be increased in the 7 to 10% range, similar to that adjustment suggested for air distribution system costs.

2.3 Controls

Controls for the entire mechanical system are direct digital control (DDC) type.   Damper and valve actuators are assumed to be electronic. Table 2.54 presents a “basis of cost” points list for Option A1.

Table 2.5. Basis of Cost Points List for Option A1.

	Quantity of Points				
Description	**DO**	**DI**	**AO**	**AI**	**Comments**
Fan stop/start	36				SF/RF/EF
Fan status		36			
Duct static pressure				35	
OSAT				1	Global point
Return air temperatures				35	
Mixed air temperatures				35	
Coil discharge air temperature				35	
Duct supply air temperatures				35	
Zone temperatures				1330	
Terminal units			1330		Boxes,reheat coils
Filter pressure differential				35	
Duct humidity				30	
OSA damper			17		
Return air damper			13		
Relief air damper			13		
Heat recovery wheel	2				
Fan speed			26		
Pump stop/start	19				
Pump status		19			
Boiler enable/disable	3				
Boiler steam pressure				3	
Boiler stack temperature				3	
Pump speed			3		
Piping differential pressure				1	
Converter steam valves			6		
DHW heater steam valves			7		
Heating water supply temperature				3	
Heating water return temperature				3	
Heating coil valves			23		
Reheat valves			0		included above
Chiller enable/disable	3				
Chilled water supply temperature				4	
Chilled water return temperature				4	
Condenser water supply temperature				3	
Condenser water return temperature				3	
Cooling tower enable/disable	3				
Cooling tower fan speed			3		
Cooling tower status		3			
Chiller status		3			
Chilled water coil valves			16		
Subtotal	66	61	1457	1598	
15% extra points	10	9	219	240	
Total points	**76**	**70**	**1676**	**1838**	**3660**

For Option B1, add 30 points to the points list above to account for two additional air handling units.

3.0 High Performance “Target 100” Design: Options A2 (and A3) and B2 (and B3)

3.1 Secondary HVAC Systems

Secondary systems are primarily four-pipe fan coil units with minimum ventilation provided via dedicated ducted outside air system(s) with heat recovery. Some areas within the hospital will be served by advanced VAV systems and/or CV units.

Air Handling Units & Fan Coil Units - Options A2

Air handling units (AHUs) and fan coil units (FCUs), defined as the basis of costing for Option A2, are listed in Table 3.1. Of the total floor area, approximately 70% is served by fan coil units with dedicated heat recovery ventilation units. The remaining 30% of the floor areas is served by advanced variable air volume (VAV) or constant volume (CV) units.

Table 3.1. Summary of Proposed Secondary Fan Systems – Option A2.

Tag	Area Served	GSF Served	SCFM	Fan Qty	SF HP (total)	RF/EF HP (total)
S-1	Emergency Rooms	27,892	51,700	1	75	25
S-2	DT1 (code-regulated)	25,671	26,700	1	40	15
S-3	DT2 (code-regulated)	24,272	40,000	1	60	20
ERU-1/2	DT1 and DT2 general spaces		5,000	2	15	10
FCU-A	DT1/2	43,000	300	98	24.5	0
FCU-B	DT1/2	86,000	600	97	48.5	0
S-5	Surgery suite	15,512	37,000	1	60	20
S-6	Surgery suite	15,512	37,000	1	60	20
S-7	Not used	0	0	0	0	0
ERU-3/4/5/6	Patient tower		10,000	4	60	30
FCU-A	Patient tower	104,750	300	270	67.5	0
FCU-B	Patient tower	104,750	600	135	67.5	0
S-12	Kitchen	11,317	25,000	1	40	25
S-13	Laundry	2,021	3,500	1	5	2
S-14	Clinical lab	11,979	20,000	1	30	20
S-15	Pathology lab	3,697	5,000	1	10	2
ERU-7	MOB general	0	5,000	1	7.5	5
FCU-A	MOB general	22,400	300	82	20.5	0
FCU-B	MOB general	22,400	600	45	22.5	0
AC-1	Server room	671	1,020	1	2	0
Total		**521,844**			**715.5**	**194**

Total installed fan power is define d at 909.5 hp (nominal), representing a 23% reduction compared to Option A1.

Diagnostics and Treatment Air Systems – Options A2/A3.

Approximately 130,000 SF of diagnostics and treatment (DT) on both levels are not anticipated to have the HVAC design regulated by code requirements. This area is proposed to be served by zonal 4-pipe fan coil units (FCUs) and dedicated OSA energy recovery units. For purposes of costing, assume that approximately 1/3 of the floor area is served by 300 cfm FCUs. The remaining floor area is served by 600 cfm FCUs. Each fan coil will be equipped with a mixing plenum, side access filter section capable of supporting a 4-inch MERV 11 filter, heating water coil selected for 115 F EWT, and chilled water coil. Used as a basis of actual product costing for fan coil units, high performance fan coil units as manufactured by TechAire for use in the Venice Hospital (Florida) are pictured in Figure 3.1 below.

Figure 3.1. Side View before Panel is Installed showing frame, fan section, coils, and filter bolt assembly.

Two 5,000 cfm energy recovery units (ERUs) serve the fan coil units. Each ERU is equipped with an energy recovery wheel capable of recovery effectiveness of 70%. Fans will be equipped with variable frequency drives (VFDs).

In the areas that continue to be served by central air handling units and overhead ducted VAV, a number of best practices in energy efficient design of VAV systems will be layered into the design in order to improve energy performance. These practices are expected to affect cost of the systems to a degree, as summarized below:

- Air velocities will be reduced to 400 fpm (maximum) across filters and coils through the air handling unit cabinet. This is expected to result in upsize of the cabinet by one unit size for each of the AHUs scheduled to remain.
- Fan wheels will be selected for maximum mechanical efficiency. This is expected to increase wheel diameter by one unit size, but will fit nicely with the upsized AHU cabinent.
- High efficiency, high performance filters will be used for pre- and final-filters. Pre-filters will be 4-inch mini-pleat type (Farr 30/30, or equivalent). Final filters will be 12-inch mini-pleat cartridge type (MERV 14 minimum efficiency).
- Terminal units will be sized for 0.5 inch wc maximum pressure drop. Maximum air flow rates are terminal units will be established to allow peak loads to be met at 60 deg. F air temperatures. This is expected to result in VAV box sizes that are identical to the prototype baseline even though peak cooling loads have been reduced through a combination of high performance windows and ultra-efficient electric lighting.
- Control sequences and points will incorporate occupancy sensor signals in a comprehensive way. This is addressed within the points list provided in Section 3.3.

Patient Tower Systems – Options A2/A3

Patient rooms are proposed to be served by 300 cfm 4-pipe horizontal fan coil units located just inside of the corridor wall, and accessed from the corridor for maintenance. Each fan coil will be equipped with a mixing plenum, side access filter section capable of supporting a 4-inch MERV 14 filter, heating water coil selected for 115 F EWT, and chilled water coil. Each patient room fan coil will be served by a dedicated ventilation duct providing 75 cfm to each fan coil. For purposes of costing, the core areas are divided into (27) thermal zones per floor, each served by a 600 cfm horizontal fan coil unit. Note that condensate drain pans and drain piping will be required for all fan coil units.

Four 10,000 cfm energy recovery units (ERUs) serve the patient tower. Each ERU is equipped with an energy recovery wheel capable of recovery effectiveness of at least 70%. Fans will be equipped with variable frequency drives (VFDs).

- Basis of costing for ERUs: McQuay RPS/RFS 025C

Air Handling Units & Fan Coil Units - Options B2/B3

Table 3.2 shows a summary of the secondary system sizing for Option B2. It is essentially identical to Option A2 except applied to a “perforated” geometry with a program adjusted to match the initial definition of that geometry. As a result, the regulated areas (especially the surgery) are similar to Option B1. The non-regulated areas are served by 4-pipe fan coil units, selected in sizes of 300 cfm and 600 cfm for purposes of cost modeling. In addition, the non-regulated areas are served by dedicated Energy Recovery Units (ERUs) to provide fresh air to these spaces at minimum energy input.

Table 3.2. Summary of Air Handling Units – Option B2.

Tag	**Area Served**	**GSF Served**	**Quan.**	**SCFM**	**SF HP (total)**	**RF/EF HP (total)**
S-1 (VAV)	Emergency Rooms	20,132	1	40,300	60	20
S-2 (VAV)	D1 and D2 required ventilation spaces	51,921	1	52,700	100	30
S-3 (VAV)	D1 and D2 regulated spaces	9,423	1	25,800	40	15
ERU-1 thru 6	DT/Patient tower ventilation (OSA)	0	6	10,000	45	30
FCU-A	DT/Patient tower	155,700	373	300	93.25	0
FCU-B	DT/Patient tower	181,989	241	600	120.5	0
S-5 (VAV)	Surgery suite	15,312	1	36,000	60	20
S-6 (VAV)	Surgery suite	15,312	1	36,000	60	20
S-12 (CV 100% OSA)	Kitchen	12,810	1	25,000	40	25
S-13 (CV 100% OSA)	Laundry	1,600	1	3,500	5	2
S-14 (CV 100% OSA)	Clinical lab	13,800	1	20,000	30	20
S-15 (CV 100% OSA)	Pathology lab	3,734	1	5,000	10	2
ERU-7	MOB (OSA)	0	1	5,000	7.5	5
FCU-A	MOB	25,200	93	300	23.25	0
FCU-B	MOB	22,766	46	600	23	0
AC-1	Server room	600	1	1100	2	0
Total		530,299			719.5	189

Total installed fan power is define d at 908.5 hp (nominal), representing a 30% reduction compared to Option B1.

A summary of comparison points is listed below, for purposes of developing a cost estimate of the Option B2 secondary HVAC systems.

Comparing Options B2/B3 to Options A2/A3

- Option B2/3 is defined to have more fan coil units (FCUs) than defined for Option A2/3. In Option A2, there are (450) 300 cfm units and (277) 600 cfm units. In Option B2/3, there are (466) 300-cfm units and (287) 600 cfm units. The cost of the fan coil units can be assumed to increase accordingly relative to Option A2/3.
- The air flow rates for the Energy Recovery Units in Options A2/3 and B2/3 are identical. Option B2/3 defines six (6) 10,000 cfm ERUs for the hospital areas, and one (1) 5,000 cfm unit for the MOB. The cost of the ERUs can be assumed to be about the same as that carried for Option A2.
- Configuration of individual FCUs and ERUs is similar to Option A2/3.
- Configuration of remaining VAV systems, designed for advanced performance, is similar to Option A2/3.

Air Distribution – Option A2/A3

Overall, air distribution systems will change significantly from the baseline concepts (Options A1 and B1). Wherever fan coil units are used, duct systems will be low pressure type and will be localized. Ventilation air will be ducted to the fan coil units within a medium pressure/low pressure duct system. For purposes of costing, typical fan coil unit air distribution shall be assumed to be as summarized in Table 3.3, for about half of perimeter patient rooms, served by one of four ERUs. (This covers an area of about 40,000 SF). A typical floor layout is shown in Figure 3.2. All duct construction shall be galvanized steel.

Table 3.3. Typical Air System Distribution Elements – Options A2/A3.

		Fittings	
Element	Length, ft.	Description	Quan.
Riser system (S/E)			
34" dia.	40	Elbow	2
30" dia	30	Reducer fitting	2
28" dia	30	Reducer fitting	2
24" dia.	30	Reducer fitting	2
18" dia.	40	Elbow	2
		Rect-to-round	10
Horizontal ducts (S/R)			
12" dia.	1230	Elbow	20
10" dia.	1240	Elbow	10
8" dia.	500		
6" dia.	300		
		Conical take-offs	135
Terminal Units			
300 cfm FCUs			135
300 cfm diffusers			135
224 cfm RA grilles			135
75 cfm exhaust air grilles			135

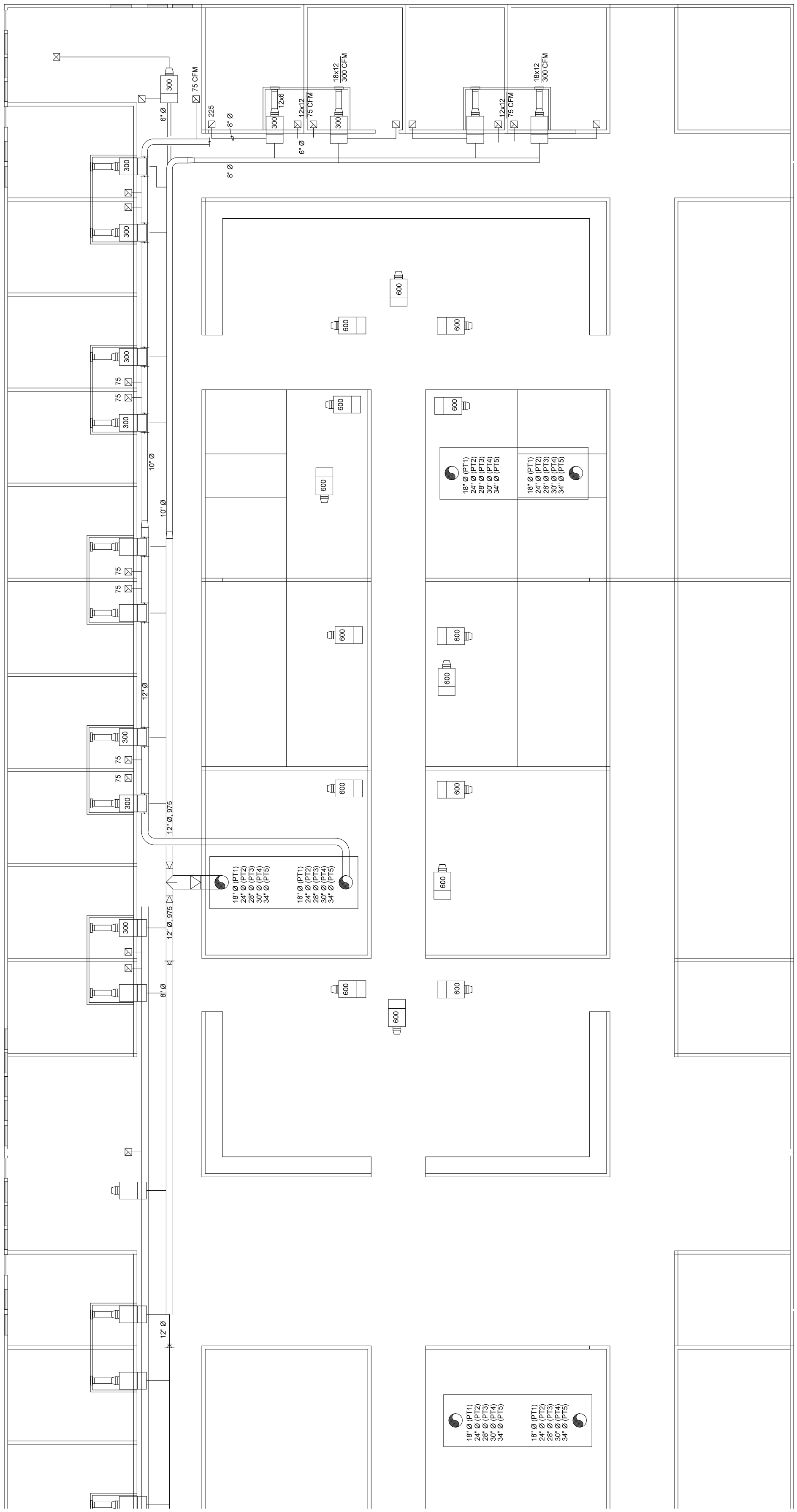


Figure 3.2. Partial Plan – Typical Patient Floor Duct Layout – Option A2/A3 (Not to Scale)

Air Distribution, Terminal Units, and Fan Coil Units – Option B2/B3

The total number of terminal units (thermal zones) for the VAV air distribution system has not been rigorously defined for purposes of this cost model. The remaining VAV systems serving code regulated areas in the Emergency Dept., Diagnostics and Treatment, and Surgery Areas are defined to require 197,800 cfm (304 terminal units (TUs) at an average cooling air flow rate of 650 cfm per TU). Option A2/A3 can be considered to have more terminal units by about the same percentage difference as exhibited in fan coil unit totals, i.e, about 317 TUs. Cost suggestions are listed below.

- Cost of fan coil units, relative to Option A2/A3, should *increase* proportional to the increased number of units.
- Cost of VAV terminal units, relative to Option A2/A3, should *decrease* proportional to the reduced number of units.
- Cost of sheet metal associated with air distribution should increase modestly, relative to Option A2/A3, to account for the longer runs of ventilation ducting and the increased amount of low pressure ductwork.

Air Handling Units Exhaust Air Coils – Options A3 and B3

As discussed above, secondary systems for Options A3 and B3 are very similar to A2 and B2. They are primarily four-pipe fan coil units with minimum ventilation provided via dedicated ducted outside air system(s) with heat recovery. Some areas within the hospital will be served by advanced VAV systems and/or CV units. These include the Emergency Room (S-1); code-regulated zones in Diagnostic and Treatment (S-2 and S-3); surgery suites (S-5, S-6, and S-7); dietary (S-12); laundry (S-13); clinical lab (S-14); and pathology lab (S-15).

This plant alternative requires modifications to be made to S-1, S-2, S-3, S-5, S-6, and S-7. The modifications will consist of adding a heat recovery chilled water coil to the exhaust air stream for each unit. This will require a filter bank for coil protection, modification to the air handling unit to install the coil, modification to the return fan to allow for the added pressure drop, and modification to piping and valving to accommodate the plumbing of the coil. For purposes of this costing effort, coils have been selected as follows:

- Coil face velocity: 400 fpm
- Coil entering air temperatures: 68F dbt / 57F wbt
- Coil leaving air temperatures: 50F dbt / 49F wbt
- Ave. added pressure drop (filter/ 6-row 8 fpi coil): 0.65 inches wc

Table 3.4 summarizes the increased fan horsepower (nominal) that is anticipated for the six affected air handling units. Note that this will also affect the sizing of the variable frequency drives (VFDs) that are to be provided with each fan motor.

Table 3.4. Summary of Increased Exhaust Fan Motors and Drives – Option A3.

Tag	Area Served	GSF Served	SCFM	Fan Qty	A2 RF/EF HP	A3 RF/EF HP
S-1	Emergency Rooms	27,892	51,700	1	25	40
S-2	DT1 (code-regulated)	25,671	26,700	1	15	25
S-3	DT2 (code-regulated)	24,272	40,000	1	20	30
S-5	Surgery suite	15,512	37,000	1	20	30
S-6	Surgery suite	15,512	37,000	1	20	30

Increased costs associated with exhaust coils added to VAV systems for Option A3 will be similar for Option B3.

3.2 Central Energy Plant

The high performance central energy plant responds to the load reduction design features of the secondary system, and integrates both heating and cooling into a modular heater-chiller plant (comprised of heat pumps). A separate, downsized steam boiler plant provides for the remaining process steam requirements (laundry, dietary, sterilization, and humidification).

Heating water hydronic system is a low-temperature design with 115F supply water temperature and 95F return water temperature. This is used for potable hot water, preheat and central heating coils in air handling units, reheat coils at zone terminal units, and heating coils in fan coil units. Heating and chilled water loops are ground-coupled. Two variations of ground-coupling are defined – one using well water in an open loop configuration and one using a closed loop configuration consisting of a large vertical bore-field with 300-foot bores.

Central Heater-Chiller Plant (Open Loop) - Option A2

The central heater-chiller plant consists of three 400-ton water-to-water heat pumps (heat recovery chillers) and one 800-ton cooling-dedicated centrifugal chiller. Plant sizing was approached in a manner similar to the baseline boiler and chiller plants. The plant capacities respond to the load reduction features of the high performance design including the elimination of reheat loads in about 70% of the conditioned area of the facility, and the solar control features associated with advanced glazing. Figure 3.3 presents a schematic diagram of the plant.

Heating system capacity was established, using the predicted plant loads from "in-progress" DOE2 energy and loads model, as follows:

- Process: 1,125 MBH
- Humidification: 1,150 MBH

Total steam load: 2,275 MBH x 1.3 = 2,958 MBH (or approx. 90 bhp)

Process boiler plant will consist of two 90 bhp steam boilers – one to meet load and one for back-up. Other heating loads are as follows:

- Combined DHW/hydronic loop heat load: 9646 MBH x 1.3 = 12540 MBH

Two heat pumps would need to provide 6270 MBH (400 tons nominal capacity) of heat output each. One of these units will be a dedicated heating unit. One will be a unit meeting both heating and cooling loads. A back-up 400 ton heat pump will be installed for heating equipment redundancy.

Total installed heating capacity within the plant is just under 50 Btuh/SF.

Basis of costing specifications are listed below:

- Heat Pumps: Multi-stack MS50 series (and/or equivalent products from Heat Harvester).
- Pumps: Based-mounted end-suction, Bell & Gossett Series 1510.

Cooling system capacity was established, using the predicted plant loads from the DOE2 energy and loads model, as follows:

- Secondary chilled water loop: 8337 MBH
- Surgery chilled water loop (modeled separately): 3014 MBH

Total chilled water load: 11351 MBH x 1.3 = 14756 MBH

A total capacity of about 1200 tons is defined. For this integrated plant concept, one of the 400 ton heat pumps will provide cooling as well as heating. For peak cooling period loads, a dedicated 800-ton centrifugal chiller is assumed to be installed. The back-up heat pump (400 tons) will also function to provide back-up for the cooling equipment. Total installed cooling plant capacity is 433 SF/ton, representing a 50% reduction compared to the prototype baseline cooling plant.

Basis of costing specifications are listed below:

- Heat Pumps: Multi-stack MS50 series (and/or equivalent products from Heat Harvester)
- Chillers: York Max E series
- Pumps: Based-mounted end-suction, Bell & Gossett Series 1510

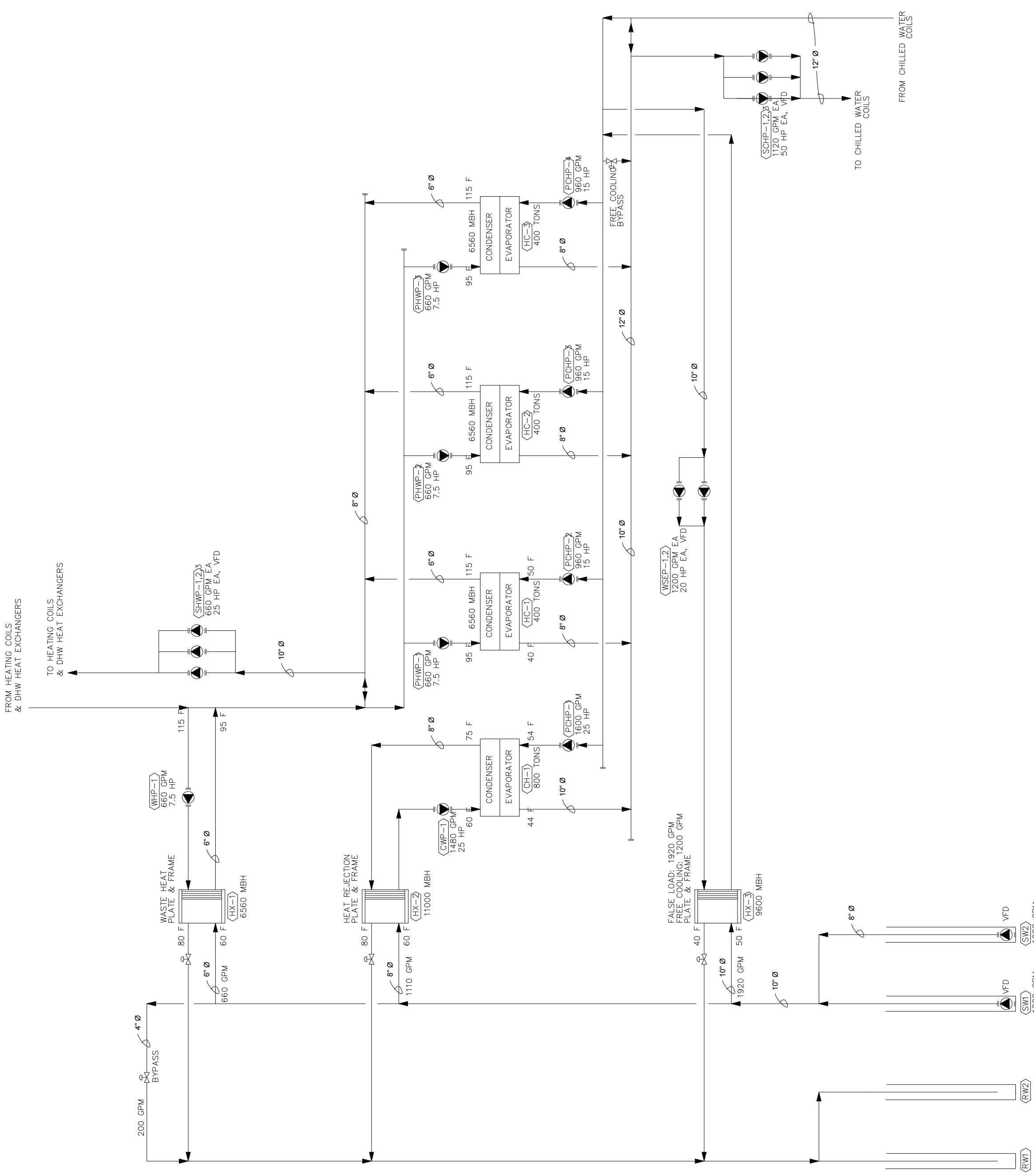


Figure 3.2. Schematic Diagram – Open Loop Heater Chiller – Option A2

The plant is coupled to an open ground-water loop with supply well capacity defined at 2000 gpm. A minimum of two supply wells and two re-injection wells should be developed (each at 1000 gpm capacity). Well pumps should be equipped with variable frequency drives (VFDs) for flow control. Well water loop and building hydronic loops are physically isolated via plate and frame heat exchangers selected for close approach temperatures (3 deg F or less). Three heat exchangers are defined – one for "false loading" of the heat pumps and/or free cooling using well water as the source of cooling, one for heat rejection from the 800 ton cooling-only chiller, and one for general heat rejection from the heating water loop (for periods where heat pumps are used for both heating and cooling). Figure 3.2 indicates configuration and capacity of each heat exchanger, as well as associated pumps.

Basis of costing specifications are listed below:

- Heat Exchangers: Plate and frame type; sized for close approach (3 deg. F or less)

Potable Water Heating Heat Exchangers

Small, modular brazed plate heat double wall exchangers sized for close approach are proposed to provide potable hot water in an instantaneous manner using low temperature heating water from the heater-chiller plant. Four (4) 20"x10" heat exchangers (200 plates each) are required to replace each steam-to-water heater as proposed in the prototype baseline system. A total of (28) heat exchangers arranged in a modular arrangement will be required.

This heat exchanger configuration assumes that entering cold water is pre-heated using heat recovered from warm waste water streams. The gravity film heat exchanger (GFX) technology is assumed to be integrated into the potable water heating system. This will require the following plumbing system modifications to the prototype baseline system:

- The proposed heat recovery system for hot waste water will recover heat from shower and sterilizer waste water and pre-heat incoming cold water at a central point of heat transfer. This will be located in a ground level mechanical room, and will require a separated waste/vent piping system for showers and sterilizers. Figure 3.3 illustrates a conceptual riser diagram for the waste/vent piping associated with Option A2. (Waste lines from kitchen dishwashing can potentially be connected. Two 4-inch risers are proposed, each serving half of the showers in the patient tower, and continuing down through D&T levels to mechanical space on the ground floor. Sterilizers on the 2nd level of D&T can be tied into the system.

- A custom heat recovery system is proposed to be designed and constructed using gravity film heat exchanger (GFX) technology. The risers should be located (in plan) so that they enter the same mechanical area and can be brought together with a 6-inch waste line. Hot waste water will be collected into a vented collection tank, of at least 120 gallons. Outlets located high on either side of the tank will allow water to be metered by gravity to the inlets on the top of (16) 80" tall GFX heat exchangers. Incoming cold water will be piping to the bottom connection of each heat exchanger and will be controlled by heat activated 2-position valves. Additional special components of the system are anticipated to include: (1) metering orifices designed to allow 5 gpm of wastewater flow into each heat exchanger at low pressure drops, (2) disinfection and flushing/cleaning provisions for the hot water collection tank, and (3) digital control overlay to integrate component control into a single system.

Basis of costing specifications are listed below:

- Modular Heat Exchangers: Brazed plate double wall, GEA DW series
- Gravity Film Heat Exchangers: GFX 80-LC

System components, identified for cost modeling, include the components listed in Table 3.4.

Table 3.4. Wastewater Heat Recovery System Elements – Option A2.

Component	**Quan.**		**Unit**
3" CI no hub pipe	4000		LF
4" CI waste pipe	200		LF
6" CI waste pipe	50		LF
4" roof penetrations	2		ea
GFX-80 (80" length)	16		ea
4"x 4" CI Y-fittings	32		ea
4" oriface plates (metering)	16		ea
Custom pipe fabrication at oriface plate	16		ea
Mounting hardware for GFX	16		ea
UV disinfection module	1		ea
1-1/2" Cu pipe insulated	40		LF
3/4" Cu pipe insulated	32		LF
3/4" x__ tees	32		ea
3/4" solenoid valves	16		ea
120 gallon SS tank, insulated.	1		ea

Condensate Return

All steam-using components will be equipped with steam traps (assume float and thermostatic type), compatible with steam pressure delivered to device. Condensate return on each level will be via gravity, back to a local receiver. Condensate will be pumped from each receiver back to the plant feedwater system. Number of traps, and size of condensate lines and receivers will be significantly downsized relative to the prototype baseline design.

Hydronic and Pumping Systems

Two submersible well water pumps are defined for this plant option. Each pump is projected to be a 100 hp pump with variable frequency drive (VFD) control. Both heating water and chilled water systems are defined as primary-secondary systems, for purposes of the cost modeling. Primary pumps on the hot and cold sides are constant speed pumps sized for the chiller or heat pump served. Primary chilled water pumps and condenser/heating water pumps are directly linked to each chiller and will operate when that chiller is enabled. Automatic flow control valves (2-way, 2-position) are assumed to be installed on each chiller to isolate the chiller from the primary loops when not in operation.

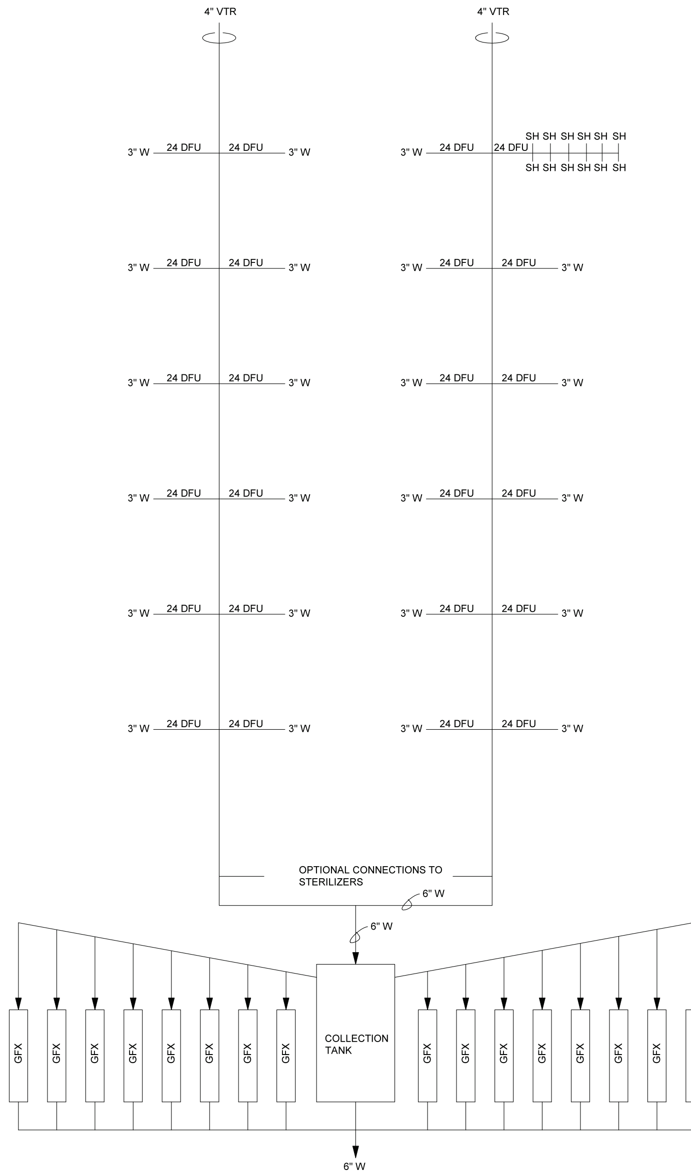


Figure 3.3. Schematic Riser Diagram – Shower Waste System – Option A2.

The secondary chilled water system serves about (10) central chilled water coils in the air handling units that are either VAV or CV. Seven energy recovery units (ERUs) are defined as dedicated ventilation units serving parts of the facility that are equipped with fan coil units. For purposes of this costing model, these ERUs are assumed to not have chilled water coils but are equipped with heating water coils for service during defrost operation, as needed. Just under (700) fan coil units are defined to be served by the secondary chilled water system. Riser piping is estimated to be 12-inch supply and return. Return piping design is direct return. Coils are equipped with 2-way modulating flow control valves. A bypass valve and piping arrangement is assumed to be installed at a point in the system, with a differential pressure sensor installed to control secondary pump capacity (staging and speed).

The secondary heating water system serves about (15) central heating coils, (6) pre-heat coils in VAV air handlers, and heating coils in all of the fan coil units. Valving and pump capacity control will be similar to the secondary chilled water system.

Table 3.5 summarizes the significant pumps that are anticipated to be part of this option.

Table 3.5. Hydronic System Pumps for Proposed Open Loop Heater-Chiller Plant.

Tag	Flow, GPM	Head, Ft H2O	Mech. Eff.	BHP	Nom. HP	Service	Status	VFD
P-1					0.5	Condensate pump	Lead	N
P-2					0.5	Condensate pump	Stand-by	N
P-3					2	Feedwater pump	Lead	N
P-4					2	Feedwater pump	Stand-by	N
SWP-1	1000	250	0.85	74.27	100	Well water pump	Lead	Y
SWP-2	1000	250	0.85	74.27	100	Well water pump	Lag	Y
PCHP-1	1600	35	0.8	17.68	20	Primary chilled water pump	Lead	N
CWP-1	1480	40	0.8	18.69	20	Condenser water pump	Lead	N
PCHP-2	960	35	0.75	11.31	15	Primary chilled water pump	Lead	N
PCHP-3	960	35	0.75	11.31	15	Primary chilled water pump	Lag	N
PCHP-4	960	35	0.75	11.31	15	Primary chilled water pump	Stand-by	N
PCHP-2	1600	40	0.75	21.55	25	Primary chilled water pump	Lag	N
PCHP-3	1600	40	0.75	21.55	25	Primary chilled water pump	Stand-by	N
SCHP-1	1120	100	0.8	35.35	50	Secondary chilled water pump	Lead	Y
SCHP-2	1120	100	0.8	35.35	50	Secondary chilled water pump	Lag	Y
SCHP-3	1120	100	0.8	35.35	50	Secondary chilled water pump	Stand-by	Y
WSEP-1	1200	35	0.75	14.14	20	Waterside economizer pump	Lead	Y
WSEP-2	1200	35	0.75	14.14	20	Waterside economizer pump	Stand-by	Y
PHWP-1	660	35	0.75	7.78	10	Primary heating water pump	Lead	N
PHWP-2	660	35	0.75	7.78	10	Primary heating water pump	Lag	N
PHWP-3	660	35	0.75	7.78	10	Primary heating water pump	Stand-by	N
SHWP-1	660	100	0.8	20.83	25	Secondary heating water pump	Lead	Y
SHWP-2	660	100	0.8	20.83	25	Secondary heating water pump	Lag	Y
SHWP-3	660	100	0.8	20.83	25	Secondary heating water pump	Stand-by	Y
WHP-1	660	35	0.75	7.78	10	Waste heat pump	Lead	N
Total				**489.90**	**645**			

Central Heater-Chiller Plant (Closed Loop)

The closed loop variation of the central heater-chiller plant is similar in most respects to the open loop version. Instead of a set of supply and re-injection wells and associated heat exchangers to connect the well loop to the plant and building loops, the closed loop option uses an earth-to-water heat exchanger consisting of (416) 300-foot deep bores in combination with a 400 ton auxiliary cooling tower. The borefield and cooling tower provide similar function as the wells in that they accommodate “false loading” of the heat pumps in the winter (using heat from the thermal mass of the earth), and provide heat rejection capacity in the summer. During mild seasons, the tower-borefield combination can provide free cooling in the form of moderately cool water that can be circulated to chilled water coils on systems that require cooling during moderate weather.

Table 3.6 provides a list of significant pumps that are anticipated to be required. Figure 3.4 provides a schematic diagram of the closed loop system.

Table 3.6. Hydronic System Pumps for Proposed Closed Loop Heater-Chiller Plant.

Tag	Flow, GPM	Head, Ft H2O	Mech. Eff.	BHP	Nom. HP	Service	Status	VFD
P-1					0.5	Condensate pump	Lead	N
P-2					0.5	Condensate pump	Stand-by	N
P-3					2	Feedwater pump	Lead	N
P-4					2	Feedwater pump	Stand-by	N
GLP-1	1040	40	0.8	13.13	15	Ground loop pump	Lead	Y
GLP-2	1040	40	0.8	13.13	15	Ground loop pump	Lag	Y
GLP-3	1040	40	0.8	13.13	15	Ground loop pump	Stand-by	Y
PCWP-1	1040	25	0.7	9.38	15	Primary condenser water pump	Lead	Y
PCWP-2	1040	25	0.7	9.38	15	Primary condenser water pump	Lag	Y
PCWP-3	1040	25	0.7	9.38	15	Primary condenser water pump	Stand-by	Y
PCHP-1	1600	35	0.8	17.68	20	Primary chilled water pump	Lead	N
CWP-1	1480	40	0.8	18.69	20	Condenser water pump	Lead	N
PCHP-2	960	35	0.75	11.31	15	Primary chilled water pump	Lead	N
PCHP-3	960	35	0.75	11.31	15	Primary chilled water pump	Lag	N
PCHP-4	960	35	0.75	11.31	15	Primary chilled water pump	Stand-by	N
PCHP-2	1600	40	0.75	21.55	25	Primary chilled water pump	Lag	N
PCHP-3	1600	40	0.75	21.55	25	Primary chilled water pump	Stand-by	N
SCHP-1	1120	100	0.8	35.35	50	Secondary chilled water pump	Lead	Y
SCHP-2	1120	100	0.8	35.35	50	Secondary chilled water pump	Lag	Y
SCHP-3	1120	100	0.8	35.35	50	Secondary chilled water pump	Stand-by	Y
WSEP-1	1200	35	0.75	14.14	20	Waterside economizer pump	Lead	Y
WSEP-2	1200	35	0.75	14.14	20	Waterside economizer pump	Stand-by	Y
WESP-3	1200	50	0.8	18.94	20	Auxillary tower pump	Lead	N
PHWP-1	660	35	0.75	7.78	10	Primary heating water pump	Lead	N
PHWP-2	660	35	0.75	7.78	10	Primary heating water pump	Lag	N
PHWP-3	660	35	0.75	7.78	10	Primary heating water pump	Stand-by	N
SHWP-1	660	100	0.8	20.83	25	Secondary heating water pump	Lead	Y
SHWP-2	660	100	0.8	20.83	25	Secondary heating water pump	Lag	Y
SHWP-3	660	100	0.8	20.83	25	Secondary heating water pump	Stand-by	Y
WHP-1	660	35	0.75	7.78	10	Waste heat pump	Lead	N
Total				**427.83**	**555**			

Bore-field Sizing

For Option A2, the borefield was sized with borefield-sizing software using monthly system loads from the "work-in-progress" Option A2 energy models. Thermal conductivity values associated with basalt were used. Bore spacing of 15 feet in one direction and 20 feet in the other was assumed. Total required borehole lengths were calculated as follows:

- Heating: 71,598 feet
- Cooling: 96,184 feet

Cooling loads will determine borehole length. At 300 feet per hole:

- No. of boreholes = 96,184 feet / 300 feet per hole = 320 holes
- For costing model purposes, use the following for Option 2:
- No. of boreholes = 320 holes x 1.3 oversize factor = 416 holes <<<<<<

Option B2 is estimated to have cooling loads similar to Option A2 but to have increased heating loads (by about 20% as assumed for costing model purposes). Total required borehole lengths are adjusted as follows

- Heating: 71,598 feet x 1.20 = 85,918 feet
- Cooling: 96,184 feet (no change from Option A2)

Despite heating load increase, cooling loads will still determine borehole length, and this will be identical to Option A2.

- No. of boreholes = 96,184 feet / 300 feet per hole = 320 holes
- For costing model purposes, use the following for Option 2:
- No. of boreholes = 320 holes x 1.3 oversize factor = 416 holes <<<<<<

Figure 3.4 illustrates the closed loop plant option.

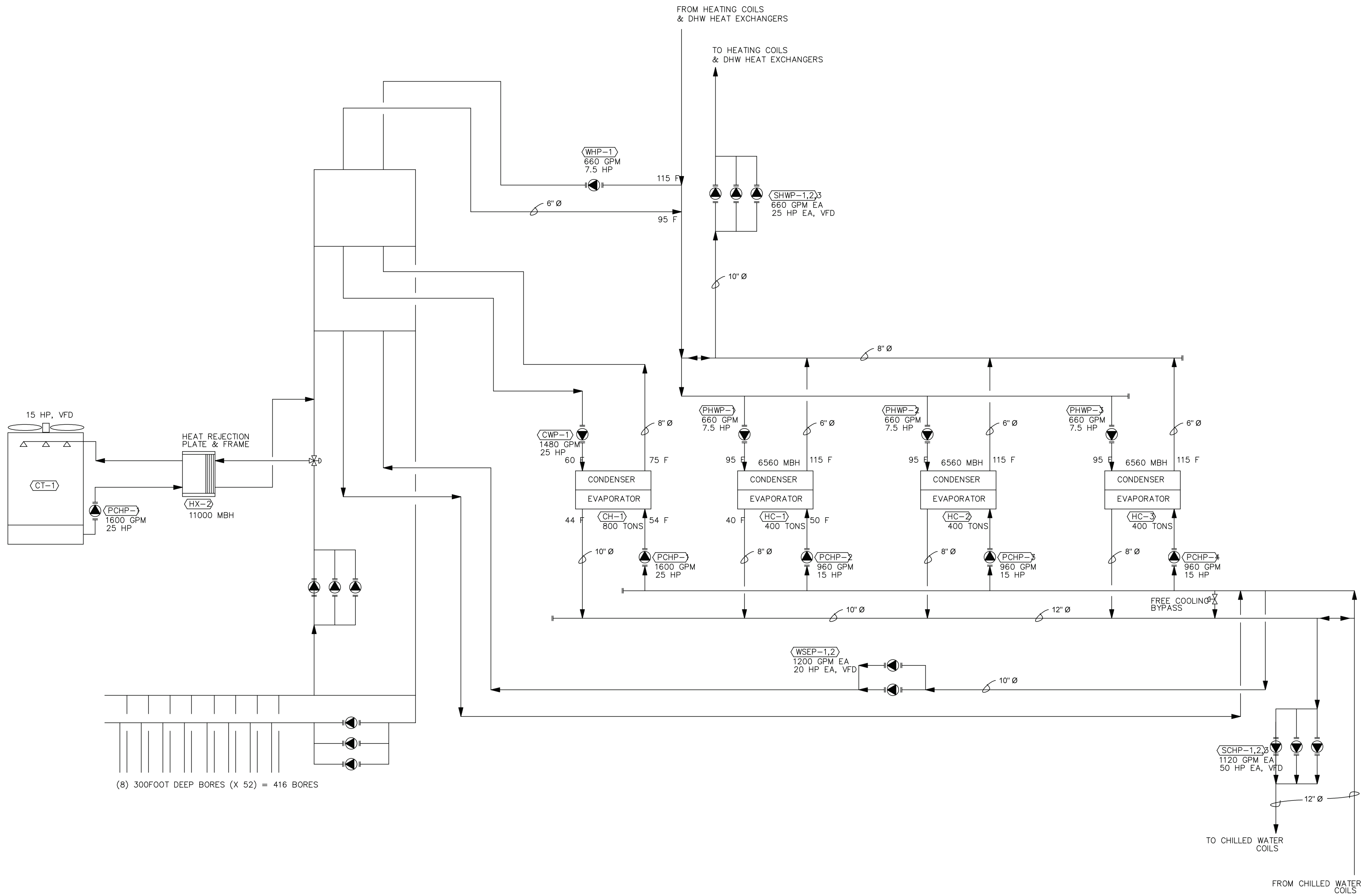


Figure 3.4. Schematic Diagram – Closed Loop Heater-Chiller Plant – Option A2.

Alternative Central Energy Plant – Option A3

This alternative plant concept is based on heat recovery chillers in combination with supplemental fossil fuel fired hot water boilers and cooling towers to handle peak loads conditions. There will be no ground-coupled borefield in this alternative central plant. Supplemental sources of heat are anticipated to include:

- Enhanced heat recovery / heat rejection via coils in the exhaust air streams from the remaining VAV systems. Coils, installed in six air handling units, will provide an average of 1800 MBH of available recovered heat (plus heat of compression) to meet heating needs.
- Peaking natural gas-fired hot water boiler of approximately 4600 MBH (output) capacity. Four condensing boilers will be installed at 2000 MBH input each (one for back-up). Back-up fuel is assumed to be propane.
- Peaking cooling towers for peak summertime heat rejection and supplemental wintertime heat rejection. The summertime cooling tower is estimated to be about 1,200 gpm. The supplemental wintertime cooling tower is estimated to be sized at about 280 gpm. (A third 1200 gpm cooling tower will be part of the plant to provide waterside economizer functionality, and to provide back-up for the peaking tower).

Like the ground-coupled high performance plant, the alternative high performance central energy plant responds to the load reduction design features of the secondary system, and integrates both heating and cooling into a heat recovery chiller plant. A separate, downsized steam boiler plant provides remaining process steam requirements (laundry, dietary, sterilization, and humidification).

Heating water hydronic system is a low-temperature design with 115F supply water temperature and 95F return water temperature. This is used for potable hot water, preheat and central heating coils in air handling units, reheat coils at zone terminal units, and heating coils in fan coil units. Whenever a need for heating exists and there is sufficient cooling load (including the exhaust air cooling coils), the heat recovery chillers will operate to meet cooling load and produce 115F leaving condenser water. When there is insufficient cooling load to provide for all of the heating needs via recovered heat, supplementary condensing hot water boilers will be used to boost the leaving heating water temperature to 115F.
Boilers will be condensing, modulating type and will be dual fuel – designed to operate on natural gas and propane. Propane storage for back-up fuel will need to be provided on site.

Back-up Fuel Storage

Propane storage of about 1,500 gallons will provide two weeks of winter-time back-up fuel for anticipated use of the condensing boilers in supplemental heat mode.

The boilers are sufficient to provide entire heating system back-up should the heat recovery chillers experience consequential operating problems during the heating season. Propane storage of about 6,000 gallons will provide two weeks of winter-time back-up fuel for complete reliance on the condensing boilers for space and potable water heating.

Heat Recovery Chiller Plant

The heat recovery chillers consist of two 400-ton heat recovery chillers. One 800-ton cooling-dedicated centrifugal chiller is also included in the plant for summertime peak cooling operation. Plant sizing was approached in a manner similar to the baseline boiler and chiller plants. The plant capacities respond to the load reduction features of the high performance design including the elimination of reheat loads in about 70% of the conditioned area of the facility, and the solar control features associated with advanced glazing. Figure 3.1 (next page) presents a schematic diagram of the plant.

Heating system capacity was established, using the predicted plant loads from the DOE2 energy and loads model, as follows:

- Process: 1,125 MBH
- Humidification: 1,150 MBH

Total steam load: 2,275 MBH x 1.3 = 2,958 MBH (or approx. 90 bhp)

Process boiler plant will consist of two 90 bhp steam boilers – one to meet load and one for back-up. Other heating loads are as follows:

- Combined DHW/hydronic loop heat load (to be met with recovered heat):
  3739 MBH x 1.3 = 4860 MBH

One heat recovery chiller at 315 tons cooling capacity (400 tons nominal capacity) would meet this load. . A back-up 400 ton heat pump will be installed for heating equipment redundancy.

- Combined DHW/hydronic loop heat load (to be met with supplemental heat):
  3547 MBH x 1.3 = 4610 MBH

Three (3) condensing boilers rated at 2,000 MBH each would meet this load. A fourth 2000 MBH boiler will be installed for heating equipment redundancy.

Total installed heating capacity within the plant is just under 37 Btuh/SF.

Basis of costing specifications are listed below:

- Heat Recovery Chillers: Multi-stack MS50 series; Heat Harvester.
- Supplemental Boilers: Aerco BMK 2.0 series
- Pumps: Based-mounted end-suction, Bell & Gossett Series 1510.

Cooling system capacity was established, using the predicted plant loads from the DOE2 energy and loads model, as follows:

- Secondary chilled water loop (including all coils): 9,783 MBH x 1.3 = 12,718 MBH

A total capacity of about 1100 tons is defined. This does not include the additional cooling load associated with the exhaust air heat recovery coils (up to 200 tons). Because the primary use of the exhaust air heat recovery will be in the wintertime, the exhaust air cooling load was not considered as a meaningful contributor to summertime peak. For this integrated plant concept, one of the 400 ton heat recovery chillers will provide cooling as well as heating. For peak cooling period loads, a dedicated 800-ton centrifugal chiller is assumed to be installed. The back-up heat recovery chiller (400 tons) will also function to provide back-up for the cooling equipment. Total installed cooling plant capacity is 433 SF/ton.

Basis of costing specifications are listed below:

- Heat Recovery Chillers: Multi-stack MS50 series, Heat Harvester
- Chillers: York Max E series
- Pumps: Based-mounted end-suction, Bell & Gossett Series 1510

Heat rejection will be to space and water heating as a priority. When the 800-ton chiller is operating, an 800-ton cooling tower will be used for heat rejection. Two 400-ton cooling towers will also be installed – one for waterside economizer “free cooling” in the winter and another for supplemental heat rejection from the heat recovery condenser water loop, on an as-needed basis.

Table 3.7 provides a list of significant pumps that are anticipated to be required.

Table 3.7. Summary of Hydronic System Pumps.

Tag	Flow, GPM	Head, Ft H2O	Mech. Eff.	BHP	Nom. HP	Service	Status	VFD
P-1					0.5	Condensate pump	Lead	N
P-2					0.5	Condensate pump	Stand-by	N
P-3					2	Feedwater pump	Lead	N
P-4					2	Feedwater pump	Stand-by	N
PCHP-1	1600	35	0.8	17.68	20	Primary chilled water pump	Lead	N
CWP-1	1480	40	0.8	18.69	20	Condenser water pump	Lead	N
PCHP-1	960	35	0.75	11.31	15	Primary chilled water pump	Lead	N
PCHP-2	960	35	0.75	11.31	15	Primary chilled water pump	Lag	N
PCHP-3	1600	40	0.75	21.55	25	Primary chilled water pump	Lag	N
PCHP-4	1600	40	0.75	21.55	25	Primary chilled water pump	Stand-by	N
SCHP-1	1120	100	0.8	35.35	50	Secondary chilled water pump	Lead	Y
SCHP-2	1120	100	0.8	35.35	50	Secondary chilled water pump	Lag	Y
SCHP-3	1120	100	0.8	35.35	50	Secondary chilled water pump	Stand-by	Y
WSEP-1	1200	35	0.75	14.14	20	Waterside economizer pump	Lead	Y
WSEP-2	1200	35	0.75	14.14	20	Waterside economizer pump	Stand-by	Y
WESP-3	1200	50	0.8	18.94	20	Auxillary tower pump	Lead	N
PHWP-1	660	35	0.75	7.78	10	Primary heating water pump	Lead	N
PHWP-2	660	35	0.75	7.78	10	Primary heating water pump	Lag	N
SHWP-1	660	100	0.8	20.83	25	Secondary heating water pump	Lead	Y
SHWP-2	660	100	0.8	20.83	25	Secondary heating water pump	Lag	Y
SHWP-3	660	100	0.8	20.83	25	Secondary heating water pump	Stand-by	Y
WHP-1	1200	35	0.75	14.4	20	Waste heat pump	Lead	Y
WHP-2	1200	35	0.75	14.4	20	Waste heat pump	Stand-by	Y
BP-1	180	35	0.65	2.5	3	Boiler pump	Lead	N
BP-2	180	35	0.65	2.5	3	Boiler pump	Lag	N
BP-3	180	35	0.65	2.5	3	Boiler pump	Lag	N
BP-4	180	35	0.65	2.5	3	Boiler pump	Stand-by	N
Total				**372.21**	**482**			

Total pump horsepower is estimated at 482 hp (nominal). This is a decrease from the 555 hp (nominal) associated with the closed loop ground-coupled plant.

Figure 3.5 shows the configuration of the heat recovery plant alternative.

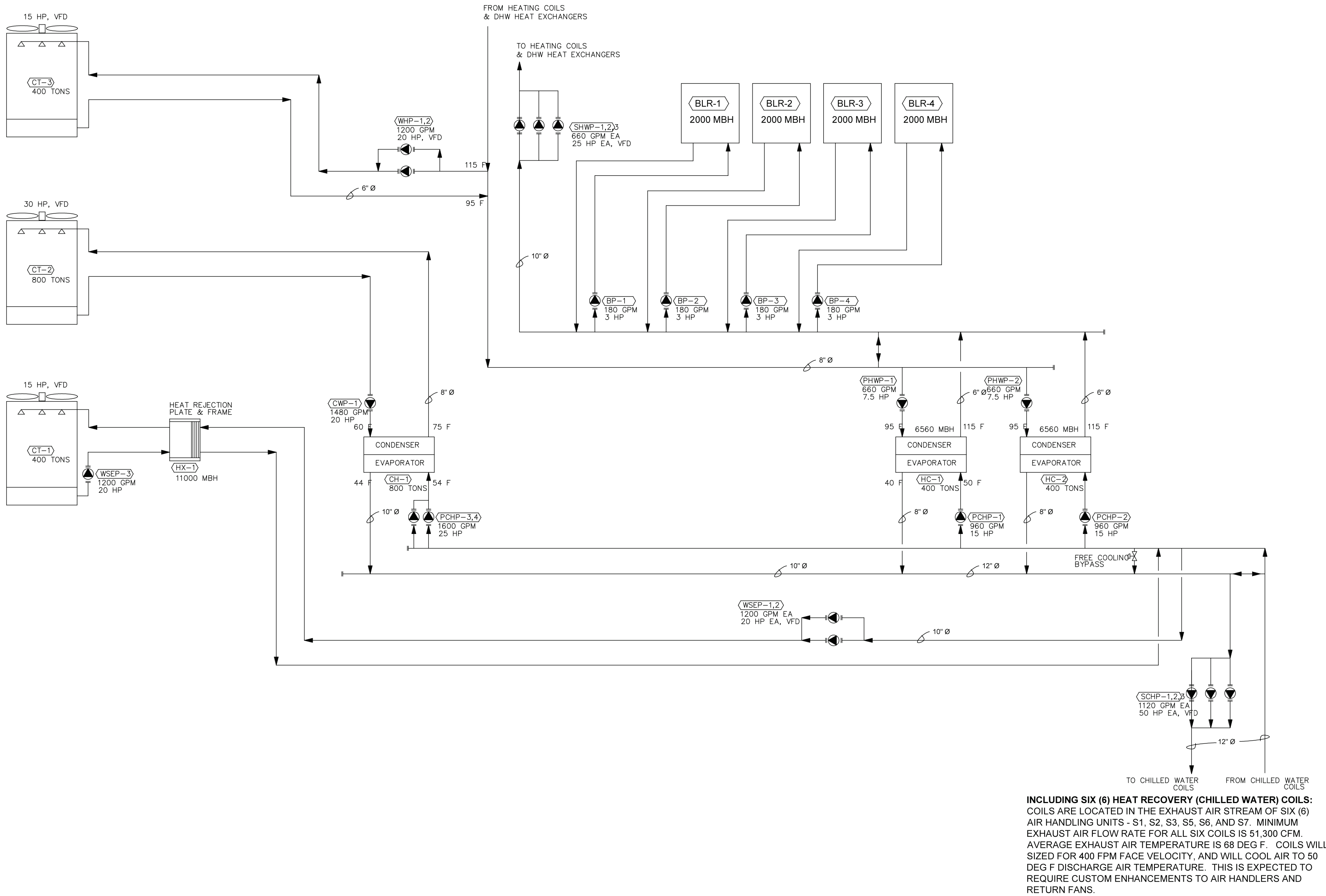


Figure 3.5. Schematic Diagram – Heat Recovery Chiller Plant – Option A3.

Central Energy Plant – Option B2

The plant concepts defined for Option A2 also apply to Option B2. The steam boilers, steam distribution, condensate return, and associated appurtenances to meet process and humidification needs are identical to that defined for Option A2.

Heater-Chiller (Heat Pump) Plant. "Work-in-progress" diversified peak heating and cooling loads (for potable water heating, space heating, and space cooling are predicted to be slightly higher than the peak loads for Option A2. Those loads and the plant equipment sizing for Option B2 are summarized below.

<u>Peak Heating Load</u>

- Combined DHW/hydronic loop peak load: 11,097 MBH x 1.3 = 14,426 MBH
- Two heat pumps would need to provide 7213 MBH each. Two heat pumps at 500 tons (nominal capacity) each are defined for the purposes of costing the heat pump plant. One 500 ton heat pump will be a dedicated unit for heating. Another will alternate between heating and cooling. A third 500 ton heat pump will be installed as a redundant heating machine. Total installed heating capacity is slightly higher than Option A2, at 50 Btuh/SF.
- The cost of the heat pump plant for Option B2 will be higher than Option A2. Option A2 is defined with three (3) 400-ton heat pumps. Option B2 is defined with three (3) 500-ton heat pumps. Cost will be higher accordingly.

<u>Peak Cooling Load</u>

Total required cooling capacity for Option B2 with a 1.3 oversize factor is just over 1200 tons. This is about the same size as Option A2. The supplemental 800 ton chiller, defined for Option A2, will remain in Option B2, as will the supplemental cooling tower and heat exchanger.

- Besides the larger 500-ton heat pump, the costs for the cooling plant in Option B2 should be the same as Option A2.

<u>Open Loop Well Water Size</u>

To match increased heating capacity of the plant, an open loop heat pump plant is expected to require a well water flow rate of 2,300 gpm. This is 15% bigger than the well water capacity projected for Option A2. Well configuration is defined similar to Option A2.

- Costs for an open loop system would be modestly higher than Option A2 due to the higher flow rate.

Potable Water Systems – Option B2

Costs for potable water heating heat exchangers, pumps, and controls will be similar to Option A2. The heat recovery concept is the similar to Option A2, but the implementation will be different due to the different massing scheme. A separate installation shall serve each of the three patient tower wings. System components, identified for cost modeling, include the following:

Table 3.8. Wastewater Heat Recovery System Elements – Option B2.

Component	**Quan.**		**Unit**
3" CI no hub pipe	5020		LF
4" CI waste pipe	300		LF
4" roof penetrations	3		ea
GFX-80 (80" length)	18		ea
4"x 4" CI Y-fittings	36		ea
4" oriface plates (metering)	18		ea
Custom pipe fabrication at oriface plate	18		ea
Mounting hardware for GFX	18		ea
UV disinfection module	3		ea
1-1/2" Cu pipe insulated	45		LF
3/4" Cu pipe insulated	36		LF
3/4" x__ tees	36		ea
3/4" solenoid valves	18		ea
120 gallon SS tank, insulated.	3		ea

Pumps and Hydronic Systems – Option B2

Hydronic systems will be configured similarly to Option A2. Some pumps and associated piping systems will need to be upsized. These pumps are listed below.

- SWP-1: Well water pump (open loop): 1150 gpm, 85 bhp, 100 hp (nominal)
- SWP-2: Same as SWP-1
- GLP-1: Ground loop pump (closed loop): 1200 gpm, 15 bhp, 20 hp (nominal)
- GLP-2: Same as GLP-1
- GLP-3: Same as GLP-1.
- PHWP-1: Primary heating water pump: 790 gpm, 9.3 bhp, 15 hp (nominal)
- PHWP-2: Same as PHWP-1.
- PHWP-3: Same as PHWP-1.
- SHWP-1: Secondary heating water pump: 790 gpm, 25 bhp, 30 hp (nominal)
- SHWP-2: Same as SHWP-1.
- SHWP-3: Same as SHWP-1.

Alternative Heat Recovery Plant – Option B3.

Costing of plant Option B3 should be similar to that for Plant Option A3, expressed as cost modifications to the ground-coupled heat pumps plant option B2.

3.3 Controls

Control systems will be fully digital. A preliminary points list, defined for purposes of cost modeling for Option A2, is presented below assuming the closed loop option for the central plant.

Table 3.9. Points List for Option A2.

		Quantity of Points				
No.	**Description**	**DO**	**DI**	**AO**	**AI**	**Comments**
	Fan / FCU stop/start	714				SF/RF/EF
	Fan status		714			
	Duct static pressure				10	
	OSAT				1	Global point
	Return air temperatures				6	
	Mixed air temperatures				6	
	Coil discharge air temperature				10	
	Duct supply air temperatures				714	
	Zone temperatures				714	
	Fan coil unit valves			1408		HW coil, CHW coil
	Filter pressure differential				10	
	Duct humidity				30	
	OSA damper			6		
	Return air damper			6		
	Relief air damper			6		
	Heat recovery wheel	9				
	Fan speed			6		
	Pump stop/start	30				
	Pump status		30			
	Boiler enable/disable	2				
	Boiler steam pressure				2	
	Boiler stack temperature				2	
	Pump speed			14		
	Piping differential pressure				5	
	DHW heating water valves			28		
	Heating water supply temperature				3	
	Heating water return temperature				3	
	Heating coil valves			14		
	Chiller enable/disable	4				
	Chilled water supply temperature				8	
	Chilled water return temperature				8	
	Condenser water supply temperature				1	
	Condenser water return temperature				1	
	Waterside economizer valve			1		
	Cooling tower enable/disable	1				
	Cooling tower fan speed			1		
	Cooling tower status		1			
	Chiller status		1			
	Chilled water coil valves			10		
	Addition hydronic loop temperatures				8	
	Subtotal	760	746	1500	1534	
	15% extra points	114	112	225	230	
	Total points	**874**	**858**	**1725**	**1764**	**5221**

For Option B2, add 400 points to the points list for Option A2 to account for additional thermal zones and natural ventilation system in south corridors.

For Option A3, another preliminary points list (presented below) has been defined for purposes of cost modeling. The anticipated number of control and monitoring points is essentially the same as previously identified for the ground-coupled heat pump plant options.

Table 3.10. Preliminary Points List for Option A3.

		Quantity of Points				
No.	**Description**	**DO**	**DI**	**AO**	**AI**	**Comments**
	Fan / FCU stop/start	714				SF/RF/EF
	Fan status		714			
	Duct static pressure				10	
	OSAT				1	Global point
	Return air temperatures				6	
	Mixed air temperatures				6	
	Coil discharge air temperature				10	
	Duct supply air temperatures				714	
	Zone temperatures				714	
	Fan coil unit valves			1408		HW coil, CHW coil
	Filter pressure differential				10	
	Duct humidity				30	
	OSA damper			6		
	Return air damper			6		
	Relief air damper			6		
	Heat recovery wheel	9				
	Fan speed			6		
	Pump stop/start	**22**				
	Exhaust heat recovery filter status				**6**	
	Exhaust heat recovery coil valve			**6**		
	Pump status		**22**			
	Boiler enable/disable	**6**				
	Boiler steam pressure				2	
	Boiler stack temperature				2	
	Pump speed			14		
	Piping differential pressure				5	
	DHW heating water valves			28		
	Heating water supply temperature				3	
	Heating water return temperature				3	
	Heating coil valves			14		
	Chiller enable/disable	**3**				
	Chilled water supply temperature				**6**	
	Chilled water return temperature				**6**	
	Condenser water supply temperature				1	
	Condenser water return temperature				1	
	Waterside economizer valve			1		
	Cooling tower enable/disable	**3**				
	Cooling tower fan speed			**3**		
	Cooling tower status		**3**			
	Chiller status		1			
	Chilled water coil valves			10		
	Addition hydronic loop temperatures				8	
	Subtotal	757	740	1508	1538	
	15% extra points	114	111	226	231	
	Total points	**871**	**851**	**1734**	**1769**	**5224**

Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Appendix 3.0

Energy Results

Solarc Architecture and Engineering

with support from

Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

University of Washington's Integrated Design Lab
NBBJ Architects
Solarc Architecture and Engineering
TBD Consultants
Cameron MacAllister
Mahlum Architects
Mortenson Construction

Target 100 Energy Efficiency Design Strategies (Scheme A)

The following strategies are modeled as part of Scheme A2, and are represented in the output reports presented in this document. Scheme A3 results are also represented in this document. A3 strategies are identical to A2 with the exception of the heating and cooling plant. The A3 plant is described in the bulleted list below.

- <u>Improved wall insulation and reduced wall area</u>: Wall U-value is reduced by adding more insulation**.** Option A1 U-value is 0.059 Btu/hr-SF-F. Option A2 U-value is 0.045 Btu/hr-SF-F. Floor to floor heights on the patient tower are reduced from 15 feet (Option A1) to 14 feet (Option A2), resulting in a modest reduction of overall wall area (144,415 GSF in Option A1 vs. 139,455 GSF in Option A2).

- <u>Improved roof reflectance</u>: Roof reflectance is increased from 30% (Option A1) to 70% (Option A2). This will reduce roof surface temperature during the cooling season.

- <u>High performance glazing</u>: High performance glazing is specified for all windows in Option A2. High performance glass has U-value (center of glass) of 0.29, and solar heat gain coefficient of 0.40. Glazing in Option A1 has U-value (center of glass) of 0.47, and solar heat gain coefficient of 0.45.

- <u>Motorized external shading</u>**:** All windows in Option A2 are modeled with motorized exterior window shading. Shading will be activated whenever transmitted total solar gain (from direct and diffuse radiation) exceeds 25 Btu/hr-SF. When activated, total solar radiation is reduced by 87.5%, with visible spectrum reduced by 75%. (Note that this shading element is applied to north facing windows in the energy model, but is rarely if ever activated because solar gain does not typically exceed 25 Btu/hr-SF for north glass. The cost model has shades only on the east, west, and south-facing windows).

- <u>Daylighting and light level control of electric lighting</u>: Daylighting control of electric lights is included in all perimeter zones with significant windows, including patient rooms. Control zones are assumed to penetrate approximately 20 feet into space. Patient rooms are modeled as manual on/off control with a 50% probability that lights will be turned off if light levels exceed 50 fc. Lighting control in all other spaces is modeled as continuous dimming with minimum lighting output of 10%. Lighting is dimmed to maintain a setpoint of 50 fc.

- <u>Efficient electric lighting</u>**:** Electric lighting connected load is reduced by 20% in Option A2 relative to Option A1.

- <u>Occupancy sensor lighting controls</u>: Occupancy sensors are assumed to control all lighting in administrative areas (offices), storage areas, and conference areas. Lighting power density was reduced an additional 10% for these functional areas.

- <u>Efficient “plug load” equipment</u>: Plug load power density was reduced by 2% in Option A2 compared to Option A1.

- Potable hot water heat recovery: Heat recovery from the shower drainage is modeled by reducing the load imposed by showers by 50%. For the building as a whole, this is modeled as a reduction in peak flow from 101 gpm to just under 73 gpm. Of this load, about 63 gpm is met by the ground-coupled heat pump plant. The remainder of the load is assigned to a gas-fired high efficiency "booster" water heater.

- Zonal heating and cooling via fan coil units: Fan coil units are modeled instead of large central station VAV units with reheat for all zones except surgery suites, emergency department, regulated zones of diagnostics and treatment floors, kitchen, laboratories, laundry, and the server room (representing 137,534 square feet of the total program area). Just under 75% of the program area is served by fan coils.

- Improved ventilation heat recovery: Ventilation heat recovery for the kitchen and lab 100% OSA units is improved from 50% effectiveness in Option A1 to 65% effectiveness in Option A2. All fan coil units are served by dedicated ventilation heat recovery units with 70% minimum effectiveness, and variable speed control of fans based on duct static pressure.

- Reduced air pressure requirements in large fan systems: Pressure requirements for large fan systems are reduced by 10% in Option A2, compared to Option A1.

- Maximum efficiency fan motors: Option A2 assumes all large fan system motors will be specified as "best-in-class" premium efficiency motors. Return/exhaust fans are assumed to gain 2% improvement in combined efficiency. Supply fans are assumed to gain 1% improvement in combined efficiency.

- Advanced system controls: System controls modeled in Option A2 (but not in Option A1) include:

    - Occupancy sensor-based turn-down of surgery suite an imaging VAV units: During unoccupied period, VAV terminal units serving the regulated surgery suite zones are scheduled to all air flow reduce to a minimum of about 11% of design flow rate (3 ACH). During the unoccupied period, VAV terminal units serving about 1/3 of the imaging zones (14,408 SF) are scheduled to all air flow reduce to a minimum of about 25% of design flow rate (3 ACH).
    - Occupied/unoccupied period system scheduling: Fan coil units in the Medical Office Building and Office areas are de-energized during unoccupied periods, subject to occupied/unoccupied period temperature setpoints.
    - Improved supply air temperature reset: All large fan systems with reheat are modeled with extended supply air temperature reset schedules that generally increase supply air minimum temperature setpoint by 2 deg F, and the maximum setpoint by 4 deg. F.
    - Improved static pressure reset: Fan capacity curves for variable frequency drive (VFD) control of fans are input to represent a reasonably good implementation of static pressure reset controls.
    - Dual temperature economizer control: Economizer cooling functions on large fan systems are controlled through comparison of outside air and return air temperatures in Option A2. In Option A1, economizer high limit setpoint is fixed at 65 deg F for surgery units and 72

- Modular ground-coupled heat pump plant: Heating and cooling in Option A2 is generated with a ground-coupled heat pump plant that generated chilled water (42 deg F minimum chilled water supply temperature) and heating water (115 deg F maximum heating water temperature). Heating water is also used for potable water heating with gas-fired booster heaters that will be used to increase potable hot water temperature from 115 deg. F to final setpoint. Rated coefficient of performance is 5.0 for heat pumps. This concept employs integral heat recovery, i.e., when heat pumps are meeting a cooling load, hot condenser water is first used to meet heating load before being “cooled” by the ground-coupled hydronic loop. (Option A1 has centrifugal chillers with 6.10 COP and boilers with 82% full load combustion efficiency. Note that both options generate process steam with steam boilers.)

- Variable flow heating water system: Option A1 has a variable flow chilled water system and constant flow heating water system. Option A2 has variable flow systems for both heating and chilled water. Pumps are controlled by variable frequency drives (VFDs).

- Advanced plant controls: Hydronic system temperature reset strategies are maximized in Option A2 as described below.

    - Extended load-based reset of chilled water temperatures: Option A2 resets chilled water temperature, based on load, between 42 deg F and 48 deg F. Option 1 resets chilled water temperatures between 42 deg. F and 45 deg. F.
    - Low temperature load-based reset of heating water temperatures: Option A2 resets heating water temperature, based on load, between 115 deg F and 110 deg F. Option A1 resets heating water temperatures between 180 deg. F and 170 deg. F.

- Efficient exterior lighting: Option A2 reduces exterior lighting load by 20% (from 20 kW to 16 kW).

- A3 enhanced heat recovery chiller plant: Option A3 serves the A2 heating and cooling loads by employing a heat recovery chiller plant that can be additionally loaded using chilled water coils in the exhaust air stream of the VAV units serving surgery, emergency, and imaging. The heat recovery chillers generate chilled water (42 deg F minimum chilled water supply temperature) and heating water (115 deg F maximum heating water temperature). Recovered heat is also used for pre-heating of potable hot water. When recovered heat from the chillers is not sufficient to meet load, supplemental gas-fired condensing boilers will fire to provide added heating. Potable hot water booster heating will be accomplished using gas-fired booster heaters that will be used to increase potable hot water temperature from 115 deg. F to final setpoint. Rated coefficient of performance is 4.55 for heat recovery chillers.

Energy Modeling Pre-formatted Output Reports

Building Energy Performance Summary (BEPS)

The BEPS report shows a summary of predicted annual energy end uses in MMBtu/yr. Energy use index (EUI) for Option A1 is 223.9 kBtu/SF-yr (520,983 SF in model). Energy use index for Option A2 is 100.3 kBtu/SF-year. Energy use index for Option A3 is 115.8 kBtu/SF-year. The BEPS reports for each model are shown below in two versions: (1) as modeled with much of the potable hot water load "attached" to the heating plant as a process load, and (2) modified to show the potable hot water load under the appropriate end use category. The modification is necessary for proper accounting of energy end uses because all energy used to meet all process loads is included as part of the "Misc Equip" end use category.

Option A1 (as modeled):

```
High Performance Hospital – Scheme A1   Baseline - Conventional                  DOE-2.2-47b    4/14/2010    14:38:41  BDL RUN  1

REPORT- BEPS Building Energy Performance                                                   WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------------------------

                        TASK     MISC    SPACE    SPACE     HEAT    PUMPS     VENT   REFRIG  HT PUMP   DOMEST      EXT
              LIGHTS   LIGHTS   EQUIP  HEATING  COOLING   REJECT    & AUX     FANS  DISPLAY  SUPPLEM  HOT WTR    USAGE     TOTAL
             -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  --------

EM1  ELECTRICITY
    MBTU     11912.4      0.0  15929.1    278.1   3506.5     21.6   2354.7  12924.6      0.0      0.0      3.2    224.2   47154.5

FM1  NATURAL-GAS
    MBTU         0.0      0.0  25483.9  43211.5      0.0      0.0      0.0      0.0      0.0      0.0    560.5      0.0   69255.9
             =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  ========

    MBTU     11912.4      0.0  41413.0  43489.6   3506.5     21.6   2354.7  12924.6      0.0      0.0    563.8    224.2  116410.4


                   TOTAL SITE ENERGY     116410.38 MBTU    223.4 KBTU/SQFT-YR GROSS-AREA    223.4 KBTU/SQFT-YR NET-AREA
                   TOTAL SOURCE ENERGY   210719.51 MBTU    404.5 KBTU/SQFT-YR GROSS-AREA    404.5 KBTU/SQFT-YR NET-AREA

                   PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.5
                   PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.0

                   NOTE:  ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.
```

Option A1 (modified):

```
High Performance Hospital – Scheme A1   Baseline - Conventional                  DOE-2.2-47b    4/14/2010    14:38:41  BDL RUN  1

REPORT- BEPS Building Energy Performance                                                   WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------------------------

                        TASK     MISC    SPACE    SPACE     HEAT    PUMPS     VENT   REFRIG  HT PUMP   DOMEST      EXT
              LIGHTS   LIGHTS   EQUIP  HEATING  COOLING   REJECT    & AUX     FANS  DISPLAY  SUPPLEM  HOT WTR    USAGE     TOTAL
             -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  --------

EM1  ELECTRICITY
    MBTU     11912.4      0.0  15823.5    278.1   3506.5     21.6   2354.7  12924.6      0.0      0.0    108.8    224.2   47154.5

FM1  NATURAL-GAS
    MBTU         0.0      0.0   8362.5  43211.5      0.0      0.0      0.0      0.0      0.0      0.0  17681.9      0.0   69255.9
             =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  ========

    MBTU     11912.4      0.0  24186.0  43489.6   3506.5     21.6   2354.7  12924.6      0.0      0.0  17790.7    224.2  116410.4

                   TOTAL SITE ENERGY     116410.38 MBTU    223.4 KBTU/SQFT-YR GROSS-AREA    223.4 KBTU/SQFT-YR NET-AREA
                   TOTAL SOURCE ENERGY   210719.51 MBTU    404.5 KBTU/SQFT-YR GROSS-AREA    404.5 KBTU/SQFT-YR NET-AREA

                   PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.5
                   PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.0

                   NOTE:  ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.
```

Option A2 (as modeled):

High Performance Hospital – Scheme A2   Target 100 - Conventional   DOE-2.2-47b   4/14/2010   14:35:34   BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Seattle   WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	8763.6	0.0	17261.3	2633.3	1967.8	0.0	1686.9	10241.0	0.0	0.0	25.2	179.4	42758.3
FM1 NATURAL-GAS													
MBTU	0.0	0.0	8362.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	9491.6
MBTU	8763.6	0.0	25623.8	2633.3	1967.8	0.0	1686.9	10241.0	0.0	0.0	1154.3	179.4	52249.9

TOTAL SITE ENERGY 52249.93 MBTU   100.3 KBTU/SQFT-YR GROSS-AREA   100.3 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 137766.70 MBTU   264.4 KBTU/SQFT-YR GROSS-AREA   264.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option A2 (modified):

High Performance Hospital – Scheme A2   Target 100 - Conventional   DOE-2.2-47b   4/14/2010   14:35:34   BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Seattle   WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	8763.6	0.0	15664.3	2633.3	1967.8	0.0	1686.9	10241.0	0.0	0.0	1622.2	179.4	42758.3
FM1 NATURAL-GAS													
MBTU	0.0	0.0	8362.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	9491.6
MBTU	8763.6	0.0	24026.8	2633.3	1967.8	0.0	1686.9	10241.0	0.0	0.0	2751.3	179.4	52249.9

TOTAL SITE ENERGY 52249.93 MBTU   100.3 KBTU/SQFT-YR GROSS-AREA   100.3 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 137766.70 MBTU   264.4 KBTU/SQFT-YR GROSS-AREA   264.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option A3 (as modeled):

High Performance Hospital – Scheme A3   Target 100 – Conventional / No Borefield DOE-2.2-47b   4/14/2010   14:31:17   BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Seattle   WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	8763.6	0.0	21048.4	13.7	4908.9	16.9	1330.3	10241.0	0.0	0.0	25.2	179.4	46527.4
FM1 NATURAL-GAS													
MBTU	0.0	0.0	10182.2	2499.1	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	13810.4
MBTU	8763.6	0.0	31230.6	2512.8	4908.9	16.9	1330.3	10241.0	0.0	0.0	1154.3	179.4	60337.8

TOTAL SITE ENERGY 60337.79 MBTU   115.8 KBTU/SQFT-YR GROSS-AREA   115.8 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 153392.73 MBTU   294.4 KBTU/SQFT-YR GROSS-AREA   294.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option A3 (modified):

```
High Performance Hospital – Scheme A3   Target 100 – Conventional / No Borefield DOE-2.2-47b    4/14/2010    14:31:17  BDL RUN  1

REPORT- BEPS Building Energy Performance                                                 WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------------------

                         TASK     MISC    SPACE    SPACE     HEAT    PUMPS     VENT   REFRIG  HT PUMP   DOMEST      EXT
               LIGHTS   LIGHTS    EQUIP  HEATING  COOLING   REJECT   & AUX     FANS  DISPLAY  SUPPLEM  HOT WTR    USAGE     TOTAL
              -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  -------  --------

EM1  ELECTRICITY
    MBTU       8763.6      0.0  15664.3   5397.8   4908.9     16.9   1330.3  10241.0      0.0      0.0     25.2    179.4   46527.4

FM1  NATURAL-GAS
    MBTU          0.0      0.0   8362.5   2499.1      0.0      0.0      0.0      0.0      0.0      0.0   2948.8      0.0   13810.4
              =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  =======  ========

    MBTU       8763.6      0.0  24026.8   7896.9   4908.9     16.9   1330.3  10241.0      0.0      0.0   2974.0    179.4   60337.8

                   TOTAL SITE ENERGY      60337.79 MBTU    115.8 KBTU/SQFT-YR GROSS-AREA    115.8 KBTU/SQFT-YR NET-AREA
                   TOTAL SOURCE ENERGY  153392.73 MBTU    294.4 KBTU/SQFT-YR GROSS-AREA    294.4 KBTU/SQFT-YR NET-AREA

                   PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE =  0.0
                   PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED                =  0.0

                   NOTE:  ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.
```

Energy Cost Summary (ES-D)

The ES-D report shows a summary of annual energy costs. Electric and natural gas rates (firm) for Puget Sound Energy are used. Option A1 has a predicted annual energy cost of $3.16/SF. Option A2 has a predicted annual energy cost of $1.76/SF. Annual savings associated with Option A2 is about $730,000.

Option A3 has a predicted annual energy cost of $1.99/SF. Annual savings associated with Option A3 is about $614,000.

```
High Performance Hospital – Scheme A1   Baseline - Conventional                DOE-2.2-47b    4/14/2010    14:38:41  BDL RUN  1

REPORT- ES-D Energy Cost Summary                                                         WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------------------

                                                                      METERED          TOTAL      VIRTUAL
                                                                       ENERGY         CHARGE         RATE    RATE USED
UTILITY-RATE                       RESOURCE           METERS          UNITS/YR            ($)     ($/UNIT)    ALL YEAR?
--------------------------------   ----------------   -----------   -------------------   ----------   ----------   ---------

PSE Elec 26 Com/Ind Lrg Demand     ELECTRICITY        EM1            13816263. KWH        906789.       0.0656       YES

PSE Gas 31 NRes After 10-9-1993    NATURAL-GAS        FM1              692559. THERM      742015.       1.0714       YES

                                                                                          ==========
                                                                                            1648804.

                                                              ENERGY COST/GROSS BLDG AREA:       3.16
                                                                ENERGY COST/NET BLDG AREA:       3.16


High Performance Hospital – Scheme A2   Target 100 - Conventional              DOE-2.2-47b    4/14/2010    14:35:34  BDL RUN  1

REPORT- ES-D Energy Cost Summary                                                         WEATHER FILE- Seattle      WA TMY2
---------------------------------------------------------------------------------------------------------------------------

                                                                      METERED          TOTAL      VIRTUAL
                                                                       ENERGY         CHARGE         RATE    RATE USED
UTILITY-RATE                       RESOURCE           METERS          UNITS/YR            ($)     ($/UNIT)    ALL YEAR?
--------------------------------   ----------------   -----------   -------------------   ----------   ----------   ---------

PSE Elec 26 Com/Ind Lrg Demand     ELECTRICITY        EM1            12528187. KWH        817267.       0.0652       YES

PSE Gas 31 NRes After 10-9-1993    NATURAL-GAS        FM1               94916. THERM      101849.       1.0730       YES

                                                                                          ==========
                                                                                             919117.

                                                              ENERGY COST/GROSS BLDG AREA:       1.76
                                                                ENERGY COST/NET BLDG AREA:       1.76
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High Performance Hospital – Scheme A3 Target 100 – Conventional / No Borefield DOE-2.2-47b 4/14/2010 14:31:17 BDL RUN 1

REPORT- ES-D Energy Cost Summary WEATHER FILE- Seattle WA TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
PSE Elec 26 Com/Ind Lrg Demand	ELECTRICITY	EM1	13632526. KWH	886849.	0.0651	YES
PSE Gas 31 NRes After 10-9-1993	NATURAL-GAS	FM1	138104. THERM	148110.	1.0725	YES
				========== 1034959.		

ENERGY COST/GROSS BLDG AREA: 1.99
ENERGY COST/NET BLDG AREA: 1.99

Exterior Surface Summary (LV-D)

The LV-D report shows a summary of external surfaces as included in the energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces. The LV-D reports for the Option A1 and A2 models are shown below. Option A3 is identical to A2.

High Performance Hospital – Scheme A1 Baseline - Conventional DOE-2.2-47b 4/14/2010 14:38:41 BDL RUN 1

REPORT- LV-D Details of Exterior Surfaces WEATHER FILE- Seattle WA TMY2

(CONTINUED)

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.517	0.058	0.194	13448.22	31991.28	45439.50
EAST	0.510	0.058	0.231	9828.71	15755.30	25584.00
SOUTH-EAST	0.000	0.058	0.058	0.00	100.00	100.00
SOUTH	0.519	0.058	0.180	12654.82	35053.18	47708.00
SOUTH-WEST	0.513	0.058	0.276	4138.18	4481.82	8620.00
WEST	0.516	0.058	0.162	3841.52	13122.49	16964.00
ROOF	0.000	0.032	0.032	0.00	107833.55	107833.55
ALL WALLS	0.515	0.058	0.197	43911.44	100504.05	144415.50
WALLS+ROOFS	0.515	0.044	0.126	43911.44	208337.59	252249.05
UNDERGRND	0.000	0.094	0.094	0.00	127153.95	127153.95
BUILDING	0.515	0.063	0.115	43911.44	335491.53	379402.97

REPORT- LV-D Details of Exterior Surfaces   WEATHER FILE- Seattle   WA TMY2
---(CONTINUED)---

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.349	0.044	0.152	15365.26	28134.23	43499.50
EAST	0.337	0.044	0.154	9435.13	15608.87	25044.00
SOUTH-EAST	0.000	0.044	0.044	0.00	100.00	100.00
SOUTH	0.350	0.044	0.143	14772.22	30995.79	45768.00
SOUTH-WEST	0.333	0.044	0.142	2932.36	5687.64	8620.00
WEST	0.348	0.044	0.145	5460.40	10963.60	16424.00
ROOF	0.000	0.032	0.032	0.00	107833.55	107833.55
ALL WALLS	0.346	0.044	0.148	47965.37	91490.14	139455.50
WALLS+ROOFS	0.346	0.037	0.097	47965.37	199323.69	247289.05
UNDERGRND	0.000	0.094	0.094	0.00	127153.95	127153.95
BUILDING	0.346	0.059	0.096	47965.37	326477.66	374443.00

Building Peak Load Components (LS-C)

The LS-C report shows a summary of building-level heating and cooling peak loads at a single interior reference temperature. Loads are those imposed by the building envelope and internal loads (people, lights, and equipment). *Loads imposed by HVAC systems (fan heat, reheat/over-cooling, and ventilation) are not shown.* Option A2 peak cooling load (as contributed by envelope and internal gains) is about 25% less than Option A1. Option A2 peak heating load is about 24% less than Option A1.

Note that roof loads are shown in zone level (LS-B) reports for “plenum” spaces. LS-C statistics (with roof loads added in) are listed below.

- A1 total peak cooling load: 6335.5 KBtu/hr (528 tons); occurs on September 2 at 5 pm.
- A1 total peak heating load: 969.5 kBtu/hr; occurs on November 28 at 5 am.

- A2 total peak cooling load: 4728.2 KBtu/hr (394 tons); occurs on September 2 at 5 pm.
- A2 total peak heating load: 736.7 kBtu/hr; occurs on March 1at 4 am.

Option A1:

High Performance Hospital – Scheme A1   Baseline - Conventional   DOE-2.2-47b   4/14/2010   14:38:41 BDL RUN 1

REPORT- LS-C BuiLding Peak Load Components   WEATHER FILE- Seattle   WA TMY2

*** BUILDING ***

FLOOR AREA	520983	SQFT	48399	M2
VOLUME	5209834	CUFT	147542	M3

	COOLING LOAD		HEATING LOAD	
TIME	SEP 2 5PM		NOV 28 5AM	
DRY-BULB TEMP	98 F	37 C	33 F	1 C
WET-BULB TEMP	67 F	19 C	27 F	-3 C
TOT HORIZONTAL SOLAR RAD	156 BTU/H.SQFT	491 W/M2	0 BTU/H.SQFT	0 W/M2
WINDSPEED AT SPACE	8.7 KTS	4.5 M/S	11.6 KTS	6.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		0	

	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALL CONDUCTION	56.316	16.501	0.000	0.000	-69.783	-20.446
ROOF CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS+FRM COND	919.659	269.460	0.000	0.000	-833.866	-244.323
WINDOW GLASS SOLAR	703.722	206.190	0.000	0.000	15.418	4.517
DOOR CONDUCTION	3.176	0.931	0.000	0.000	-3.553	-1.041
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	-157.593	-46.175	0.000	0.000	-95.075	-27.857
OCCUPANTS TO SPACE	478.608	140.232	345.034	101.095	80.146	23.483
LIGHT TO SPACE	1813.057	531.226	0.000	0.000	309.960	90.818
EQUIPMENT TO SPACE	1549.323	453.952	0.000	0.000	160.732	47.095
PROCESS TO SPACE	104.228	30.539	92.858	27.207	0.000	0.000
INFILTRATION	366.964	107.520	0.000	0.000	-387.826	-113.633
TOTAL	5837.460	1710.376	437.892	128.302	-823.845	-241.387
TOTAL / AREA	0.011	0.035	0.001	0.003	-0.002	-0.005

TOTAL LOAD	6275.352 KBTU/H	1838.678	KW	-823.845 KBTU/H	-241.387	KW
TOTAL LOAD / AREA	12.05 BTU/H.SQFT	37.988	W/M2	1.581 BTU/H.SQFT	4.987	W/M2

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*****************************************************************
*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
*****************************************************************
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SPACE Plenum 2nd (G.20)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS   73 F / 23 C

MULTIPLIER	1.0		FLOOR MULTIPLIER		1.0	
FLOOR AREA	96612	SQFT	8975	M2		
VOLUME	772896	CUFT	21888	M3		

	COOLING LOAD		HEATING LOAD	
TIME	JUL 24 10PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	62 F	17 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	5.3 KTS	2.7 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	2		2	

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALL CONDUCTION	12.738	3.732	0.000	0.000	-24.186	-7.087
ROOF CONDUCTION	29.635	8.683	0.000	0.000	-73.797	-21.623
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	42.373	12.415	0.000	0.000	-97.984	-28.709
TOTAL / AREA	0.000	0.001	0.000	0.000	-0.001	-0.003

TOTAL LOAD	42.373 KBTU/H	12.415 KW	-97.984 KBTU/H	-28.709 KW
TOTAL LOAD / AREA	0.44 BTU/H.SQFT	1.383 W/M2	1.014 BTU/H.SQFT	3.199 W/M2

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*****************************************************************
*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
*****************************************************************
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SPACE PT Plnm (T.85)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS 73 F / 23 C

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0
FLOOR AREA	41904	SQFT	3893	M2
VOLUME	209520	CUFT	5934	M3

	COOLING LOAD		HEATING LOAD	
TIME	JUL 24 10PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	62 F	17 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	5.1 KTS	2.6 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	2		2	

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALL CONDUCTION	6.119	1.793	0.000	0.000	-11.558	-3.387
ROOF CONDUCTION	24.089	7.058	0.000	0.000	-56.692	-16.611
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	30.209	8.851	0.000	0.000	-68.250	-19.997
TOTAL / AREA	0.001	0.002	0.000	0.000	-0.002	-0.005

TOTAL LOAD	30.209 KBTU/H	8.851 KW	-68.250 KBTU/H	-19.997 KW
TOTAL LOAD / AREA	0.72 BTU/H.SQFT	2.274 W/M2	1.629 BTU/H.SQFT	5.137 W/M2

NOTE 1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION
3)THE ABOVE LOADS ARE CALCULATED ASSUMING A CONSTANT INDOOR SPACE TEMPERATURE

SPACE MOBPlnm (T.21)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS   73 F / 23 C

MULTIPLIER	1.0	FLOOR MULTIPLIER	1.0

FLOOR AREA	11222	SQFT	1042	M2
VOLUME	56108	CUFT	1589	M3

	COOLING LOAD		HEATING LOAD	
TIME	JUL 24 10PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	62 F	17 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	5.1 KTS	2.6 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	2		2	

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALL CONDUCTION	3.110	0.911	0.000	0.000	-5.224	-1.531
ROOF CONDUCTION	6.466	1.895	0.000	0.000	-15.158	-4.441
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	9.576	2.806	0.000	0.000	-20.381	-5.972
TOTAL / AREA	0.001	0.003	0.000	0.000	-0.002	-0.006

TOTAL LOAD	9.576 KBTU/H	2.806 KW	-20.381 KBTU/H	-5.972 KW
TOTAL LOAD / AREA	0.85 BTU/H.SQFT	2.691 W/M2	1.816 BTU/H.SQFT	5.728 W/M2

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*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
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Option A2:

High Performance Hospital – Scheme A2   Target 100 - Conventional   DOE-2.2-47b   4/14/2010   14:35:34 BDL RUN 1

REPORT- LS-C BuiLding Peak Load Components   WEATHER FILE- Seattle   WA TMY2

*** BUILDING ***

FLOOR AREA	520983	SQFT	48399	M2
VOLUME	5209834	CUFT	147542	M3

	COOLING LOAD		HEATING LOAD	
TIME	SEP 2 5PM		MAR 1 4AM	
DRY-BULB TEMP	98 F	37 C	35 F	2 C
WET-BULB TEMP	67 F	19 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	156 BTU/H.SQFT	491 W/M2	0 BTU/H.SQFT	0 W/M2
WINDSPEED AT SPACE	8.7 KTS	4.5 M/S	13.1 KTS	6.7 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		10	

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALL CONDUCTION	36.393	10.663	0.000	0.000	-59.630	-17.472
ROOF CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS+FRM COND	405.800	118.899	0.000	0.000	-517.085	-151.506
WINDOW GLASS SOLAR	278.865	81.707	0.000	0.000	31.933	9.356
DOOR CONDUCTION	1.337	0.392	0.000	0.000	-1.150	-0.337
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	-157.972	-46.286	0.000	0.000	-208.917	-61.213
OCCUPANTS TO SPACE	480.731	140.854	345.034	101.095	85.189	24.960
LIGHT TO SPACE	1239.359	363.132	0.000	0.000	311.146	91.166
EQUIPMENT TO SPACE	1524.042	446.544	0.000	0.000	204.374	59.881
PROCESS TO SPACE	104.228	30.539	92.858	27.207	0.000	0.000
INFILTRATION	366.964	107.520	0.000	0.000	-428.776	-125.631
TOTAL	4279.746	1253.966	437.892	128.302	-582.915	-170.794
TOTAL / AREA	0.008	0.026	0.001	0.003	-0.001	-0.004

TOTAL LOAD	4717.638 KBTU/H	1382.268	KW	-582.915 KBTU/H	-170.794	KW
TOTAL LOAD / AREA	9.06 BTU/H.SQFT	28.559	W/M2	1.119 BTU/H.SQFT	3.529	W/M2

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*****************************************************************
*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
*****************************************************************
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SPACE Plenum 2nd (G.20)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS 73 F / 23 C

MULTIPLIER 1.0 FLOOR MULTIPLIER 1.0

FLOOR AREA 96612 SQFT 8975 M2
VOLUME 772896 CUFT 21888 M3

	COOLING LOAD		HEATING LOAD	
TIME	SEP 3 9PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	61 F	16 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	4.5 KTS	2.3 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		2	

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALL CONDUCTION	10.676	3.128	0.000	0.000	-18.355	-5.378
ROOF CONDUCTION	4.456	1.306	0.000	0.000	-77.737	-22.777
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	15.132	4.434	0.000	0.000	-96.092	-28.155
TOTAL / AREA	0.000	0.000	0.000	0.000	-0.001	-0.003

	COOLING		HEATING	
TOTAL LOAD	15.132 KBTU/H	4.434 KW	-96.092 KBTU/H	-28.155 KW
TOTAL LOAD / AREA	0.16 BTU/H.SQFT	0.494 W/M2	0.995 BTU/H.SQFT	3.137 W/M2

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*****************************************************************
*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
*****************************************************************
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SPACE MOBPlnm (T.21)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS 73 F / 23 C

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0	
FLOOR AREA	11222	SQFT	1042	M2	
VOLUME	56108	CUFT	1589	M3	

	COOLING LOAD		HEATING LOAD	
TIME	SEP 3 9PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	61 F	16 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	4.4 KTS	2.2 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		2	

	COOLING SENSIBLE (KBTU/H)	COOLING SENSIBLE (KW)	COOLING LATENT (KBTU/H)	COOLING LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALL CONDUCTION	2.579	0.756	0.000	0.000	-3.959	-1.160
ROOF CONDUCTION	1.331	0.390	0.000	0.000	-16.033	-4.698
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	3.910	1.146	0.000	0.000	-19.992	-5.858
TOTAL / AREA	0.000	0.001	0.000	0.000	-0.002	-0.006

	COOLING		HEATING	
TOTAL LOAD	3.910 KBTU/H	1.146 KW	-19.992 KBTU/H	-5.858 KW
TOTAL LOAD / AREA	0.35 BTU/H.SQFT	1.099 W/M2	1.782 BTU/H.SQFT	5.619 W/M2

NOTE
----
1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR LOADS
2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION IN CONSIDERATION
3)THE ABOVE LOADS ARE CALCULATED ASSUMING A CONSTANT INDOOR SPACE TEMPERATURE

SPACE PT Plnm (T.85)
SPACE TEMPERATURE USED FOR THE LOADS CALCULATION IS   73 F / 23 C

MULTIPLIER	1.0		FLOOR MULTIPLIER	1.0	
FLOOR AREA	41904	SQFT	3893	M2	
VOLUME	167616	CUFT	4747	M3	

	COOLING LOAD		HEATING LOAD	
TIME	SEP 3 9PM		DEC 12 11AM	
DRY-BULB TEMP	73 F	23 C	36 F	2 C
WET-BULB TEMP	61 F	16 C	32 F	0 C
TOT HORIZONTAL SOLAR RAD	0 BTU/H.SQFT	0 W/M2	70 BTU/H.SQFT	220 W/M2
WINDSPEED AT SPACE	4.3 KTS	2.2 M/S	0.0 KTS	0.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		2	

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	HEATING SENSIBLE (KBTU/H)	HEATING SENSIBLE (KW)
WALL CONDUCTION	4.362	1.278	0.000	0.000	-7.025	-2.058
ROOF CONDUCTION	4.770	1.398	0.000	0.000	-60.039	-17.592
WINDOW GLASS+FRM COND	0.000	0.000	0.000	0.000	0.000	0.000
WINDOW GLASS SOLAR	0.000	0.000	0.000	0.000	0.000	0.000
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	0.000	0.000	0.000	0.000	0.000	0.000
OCCUPANTS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
LIGHT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
EQUIPMENT TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	9.133	2.676	0.000	0.000	-67.064	-19.650
TOTAL / AREA	0.000	0.001	0.000	0.000	-0.002	-0.005

	COOLING		HEATING	
TOTAL LOAD	9.133 KBTU/H	2.676 KW	-67.064 KBTU/H	-19.650 KW
TOTAL LOAD / AREA	0.22 BTU/H.SQFT	0.687 W/M2	1.600 BTU/H.SQFT	5.047 W/M2

```
*****************************************************************
*                                                               *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR      *
*  ----    LOADS                                                *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION        *
*          IN CONSIDERATION                                     *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A            *
*          CONSTANT INDOOR SPACE TEMPERATURE                    *
*                                                               *
*****************************************************************
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Building HVAC Load Summary (SS-D)

The SS-D report shows a summary of total system peak and annualized heating and cooling loads for all building systems. Loads include all components: envelope, internal gains, reheat/overcooling, fan heat, and ventilation. Effect of HVAC controls, such as thermostat setpoints, is also included.

Option A1 peak cooling coil load: 13,073,147 Btuh (1089 tons), or 478 SF/ton
Option A2 peak cooling coil load: 8,994,810 Btuh (750 tons), or 695 SF/ton

Option A1 peak heating coil load: 5,981,730 Btuh , or 11.48 Btuh/SF
Option A2 peak heating coil load: 3,697,341 Btuh, or 7.1 Btuh/SF

High Performance Hospital – Scheme A1 Baseline - Conventional DOE-2.2-47b 4/14/2010 14:38:41 BDL RUN 1

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- Seattle WA TMY2

	- - - COOLING - - -						- - - HEATING - - -						- - - ELEC - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	1.72373	14	12	53.F	52.F	333.083	-3001.010	1	1	34.F	30.F	-5981.730	863448.	1480.741
FEB	60.55465	21	14	65.F	50.F	4334.548	-2472.716	15	4	31.F	29.F	-5391.814	779910.	1483.798
MAR	179.96518	29	17	70.F	53.F	6425.333	-2635.156	1	4	35.F	32.F	-5579.955	863583.	1484.684
APR	389.97607	29	17	71.F	61.F	9054.794	-2361.081	9	4	40.F	38.F	-4978.335	835754.	1483.867
MAY	1268.63818	7	16	71.F	62.F	9888.801	-2058.549	11	4	40.F	39.F	-4154.639	864134.	1486.908
JUN	2096.95117	18	17	82.F	67.F	11662.621	-1859.323	13	4	46.F	45.F	-3776.684	836636.	1488.185
JUL	3550.17969	31	17	84.F	66.F	11431.324	-1829.103	5	3	52.F	46.F	-3499.153	865019.	1489.588
AUG	4096.90186	6	17	83.F	66.F	11396.330	-1815.001	17	7	57.F	56.F	-3296.439	864970.	1489.073
SEP	2251.55957	2	16	98.F	69.F	13073.147	-1918.317	18	7	44.F	41.F	-4023.467	836865.	1497.064
OCT	745.34735	9	16	71.F	60.F	9133.655	-2234.730	30	4	37.F	37.F	-4513.233	864049.	1487.616
NOV	150.69620	4	15	66.F	58.F	7069.396	-2673.454	29	7	23.F	22.F	-5816.839	835877.	1483.777
DEC	5.42680	31	14	55.F	52.F	708.349	-2876.876	11	4	27.F	25.F	-5782.911	863562.	1480.101
TOTAL	14797.958						-27735.305						10173796.	
MAX						13073.147						-5981.730		1497.064

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 218048.384 (KBTU)

	- - - - - - - - C O O L I N G - - - - - - - -						- - - - - - - - H E A T I N G - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	107.54815	27	16	53.F	47.F	488.326	-1339.009	2	3	29.F	27.F	-3405.779	742453.	1339.440
FEB	157.36339	21	14	65.F	50.F	2682.293	-1053.735	15	3	31.F	29.F	-3078.305	660262.	1324.185
MAR	231.50948	29	17	70.F	53.F	4389.762	-1137.968	2	3	31.F	29.F	-2975.614	723996.	1316.642
APR	345.11676	29	17	71.F	61.F	5629.734	-954.053	11	1	35.F	33.F	-2499.199	689669.	1295.130
MAY	865.38696	6	14	75.F	64.F	6865.944	-755.669	11	3	41.F	40.F	-1682.058	699281.	1303.131
JUN	1287.53064	18	17	82.F	67.F	8347.380	-663.270	13	3	46.F	45.F	-1333.921	670300.	1300.305
JUL	2030.19958	24	16	87.F	66.F	8009.884	-638.324	12	12	57.F	56.F	-1089.987	692992.	1301.788
AUG	2247.77808	6	17	83.F	66.F	8025.822	-635.230	27	9	56.F	56.F	-1131.381	693270.	1305.625
SEP	1357.86902	2	16	98.F	69.F	8994.810	-671.199	5	4	56.F	56.F	-1425.915	680826.	1321.911
OCT	535.81665	9	16	71.F	60.F	5304.708	-794.137	30	5	36.F	36.F	-2059.479	713165.	1299.700
NOV	194.27481	4	15	66.F	58.F	4156.500	-1086.361	29	2	25.F	23.F	-3697.341	709458.	1336.625
DEC	124.40903	31	16	52.F	50.F	571.184	-1233.496	11	3	29.F	25.F	-3422.232	742561.	1334.638
TOTAL	9484.790						-10962.453						8418230.	
MAX						8994.810						-3697.341		1339.440

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 126895.008 (KBTU)

Building Daylighting Reports (LS-I)

The LS-I report shows the building-wide lighting savings due to daylighting controls. Daylighting, as modeled in Option A2, is predicted to save 8% of the lighting energy predicted to be used in Option A1.

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High Performance Hospital – Scheme A2   Target 100 - Conventional            DOE-2.2-47b    4/14/2010    14:35:34  BDL RUN  1
REPORT- LS-I Energy Reduction By Daylight   Building                                    WEATHER FILE- Seattle      WA TMY2
-----------------------------------------------------------------------------------------------------------------------------
*** BUILDING ***
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HOUR OF DAY

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	ALL HOURS
JAN	0	0	0	0	0	0	0	0	3	7	10	10	9	10	8	5	1	0	0	0	0	0	0	0	4
FEB	0	0	0	0	0	0	0	1	6	9	13	13	12	13	12	10	5	1	0	0	0	0	0	0	6
MAR	0	0	0	0	0	0	2	7	11	14	15	15	14	15	13	12	10	4	0	0	0	0	0	0	8
APR	0	0	0	0	0	1	6	10	14	16	16	16	16	16	16	15	14	10	3	0	0	0	0	0	10
MAY	0	0	0	0	0	3	9	12	14	16	16	16	16	16	15	16	15	13	6	1	0	0	0	0	10
JUN	0	0	0	0	1	6	12	13	16	17	16	16	16	16	16	16	15	15	10	3	0	0	0	0	11
JUL	0	0	0	0	0	4	10	12	14	15	16	16	16	16	16	16	15	15	10	2	0	0	0	0	11
AUG	0	0	0	0	0	2	7	10	14	16	16	15	16	16	16	15	16	12	4	0	0	0	0	0	10
SEP	0	0	0	0	0	0	4	9	12	14	15	15	16	15	14	14	12	6	1	0	0	0	0	0	9
OCT	0	0	0	0	0	0	1	5	8	11	13	13	13	14	12	10	5	1	0	0	0	0	0	0	6
NOV	0	0	0	0	0	0	0	1	5	9	12	12	12	11	9	5	1	0	0	0	0	0	0	0	5
DEC	0	0	0	0	0	0	0	0	2	6	9	10	9	8	6	3	0	0	0	0	0	0	0	0	3
ANNUAL	0	0	0	0	0	2	5	7	10	12	14	14	14	14	13	11	9	6	3	1	0	0	0	0	8

PERCENT LIGHTING ENERGY REDUCTION BY DAYLIGHT

NOTE- THE ENTRIES IN THIS REPORT ARE NOT
SUBJECT TO THE DAYLIGHTING REPORT SCHEDULE

Plant Equipment Loads and Energy Use Summary (PS-C)

The PS-C report shows a summary of the predicted loading for all simulated plant equipment in each Option, including peak loads, annualized load, hours of operation at various part load conditions, and annual energy used. The loads represented in the PS-C report include coil loads, potable water heating loads, distribution system losses, and enhanced heat recovery loads (for Option A3).

Note that the majority of the potable water heating loads for all three options are reported as loads imposed on the boilers, heat pumps, or other primary heat generation equipment (rather than the potable water heaters).

High Performance Hospital – Scheme A1 Baseline - Conventional DOE-2.2-47b 4/14/2010 14:38:41 BDL RUN 1

REPORT- PS-C Equipment Loads and Energy Use WEATHER FILE- Seattle WA TMY2

MON / SUM / PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		Number of hours within each PART LOAD range 00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100 +	TOTAL RUN HOURS
B-1																	
SUM		-46213.4	125406.3	56157.5	LOAD	0	0	0	0	1009	3026	2147	1370	643	565	0	8760
PEAK		-8229.9	14.3	10040.5	ELEC	8760	0	0	0	0	0	0	0	0	0	0	8760
MON/DAY		1/19	1/ 1	1/19	FUEL	0	0	0	0	1050	3091	2108	1332	623	556	0	8760
B-2																	
SUM		-3437.6	10822.7	4175.4	LOAD	0	0	0	0	0	662	94	0	0	0	0	756
PEAK		-5602.9	14.3	6801.6	ELEC	756	0	0	0	0	0	0	0	0	0	0	756
MON/DAY		11/29	1/ 1	11/29	FUEL	0	0	0	0	12	661	83	0	0	0	0	756
B-3																	
SUM		0.0	0.0	0.0	LOAD	0	0	0	0	0	0	0	0	0	0	0	0
PEAK		0.0	0.0	0.0	ELEC	0	0	0	0	0	0	0	0	0	0	0	0
MON/DAY		0/ 0	0/ 0	0/ 0	FUEL	0	0	0	0	0	0	0	0	0	0	0	0
CH-1																	
SUM	8353.4	0.0	519842.2		LOAD	619	404	282	218	200	197	144	116	106	57	0	2343
PEAK	10621.8	0.0	496.5		ELEC	0	62	458	560	374	250	237	146	112	100	44	2343
MON/DAY	7/15	0/ 0	7/15														
CH-2																	
SUM	3853.6	0.0	210377.9		LOAD	97	83	82	57	82	126	86	64	66	32	0	775
PEAK	10649.6	0.0	496.4		ELEC	0	18	61	115	103	87	146	95	66	59	25	775
MON/DAY	7/31	0/ 0	7/31														
CH-3																	
SUM	4487.2	0.0	297171.1		LOAD	471	285	172	111	94	119	63	58	45	33	0	1451
PEAK	10595.9	0.0	494.3		ELEC	0	70	348	375	214	100	158	59	58	43	26	1451
MON/DAY	8/28	0/ 0	8/28														
CT-1																	
SUM	10437.3		3676.7		LOAD	0	0	5	330	239	1613	117	36	3	0	0	2343
PEAK	12441.7		7.9		ELEC	1801	743	90	22	2	0	0	0	0	0	0	2658
MON/DAY	7/15		7/31														
CT-2																	
SUM	4674.8		2207.4		LOAD	0	0	1	47	40	580	80	23	4	0	0	775
PEAK	12439.1		7.8		ELEC	1268	420	61	13	4	0	0	0	0	0	0	1766
MON/DAY	7/31		9/ 2														
CT-3																	
SUM	5691.9		2198.1		LOAD	0	0	12	288	155	905	64	26	1	0	0	1451
PEAK	12397.4		7.7		ELEC	1521	373	57	8	1	0	0	0	0	0	0	1960
MON/DAY	8/28		9/ 1														
DHW HX																	
SUM		-435.9	947.2	560.5	LOAD	0	0	0	0	2555	2920	1156	1034	426	669	0	8760
PEAK		-81.9	0.1	103.2	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		4/30	1/ 1	1/ 1	FUEL	0	0	0	0	2190	3285	1095	886	454	730	120	8760

SCHWP-1/2/3														
SUM	85856.7	FLOW	2370	1278	724	101	0	0	0	0	0	0	0	4473
PEAK	49.2	RPM	0	0	0	0	0	0	0	2837	1532	104	0	4473
MON/DAY	9/ 2	ELEC	1639	2325	497	12	0	0	0	0	0	0	0	4473
Pseudo Pump														
SUM	25482.3	FLOW	0	0	0	0	0	0	0	0	0	661	8099	8760
PEAK	2.9	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	661	8099	8760
CWP-1														
SUM	56462.7	FLOW	0	0	0	0	0	6	142	188	140	98	1769	2343
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	2343	2343
MON/DAY	1/14	ELEC	0	0	0	0	0	0	0	25	277	272	1769	2343
DHW Pump														
SUM	2534.8	FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK	0.3	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
PCHWP-1														
SUM	40486.1	FLOW	0	0	0	0	0	0	0	0	0	2343	0	2343
PEAK	17.3	RPM	0	0	0	0	0	0	0	0	0	0	2343	2343
MON/DAY	1/14	ELEC	0	0	0	0	0	0	0	0	0	2343	0	2343
PCHWP-2														
SUM	13391.7	FLOW	0	0	0	0	0	0	0	0	0	775	0	775
PEAK	17.3	RPM	0	0	0	0	0	0	0	0	0	0	775	775
MON/DAY	1/27	ELEC	0	0	0	0	0	0	0	0	0	775	0	775
HWP-5/6														
SUM	266702.1	FLOW	0	0	0	0	0	0	8760	0	0	0	0	8760
PEAK	30.4	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	8760	0	0	8760
HWP-1/2/3/4														
SUM	94903.1	FLOW	0	0	0	0	5884	0	0	0	0	0	0	5884
PEAK	16.1	RPM	0	0	0	0	0	0	0	0	0	0	5884	5884
MON/DAY	1/ 1	ELEC	0	0	0	0	5884	0	0	0	0	0	0	5884
PCHWP-3														
SUM	25072.7	FLOW	0	0	0	0	0	0	0	0	0	1451	0	1451
PEAK	17.3	RPM	0	0	0	0	0	0	0	0	0	0	1451	1451
MON/DAY	2/ 3	ELEC	0	0	0	0	0	0	0	0	0	1451	0	1451
CWP-2														
SUM	18933.6	FLOW	0	0	0	0	0	1	26	21	25	17	685	775
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	775	775
MON/DAY	1/27	ELEC	0	0	0	0	0	0	0	8	38	44	685	775
CWP-3														
SUM	34561.9	FLOW	0	0	0	0	0	14	141	147	95	58	996	1451
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	1451	1451
MON/DAY	2/ 3	ELEC	0	0	0	0	0	0	0	33	249	173	996	1451

REPORT- PS-C Equipment Loads and Energy Use WEATHER FILE- Seattle WA TMY2

MON SUM PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		Number of hours within each PART LOAD range 00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100 +	TOTAL RUN HOURS
CH-1																	
SUM	39.4	0.0	1665.1		LOAD	0	0	0	0	0	0	1	1	3	0	0	5
PEAK	9115.2	0.0	388.8		ELEC	0	0	0	0	0	0	1	1	2	1	0	5
MON/DAY	9/ 2	0/ 0	9/ 2														
HC-2																	
SUM	7632.7	-2007.5	550446.3		LOAD	5031	1007	442	331	303	466	303	229	227	158	233	8730
PEAK	5125.0	-5522.5	310.0		ELEC	5055	978	449	326	281	398	308	314	333	194	94	8730
MON/DAY	5/ 4	11/28	8/24														
HC-3																	
SUM	601.8	-18113.2	1156981.5		LOAD	85	57	753	1631	1993	1571	814	524	705	292	14	8439
PEAK	5209.0	-4173.2	308.4		ELEC	74	57	488	1324	1962	1922	961	604	779	227	41	8439
MON/DAY	5/31	4/24	8/19														
HC-4																	
SUM	1744.1	-54.7	106934.9		LOAD	0	0	23	7	91	218	168	76	24	5	0	612
PEAK	4405.6	-2960.2	286.2		ELEC	0	0	7	23	2	135	179	133	88	33	12	612
MON/DAY	9/ 2	11/29	9/ 2														
DHW Heater																	
SUM		-84.0	7395.3		LOAD	3047	2428	336	759	368	607	243	244	426	302	0	8760
PEAK		-36.7	3.1		ELEC	2555	2800	335	880	306	610	302	214	395	304	59	8760
MON/DAY		3/29	2/ 2														
DHW Booster Hx																	
SUM		-975.6	0.0	1129.1	LOAD	2555	2800	243	972	245	641	270	215	426	393	0	8760
PEAK		-398.8	0.0	422.3	ELEC	0	0	0	0	0	0	0	0	0	0	0	0
MON/DAY		4/29	0/ 0	1/ 1	FUEL	2510	2347	618	986	232	615	357	198	401	496	0	8760
GCHX																	
SUM	6171.2	-9569.1															
PEAK	9619.9	-4688.5															
MON/DAY	9/ 2	1/31															
SCHP-1/2/3																	
SUM			99614.5		FLOW	7490	904	362	4	0	0	0	0	0	0	0	8760
PEAK			34.2		RPM	0	0	0	0	0	0	0	0	8063	697	0	8760
MON/DAY			9/ 2		ELEC	0	8118	625	15	2	0	0	0	0	0	0	8760
DHW Loop Pump																	
SUM			1782.3		FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK			0.2		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY			1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
PCHP-1																	
SUM			86.4		FLOW	0	0	0	0	0	0	0	0	0	5	0	5
PEAK			17.3		RPM	0	0	0	0	0	0	0	0	0	0	5	5
MON/DAY			9/ 2		ELEC	0	0	0	0	0	0	0	0	0	5	0	5

REPORT- PS-C Equipment Loads and Energy Use   WEATHER FILE- Seattle   WA TMY2

(CONTINUED)

PCHP-2														
SUM	73726.3	FLOW	0	0	0	0	0	0	0	0	0	8730	0	8730
PEAK	8.4	RPM	0	0	0	0	0	0	0	0	0	0	8730	8730
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	8730	0	8730
PCHP-3														
SUM	63914.5	FLOW	0	0	0	0	0	0	0	0	0	0	8300	8300
PEAK	7.7	RPM	0	0	0	0	0	0	0	0	0	0	8300	8300
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8300	8300
GLP-1/2/3														
SUM	71702.3	FLOW	0	4087	1720	736	1673	1	5	15	523	0	0	8760
PEAK	25.4	RPM	0	0	0	0	0	0	0	2704	4749	1303	4	8760
MON/DAY	6/17	ELEC	0	5289	1056	1714	158	0	11	532	0	0	0	8760
Pump 13														
SUM	316.8	FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK	0.0	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
PHWP-4														
SUM	4627.0	FLOW	0	0	0	0	0	0	0	0	0	0	612	612
PEAK	7.6	RPM	0	0	0	0	0	0	0	0	0	0	612	612
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	612	612
PHWP-3														
SUM	63803.1	FLOW	0	0	0	0	0	0	0	0	0	0	8439	8439
PEAK	7.6	RPM	0	0	0	0	0	0	0	0	0	0	8439	8439
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8439	8439
CWP-1														
SUM	92.3	FLOW	0	0	0	0	0	0	0	0	0	0	5	5
PEAK	18.5	RPM	0	0	0	0	0	0	0	0	0	0	5	5
MON/DAY	9/ 2	ELEC	0	0	0	0	0	0	0	0	0	0	5	5
PCHP-4														
SUM	4712.7	FLOW	0	0	0	0	0	0	0	0	0	0	612	612
PEAK	7.7	RPM	0	0	0	0	0	0	0	0	0	0	612	612
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	612	612
SHWP-1/2/3														
SUM	44871.8	FLOW	8487	273	0	0	0	0	0	0	0	0	0	8760
PEAK	6.8	RPM	0	0	0	0	0	0	0	8760	0	0	0	8760
MON/DAY	11/29	ELEC	0	8760	0	0	0	0	0	0	0	0	0	8760
PHWP-2														
SUM	64999.1	FLOW	0	0	0	0	0	0	0	0	0	0	8730	8730
PEAK	7.4	RPM	0	0	0	0	0	0	0	0	0	0	8730	8730
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8730	8730

REPORT- PS-C Equipment Loads and Energy Use WEATHER FILE- Seattle WA TMY2

MON SUM PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
Blr-1																	
SUM		-1131.1	1867.0	1279.9	LOAD	1177	554	249	150	55	201	174	98	39	15	4	2716
PEAK		-1760.0	1.7	1942.5	ELEC	2716	0	0	0	0	0	0	0	0	0	0	2716
MON/DAY		2/ 8	12/ 1	12/ 1	FUEL	1188	576	216	148	58	177	191	99	41	19	3	2716
Blr-2																	
SUM		-913.7	1468.9	1036.0	LOAD	880	429	192	112	52	191	143	76	26	13	0	2114
PEAK		-1730.1	1.7	1942.5	ELEC	2114	0	0	0	0	0	0	0	0	0	0	2114
MON/DAY		12/12	12/ 1	12/ 1	FUEL	886	450	163	115	50	171	155	80	28	15	1	2114
Blr-3																	
SUM		-866.3	1458.8	972.9	LOAD	730	580	202	176	88	73	57	54	43	55	4	2062
PEAK		-1769.7	1.7	1947.4	ELEC	2062	0	0	0	0	0	0	0	0	0	0	2062
MON/DAY		12/28	12/28	12/28	FUEL	739	579	187	184	89	73	52	55	42	58	4	2062
Blr-4																	
SUM		-921.1	1349.2	1029.9	LOAD	471	475	193	179	105	90	96	81	66	44	2	1802
PEAK		-1766.6	1.7	1944.0	ELEC	1802	0	0	0	0	0	0	0	0	0	0	1802
MON/DAY		3/18	3/18	3/18	FUEL	477	480	179	187	107	87	87	80	70	47	1	1802
CH-1																	
SUM	3245.1	0.0	156622.8		LOAD	0	0	37	456	208	40	3	0	0	0	0	744
PEAK	6701.8	0.0	300.0		ELEC	0	0	0	49	344	239	108	4	0	0	0	744
MON/DAY	9/ 2	0/ 0	9/ 2														
HC-1																	
SUM	13375.0	-16722.4	2807822.3		LOAD	0	0	4445	2443	749	448	199	198	166	112	0	8760
PEAK	4632.5	-4230.4	326.3		ELEC	0	0	0	0	0	0	0	0	170	7515	1075	8760
MON/DAY	8/23	4/14	3/ 8														
HC-2																	
SUM	337.9	0.0	49290.9		LOAD	0	0	0	0	0	133	21	0	0	0	0	154
PEAK	2354.6	0.0	323.1		ELEC	0	0	0	0	0	0	0	0	0	154	0	154
MON/DAY	8/30	0/ 0	8/19														
CT-3																	
SUM	7328.7		2908.5		LOAD	0	0	0	0	8504	102	0	0	0	154	0	8760
PEAK	5950.2		7.6		ELEC	2839	924	18	20	62	39	9	1	1	0	0	3913
MON/DAY	7/24		7/24														
CT-2																	
SUM	3860.6		2044.5		LOAD	0	0	0	0	743	1	0	0	0	0	0	744
PEAK	7811.3		4.3		ELEC	0	737	7	0	0	0	0	0	0	0	0	744
MON/DAY	9/ 2		9/ 2														
DHW Heater																	
SUM		-84.0	7395.3		LOAD	3047	2428	336	759	368	607	243	244	426	302	0	8760
PEAK		-36.7	3.1		ELEC	2555	2800	335	880	306	610	302	214	395	304	59	8760

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High Performance Hospital – Scheme A3   Target 100 – Conventional / No Borefield DOE-2.2-47b    4/14/2010    14:31:17  BDL RUN  1

REPORT- PS-C Equipment Loads and Energy Use                                              WEATHER FILE- Seattle      WA TMY2
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DHW Booster Hx
      SUM            -975.6         0.0      1129.1 LOAD2555  2800   243   972   245   641   270   215   426   393     0  8760
     PEAK            -398.8         0.0       422.3 ELEC    0     0     0     0     0     0     0     0     0     0     0     0
  MON/DAY              4/29         0/ 0       1/ 1 FUEL2510  2347   618   986   232   615   357   198   401   496     0  8760

SCHP-1/2/3
      SUM                      105196.7             FLOW7564  1025   171     0     0     0     0     0     0     0     0  8760
     PEAK                          27.2              RPM    0     0     0     0     0     0     0     0  8294   466     0  8760
  MON/DAY                          9/ 2             ELEC    0  8346   413     1     0     0     0     0     0     0     0  8760

DHW Loop Pump
      SUM                        1782.3             FLOW    0     0     0     0     0     0     0     0     0     0  8760  8760
     PEAK                           0.2              RPM    0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  8760  8760

PCHP-3
      SUM                       12856.0             FLOW    0     0     0     0     0     0     0     0     0   744     0   744
     PEAK                          17.3              RPM    0     0     0     0     0     0     0     0     0     0   744   744
  MON/DAY                          3/29             ELEC    0     0     0     0     0     0     0     0     0   744     0   744

PCHP-1
      SUM                       63683.8             FLOW    0     0     0     0     0     0     0     0  8760     0     0  8760
     PEAK                           7.3              RPM    0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0  8760     0  8760

PCHP-2
      SUM                        1119.6             FLOW    0     0     0     0     0     0     0     0   154     0     0   154
     PEAK                           7.3              RPM    0     0     0     0     0     0     0     0     0     0   154   154
  MON/DAY                          3/29             ELEC    0     0     0     0     0     0     0     0     0   154     0   154

Pump 13
      SUM                         316.8             FLOW    0     0     0     0     0     0     0     0     0     0  8760  8760
     PEAK                           0.0              RPM    0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  8760  8760

CWP-1
      SUM                       12687.1             FLOW    0     0     0     0     0     0     0     0     0     0   744   744
     PEAK                          17.1              RPM    0     0     0     0     0     0     0     0     0     0   744   744
  MON/DAY                          3/29             ELEC    0     0     0     0     0     0     0     0     0     0   744   744

SHWP-1/2/3
      SUM                       55499.1             FLOW8528   232     0     0     0     0     0     0     0     0     0  8760
     PEAK                           7.9              RPM    0     0     0     0     0     0     0   580  8180     0     0  8760
  MON/DAY                          1/ 3             ELEC    0  8760     0     0     0     0     0     0     0     0     0  8760

WHP-1/2
      SUM                       70715.1             FLOW    0     0     0     0  8606     0     0     0   154     0     0  8760
     PEAK                          10.9              RPM    0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                          3/29             ELEC    0     0     0     0     0     0     0  8606     0   154     0  8760

BP-1
      SUM                        4509.4             FLOW    0     0     0     0     0     0     0     0     0  2716     0  2716
     PEAK                           1.7              RPM    0     0     0     0     0     0     0     0     0     0  2716  2716
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  2716  2716

BP-2
      SUM                        3509.9             FLOW    0     0     0     0     0     0     0     0     0  2114     0  2114
     PEAK                           1.7              RPM    0     0     0     0     0     0     0     0     0     0  2114  2114
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  2114  2114
```


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High Performance Hospital – Scheme A3   Target 100 – Conventional / No Borefield DOE-2.2-47b    4/14/2010    14:31:17  BDL RUN  1

REPORT- PS-C Equipment Loads and Energy Use                                              WEATHER FILE- Seattle      WA TMY2
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BP-3
      SUM                        3423.5             FLOW    0     0     0     0     0     0     0     0     0  2062     0  2062
     PEAK                           1.7              RPM    0     0     0     0     0     0     0     0     0     0  2062  2062
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  2062  2062

BP-4
      SUM                        2991.9             FLOW    0     0     0     0     0     0     0     0     0  1802     0  1802
     PEAK                           1.7              RPM    0     0     0     0     0     0     0     0     0     0  1802  1802
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0     0  1802  1802

PHWP-1
      SUM                       50599.3             FLOW    0     0     0     0     0     0     0     0  8760     0     0  8760
     PEAK                           5.8              RPM    0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                          1/ 1             ELEC    0     0     0     0     0     0     0     0     0  8760     0  8760

PHWP-2
      SUM                         889.5             FLOW    0     0     0     0     0     0     0     0   154     0     0   154
     PEAK                           5.8              RPM    0     0     0     0     0     0     0     0     0     0   154   154
  MON/DAY                          3/29             ELEC    0     0     0     0     0     0     0     0     0   154     0   154
```

Target 100 Energy Efficiency Design Strategies (Scheme B)

The following strategies are modeled and are represented in the output reports presented in this document.

- Improved wall insulation and reduced wall area: Wall U-value is reduced by adding more insulation**.** Option B1 U-value is 0.059 Btu/hr-SF-F. Option B2 U-value is 0.045 Btu/hr-SF-F. Floor to floor heights on the upper floors of the towers are reduced from 15 feet (Option B1) to 14 feet (Option B2), resulting in a modest reduction of overall above-grade wall area (260,526 GSF in Option B1 vs. 254,106 GSF in Option B2).

- Improved roof reflectance: Roof reflectance is increased from 30% (Option B1) to 70% (Option B2). This will reduce roof surface temperature during the cooling season.

- High performance glazing: High performance glazing is specified for all windows in Option B2. High performance glass has U-value (center of glass) of 0.29, and solar heat gain coefficient of 0.40. Glazing in Option B1 has U-value (center of glass) of 0.47, and solar heat gain coefficient of 0.45.

- Motorized external shading**:** All windows in Option B2 are modeled with motorized exterior window shading. Shading will be activated whenever transmitted total solar gain (from direct and diffuse radiation) exceeds 25 Btu/hr-SF. When activated, total solar radiation is reduced by 87.5%, with visible spectrum reduced by 75%. (Note that this shading element is applied to north facing windows in the energy model, but is rarely is ever activated because solar gain does not typically exceed 25 Btu/hr-SF for north glass. The cost model has shades only on the east, west, and south-facing windows).

- Daylighting and light level control of electric lighting: Daylighting control of electric lights is included in all perimeter zones with significant windows in Option B2, including patient rooms. Control zones are assumed to penetrate approximately 20 feet into space. Patient rooms are modeled as manual on/off control with a 50% probability that lights will be turned off if light levels exceed 50 fc. Lighting control in all other spaces is modeled as continuous dimming with minimum lighting output of 10%. Lighting is dimmed to maintain a setpoint of 50 fc in most spaces, with illuminance setpoints of 30 fc in stairwells.

- Efficient electric lighting**:** Electric lighting connected load is reduced by 20% in Option B2 relative to Option B1.

- Occupancy sensor lighting controls: For Option B2, occupancy sensors are assumed to control all lighting in administrative areas (offices), storage areas, and conference areas. Lighting power density was reduced an additional 10% for these functional areas.

- Efficient "plug load" equipment: Plug load power density was reduced by 2% in Option B2 compared to Option B1.

- Potable hot water heat recovery: Heat recovery from the shower drainage is modeled in Option B2 by reducing the load imposed by showers by 50%. For the building as a whole, this is modeled as a reduction in peak flow from 101 gpm to just under 73 gpm. Of this load, about 63 gpm is met by the ground-coupled heat pump plant. The remainder of the load is assigned to a gas-fired high efficiency "booster" water heater.

- <u>Zonal heating and cooling via fan coil units</u>: Fan coil units are modeled in much of the conditioned space in Option B2, instead of large central station VAV units with reheat. Exceptions include surgery suites, emergency department, regulated zones of diagnostics and treatment floors, kitchen, laboratories, laundry, and the server room (representing 144,704 square feet of the total program area). Just under 73% of the program area is served by fan coils.

- <u>Improved ventilation heat recovery</u>: Ventilation heat recovery for the kitchen and lab 100% OSA units is improved from 50% effectiveness in Option B1 to 65% effectiveness in Option B2. All fan coil units are served by dedicated ventilation heat recovery units with 70% minimum effectiveness, and variable speed control of fans based on duct static pressure. (Dedicated ventilation heat recovery was modeled at the individual fan coil unit with supply side pressure drop of 4.5 inches wc and exhaust side pressure drop of 3 inches wc).

- <u>Reduced air pressure requirements in large fan systems</u>: Pressure requirements for large fan systems are reduced by 10% in Option B2, compared to Option B1.

- <u>Maximum efficiency fan motors</u>: Option B2 assumes all large fan system motors will be specified as "best-in-class" premium efficiency motors. Return/exhaust fans are assumed to gain 2% improvement in combined efficiency. Supply fans are assumed to gain 1% improvement in combined efficiency.

- <u>Advanced system controls</u>: System controls modeled in Option B2 (but not in Option B1) include:

    - <u>Occupancy sensor-based turn-down of surgery suite VAV units</u>: During unoccupied period, VAV terminal units are scheduled to reduced flow to about 11% of design flow rate (3 ACH). During the unoccupied period, VAV terminal units serving about 1/3 of the imaging/procedure zones are scheduled to all air flow reduce to a minimum of about 25% of design flow rate (3 ACH).
    - <u>Occupied/unoccupied period system scheduling</u>: Fan coil units in the Medical Office Building and Office areas are de-energized during unoccupied periods, subject to occupied/unoccupied period temperature setpoints.
    - <u>Improved supply air temperature reset</u>: All large fan systems with reheat are modeled with extended supply air temperature reset schedules that generally increase supply air minimum temperature setpoint by 2 deg F, and the maximum setpoint by 4 deg. F.
    - <u>Improved static pressure reset</u>: Fan capacity curves for variable frequency drive (VFD) control of fans are input to represent a reasonably good implementation of static pressure reset controls.
    - <u>Dual temperature economizer control</u>: Economizer cooling functions on large fan systems are controlled through comparison of outside air and return air temperatures in Option 2. In Option 1, economizer high limit setpoint is fixed at 65 deg F for surgery units and 72 deg F for all other large fan systems. Fan coil units do not have air-side economizer capability.

- Natural ventilation systems: Natural ventilation and passive cooling is applied as a system concept to the south-facing corridors, and the atrium/lobby zones on the south-side (in Option B2). Fan energy input for fan coil units serving these areas was set to near-zero. Thermostat setpoints for cooling were set to 82 deg. F. Economizer cooling was enabled. Heat recovery was disabled.

- Modular ground-coupled heat pump plant: Heating and cooling in Option B2 is generated with a ground-coupled heat pump plant that generated chilled water (42 deg F minimum chilled water supply temperature) and heating water (115 deg F maximum heating water temperature). Heating water is also used for potable water heating with gas-fired booster heaters that will be used to increase potable hot water temperature from 115 deg. F to final setpoint. Rated coefficient of performance is 5.0 for heat pumps. This concept employs integral heat recovery, i.e., when heat pumps are meeting a cooling load, hot condenser water is first used to meet heating load before being "cooled" by the ground-coupled hydronic loop. (Option B1 has centrifugal chillers with 6.10 COP and boilers with 82% full load combustion efficiency. Note that both options generate process steam with steam boilers.)

- Variable flow heating water system: Option B1 has a variable flow chilled water system and constant flow heating water system. Option B2 has variable flow systems for both heating and chilled water. Pumps are controlled by variable frequency drives (VFDs).

- Advanced plant controls: Hydronic system temperature reset strategies are maximized in Option 4 as described below.

    - Extended load-based reset of chilled water temperatures: Option B2 resets chilled water temperature, based on load, between 42 deg F and 48 deg F. Option B1 resets chilled water temperatures between 42 deg. F and 45 deg. F.
    - Low temperature load-based reset of heating water temperatures: Option B2 resets heating water temperature, based on load, between 115 deg F and 110 deg F. Option B1 resets heating water temperatures between 180 deg. F and 170 deg. F.

- Efficient exterior lighting: Option B2 reduces exterior lighting load by 20% (from 20 kW to 16 kW).

- B3 enhanced heat recovery chiller plant: Option B3 serves the B2 heating and cooling loads by employing a heat recovery chiller plant that can be additionally loaded using chilled water coils in the exhaust air stream of the VAV units serving surgery, emergency, and imaging. The heat recovery chillers generate chilled water (42 deg F minimum chilled water supply temperature) and heating water (115 deg F maximum heating water temperature). Recovered heat is also used for pre-heating of potable hot water. When recovered heat from the chillers is not sufficient to meet load, supplemental gas-fired condensing boilers will fire to provide added heating. Potable hot water booster heating will be accomplished using gas-fired booster heaters that will be used to increase potable hot water temperature from 115 deg. F to final setpoint. Rated coefficient of performance is 4.55 for heat recovery chillers.

Energy Modeling Pre-formatted Output Reports

Building Energy Performance Summary (BEPS)

The BEPS report shows a summary of predicted annual energy end uses in MMBtu/yr. Energy use index (EUI) for Option A1 is 239.6 kBtu/SF-yr (520,983 SF in model). Energy use index for Option B2 is 101.1 kBtu/SF-year. Energy use index for Option A3 is 116.5 kBtu/SF-year. The BEPS reports for each model are shown below in two versions: (1) as modeled with much of the potable hot water load “attached” to the heating plant as a process load, and (2) modified to show the potable hot water load under the appropriate end use category. The modification is necessary for proper accounting of energy end uses because all energy used to meet all process loads is included as part of the “Misc Equip” end use category.

Option B1 (as modeled):

High Performance Hospital – Scheme B1   Baseline - Perforated   DOE-2.2-47b   4/12/2010   18:54:49 BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Seattle   WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	11768.3	0.0	16560.5	305.4	3623.7	22.9	2432.6	15177.8	0.0	0.0	3.2	224.2	50118.8
FM1 NATURAL-GAS													
MBTU	0.0	0.0	24849.1	51568.1	0.0	0.0	0.0	0.0	0.0	0.0	560.5	0.0	76977.7
MBTU	11768.3	0.0	41409.6	51873.5	3623.7	22.9	2432.6	15177.8	0.0	0.0	563.8	224.2	127096.5

TOTAL SITE ENERGY   127096.46 MBTU   239.6 KBTU/SQFT-YR GROSS-AREA   239.6 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY   227334.13 MBTU   428.6 KBTU/SQFT-YR GROSS-AREA   428.6 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.5
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option B1 (modified):

High Performance Hospital – Scheme B1   Baseline - Perforated   DOE-2.2-47b   4/12/2010   18:54:49 BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Seattle   WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
MBTU	11768.3	0.0	16460.8	305.4	3623.7	22.9	2432.6	15177.8	0.0	0.0	102.9	224.2	50118.8
FM1 NATURAL-GAS													
MBTU	0.0	0.0	8362.5	51568.1	0.0	0.0	0.0	0.0	0.0	0.0	17047.1	0.0	76977.7
MBTU	11768.3	0.0	24823.3	51873.5	3623.7	22.9	2432.6	15177.8	0.0	0.0	17150.0	224.2	127096.5

TOTAL SITE ENERGY   127096.46 MBTU   239.6 KBTU/SQFT-YR GROSS-AREA   239.6 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY   227334.13 MBTU   428.6 KBTU/SQFT-YR GROSS-AREA   428.6 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.5
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option B2 (as modeled):

High Performance Hospital – Scheme B2 Target 100 - Perforated DOE-2.2-47b 4/14/2010 9:57:51 BDL RUN 1

REPORT- BEPS Building Energy Performance WEATHER FILE- Seattle WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY MBTU	8199.9	0.0	17935.4	3513.3	2186.6	0.0	1950.7	10138.2	0.0	0.0	25.2	179.4	44128.8
FM1 NATURAL-GAS MBTU	0.0	0.0	8362.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	9491.6
MBTU	8199.9	0.0	26298.0	3513.3	2186.6	0.0	1950.7	10138.2	0.0	0.0	1154.3	179.4	53620.4

TOTAL SITE ENERGY 53620.37 MBTU 101.1 KBTU/SQFT-YR GROSS-AREA 101.1 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 141878.03 MBTU 267.5 KBTU/SQFT-YR GROSS-AREA 267.5 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option B2 (modified):

High Performance Hospital – Scheme B2 Target 100 - Perforated DOE-2.2-47b 4/14/2010 9:57:51 BDL RUN 1

REPORT- BEPS Building Energy Performance WEATHER FILE- Seattle WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY MBTU	8199.9	0.0	16342.0	3513.3	2186.6	0.0	1950.7	10138.2	0.0	0.0	1618.6	179.4	44128.8
FM1 NATURAL-GAS MBTU	0.0	0.0	8362.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	9491.6
MBTU	8199.9	0.0	24704.5	3513.3	2186.6	0.0	1950.7	10138.2	0.0	0.0	2747.7	179.4	53620.4

TOTAL SITE ENERGY 53620.37 MBTU 101.1 KBTU/SQFT-YR GROSS-AREA 101.1 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 141878.03 MBTU 267.5 KBTU/SQFT-YR GROSS-AREA 267.5 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option B3 (as modeled):

High Performance Hospital – Scheme B3 Target 100 – Perforated / No Borefield DOE-2.2-47b 4/14/2010 14:25:01 BDL RUN 1

REPORT- BEPS Building Energy Performance WEATHER FILE- Seattle WA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY MBTU	8199.9	0.0	22155.8	13.4	4355.4	12.9	1314.1	10138.2	0.0	0.0	25.2	179.4	46394.3
FM1 NATURAL-GAS MBTU	0.0	0.0	10532.1	3726.2	0.0	0.0	0.0	0.0	0.0	0.0	1129.1	0.0	15387.4
MBTU	8199.9	0.0	32687.9	3739.6	4355.4	12.9	1314.1	10138.2	0.0	0.0	1154.3	179.4	61781.6

TOTAL SITE ENERGY 61781.64 MBTU 116.5 KBTU/SQFT-YR GROSS-AREA 116.5 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 154570.34 MBTU 291.4 KBTU/SQFT-YR GROSS-AREA 291.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Option B3 (modified):

High Performance Hospital – Scheme B3 Target 100 – Perforated / No Borefield DOE-2.2-47b 4/14/2010 14:25:01 BDL RUN 1

REPORT- BEPS Building Energy Performance WEATHER FILE- Seattle WA TMY2

		LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY	MBTU	8199.9	0.0	16342.0	5827.2	4355.4	12.9	1314.1	10138.2	0.0	0.0	25.2	179.4	46394.3
FM1 NATURAL-GAS	MBTU	0.0	0.0	8362.5	3726.2	0.0	0.0	0.0	0.0	0.0	0.0	3298.7	0.0	15387.4
	MBTU	8199.9	0.0	24704.5	9553.4	4355.4	12.9	1314.1	10138.2	0.0	0.0	3323.9	179.4	61781.6

TOTAL SITE ENERGY 61781.64 MBTU 116.5 KBTU/SQFT-YR GROSS-AREA 116.5 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 154570.34 MBTU 291.4 KBTU/SQFT-YR GROSS-AREA 291.4 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Energy Cost Summary (ES-D)

The ES-D report shows a summary of annual energy costs. Electric and natural gas rates (firm) for Puget Sound Energy are used. Option B1 has a predicted annual energy cost of $3.37/SF. Option A2 has a predicted annual energy cost of $1.77/SF. Annual savings associated with Option B2 is about $847,000.

Option B3 has a predicted annual energy cost of $1.97/SF. Annual savings associated with Option B3 is about $739,000.

High Performance Hospital – Scheme B1 Baseline - Perforated DOE-2.2-47b 4/12/2010 18:54:49 BDL RUN 1

REPORT- ES-D Energy Cost Summary WEATHER FILE- Seattle WA TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
PSE Elec 26 Com/Ind Lrg Demand	ELECTRICITY	EM1	14684795. KWH	960923.	0.0654	YES
PSE Gas 31 NRes After 10-9-1993	NATURAL-GAS	FM1	769777. THERM	824727.	1.0714	YES
				1785650.		

ENERGY COST/GROSS BLDG AREA: 3.37
ENERGY COST/NET BLDG AREA: 3.37

High Performance Hospital – Scheme B2   Target 100 - Perforated   DOE-2.2-47b   4/14/2010   9:57:51   BDL RUN 1

REPORT- ES-D Energy Cost Summary   WEATHER FILE- Seattle   WA TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
PSE Elec 26 Com/Ind Lrg Demand	ELECTRICITY	EM1	12929727. KWH	837038.	0.0647	YES
PSE Gas 31 NRes After 10-9-1993	NATURAL-GAS	FM1 Rehe	94916. THERM	101849.	1.0730	YES
				938887.		

ENERGY COST/GROSS BLDG AREA: 1.77
ENERGY COST/NET BLDG AREA: 1.77

High Performance Hospital – Scheme B3   Target 100 – Perforated / No Borefield   DOE-2.2-47b   4/14/2010   14:25:01   BDL RUN 1

REPORT- ES-D Energy Cost Summary   WEATHER FILE- Seattle   WA TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
PSE Elec 26 Com/Ind Lrg Demand	ELECTRICITY	EM1	13593523. KWH	881582.	0.0649	YES
PSE Gas 31 NRes After 10-9-1993	NATURAL-GAS	FM1	153874. THERM	165002.	1.0723	YES
				1046583.		

ENERGY COST/GROSS BLDG AREA: 1.97
ENERGY COST/NET BLDG AREA: 1.97

Exterior Surface Summary (LV-D)

The LV-D report shows a summary of external surfaces as included in the energy models, including areas and U-values for roofs, walls, windows, floors, and underground surfaces. The LV-D reports for the Option B1 and B2 models are shown below. Option B3 is identical to B2.

High Performance Hospital – Scheme B1   Baseline - Perforated   DOE-2.2-47b   4/12/2010   18:54:49   BDL RUN 1

REPORT- LV-D Details of Exterior Surfaces   WEATHER FILE- Seattle   WA TMY2

(CONTINUED)

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.521	0.058	0.187	14787.43	38252.56	53040.00
EAST	0.512	0.058	0.185	21493.88	55533.62	77027.50
SOUTH	0.523	0.058	0.229	19508.50	33543.50	53052.00
WEST	0.511	0.058	0.188	22241.91	55164.59	77406.50
FLOOR	0.000	0.056	0.056	0.00	1350.00	1350.00
ROOF	0.000	0.032	0.032	0.00	124966.75	124966.75
ALL WALLS	0.516	0.058	0.195	78031.78	182494.25	260526.00
WALLS+ROOFS	0.516	0.047	0.142	78031.78	307461.03	385492.78
UNDERGRND	0.000	0.097	0.097	0.00	140866.00	140866.00
BUILDING	0.516	0.063	0.130	78031.78	449677.03	527708.75

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.361	0.044	0.134	14787.43	37052.57	51840.00
EAST	0.348	0.044	0.131	21493.88	53543.62	75037.50
SOUTH	0.364	0.044	0.164	19508.50	32303.50	51812.00
WEST	0.347	0.044	0.133	22241.91	53174.19	75416.10
FLOOR	0.000	0.056	0.056	0.00	1350.00	1350.00
ROOF	0.000	0.032	0.032	0.00	124966.75	124966.75
ALL WALLS	0.354	0.044	0.139	78031.78	176073.86	254105.59
WALLS+ROOFS	0.354	0.039	0.104	78031.78	301040.63	379072.38
UNDERGRND	0.000	0.097	0.097	0.00	140866.00	140866.00
BUILDING	0.354	0.057	0.102	78031.78	443256.63	521288.38

Building Peak Load Components (LS-C)

The LS-C report shows a summary of building-level heating and cooling peak loads at a single interior reference temperature. Loads are those imposed by the building envelope and internal loads (people, lights, and equipment). *Loads imposed by HVAC systems (fan heat, reheat/over-cooling, and ventilation) are not shown*. Option B2 peak cooling load (as contributed by envelope and internal gains) is about 29% less than Option B1. Option B2 peak heating load is about 21% less than Option B1.

LS-C statistics are listed below.

- B1 total peak cooling load: 7593.9 KBtu/hr (633 tons); occurs on September 2 at 5 pm.
- B1 total peak heating load: 2181.5 kBtu/hr; occurs on November 28 at 5 am.

- B2 total peak cooling load: 5414.0 KBtu/hr (451 tons); occurs on September 2 at 5 pm.
- B2 total peak heating load: 1719.0 kBtu/hr; occurs on March 1 at 4 am.

Option B1:

*** BUILDING ***

FLOOR AREA	530410	SQFT	49275	M2
VOLUME	8800400	CUFT	249227	M3

	COOLING LOAD		HEATING LOAD	
TIME	SEP 2 5PM		NOV 28 5AM	
DRY-BULB TEMP	98 F	37 C	33 F	1 C
WET-BULB TEMP	67 F	19 C	27 F	-3 C
TOT HORIZONTAL SOLAR RAD	156 BTU/H.SQFT	491 W/M2	0 BTU/H.SQFT	0 W/M2
WINDSPEED AT SPACE	8.7 KTS	4.5 M/S	11.6 KTS	6.0 M/S
CLOUD AMOUNT 0(CLEAR)-10	0		0	

	SENSIBLE		LATENT		SENSIBLE	
	(KBTU/H)	(KW)	(KBTU/H)	(KW)	(KBTU/H)	(KW)
WALL CONDUCTION	173.481	50.830	0.000	0.000	-369.648	-108.307
ROOF CONDUCTION	22.651	6.637	0.000	0.000	-115.491	-33.839
WINDOW GLASS+FRM COND	1514.752	443.822	0.000	0.000	-1499.925	-439.478
WINDOW GLASS SOLAR	1017.838	298.227	0.000	0.000	23.632	6.924
DOOR CONDUCTION	0.000	0.000	0.000	0.000	0.000	0.000
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	-184.937	-54.187	0.000	0.000	-152.941	-44.812
OCCUPANTS TO SPACE	498.732	146.128	360.553	105.642	134.612	39.441
LIGHT TO SPACE	1747.337	511.970	0.000	0.000	638.774	187.161
EQUIPMENT TO SPACE	1564.179	458.305	0.000	0.000	407.473	119.390
PROCESS TO SPACE	99.691	29.210	92.858	27.207	0.000	0.000
INFILTRATION	686.761	201.221	0.000	0.000	-1247.968	-365.655
TOTAL	7140.486	2092.162	453.410	132.849	-2181.481	-639.174
TOTAL / AREA	0.013	0.042	0.001	0.003	-0.004	-0.013

TOTAL LOAD	7593.896	KBTU/H	2225.012	KW	-2181.481	KBTU/H	-639.174	KW
TOTAL LOAD / AREA	14.32	BTU/H.SQFT	45.153	W/M2	4.113	BTU/H.SQFT	12.971	W/M2

```
****************************************************************
*                                                              *
*  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR     *
*  ----    LOADS                                               *
*        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION       *
*          IN CONSIDERATION                                    *
*        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A           *
*          CONSTANT INDOOR SPACE TEMPERATURE                   *
*                                                              *
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Option B2:


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REPORT- LS-C Building Peak Load Components                                             WEATHER FILE- Seattle      WA TMY2
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*** BUILDING ***


                    FLOOR  AREA    530410  SQFT     49275   M2
                    VOLUME        8662216  CUFT    245314   M3

                                       COOLING  LOAD                               HEATING  LOAD
                                  ==========================                ==========================
    TIME                                 SEP  2  5PM                                MAR  1  4AM

    DRY-BULB TEMP                    98 F             37 C                  35 F              2 C
    WET-BULB TEMP                    67 F             19 C                  32 F              0 C
    TOT HORIZONTAL SOLAR RAD        156 BTU/H.SQFT   491 W/M2                0 BTU/H.SQFT     0 W/M2
    WINDSPEED AT SPACE              8.6 KTS          4.4 M/S              12.9 KTS          6.6 M/S
    CLOUD AMOUNT 0(CLEAR)-10          0                                     10


                              SENSIBLE          LATENT                               SENSIBLE
                          (KBTU/H)    ( KW )  (KBTU/H)  ( KW )                  (KBTU/H)  ( KW )
                          --------    ------  --------  ------                  --------  --------

     WALL CONDUCTION        118.611    34.753     0.000   0.000                  -269.474   -78.956
     ROOF CONDUCTION         -5.205    -1.525     0.000   0.000                  -131.090   -38.409
     WINDOW GLASS+FRM COND  685.398   200.822     0.000   0.000                  -924.796  -270.965
     WINDOW GLASS SOLAR     391.599   114.738     0.000   0.000                    48.804    14.299
     DOOR CONDUCTION          0.000     0.000     0.000   0.000                     0.000     0.000
     INTERNAL SURFACE COND    0.000     0.000     0.000   0.000                     0.000     0.000
     UNDERGROUND SURF COND -185.774   -54.432     0.000   0.000                  -251.254   -73.617
     OCCUPANTS TO SPACE     508.008   148.846   366.114 107.271                   134.377    39.373
     LIGHT     TO SPACE    1111.613   325.703     0.000   0.000                   517.814   151.720
     EQUIPMENT TO SPACE    1547.648   453.461     0.000   0.000                   411.203   120.482
     PROCESS   TO SPACE      99.719    29.218    92.858  27.207                     0.000     0.000
     INFILTRATION           683.420   200.242     0.000   0.000                 -1254.599  -367.597
                          --------   -------   -------  ------                  --------  --------
     TOTAL                 4955.035  1451.825   458.971 134.479                 -1719.015  -503.671
     TOTAL / AREA             0.009     0.029     0.001   0.003                    -0.003    -0.010

     TOTAL LOAD            5414.006 KBTU/H     1586.304  KW              -1719.015 KBTU/H     -503.671  KW
     TOTAL LOAD / AREA       10.21  BTU/H.SQFT   32.192  W/M2                3.241 BTU/H.SQFT   10.221  W/M2


                                 ****************************************************************
                                 *                                                              *
                                 *  NOTE  1)THE ABOVE LOADS EXCLUDE OUTSIDE VENTILATION AIR     *
                                 *  ----     LOADS                                              *
                                 *        2)TIMES GIVEN IN STANDARD TIME FOR THE LOCATION       *
                                 *          IN CONSIDERATION                                    *
                                 *        3)THE ABOVE LOADS ARE CALCULATED ASSUMING A           *
                                 *          CONSTANT INDOOR SPACE TEMPERATURE                   *
                                 *                                                              *
                                 ****************************************************************
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Building HVAC Load Summary (SS-D)

The SS-D report shows a summary of total system peak and annualized heating and cooling loads for all building systems. Loads include all components: envelope, internal gains, reheat/overcooling, fan heat, and ventilation. Effect of HVAC controls, such as thermostat setpoints, is also included.

Option B1 peak cooling coil load: 14,058,157 Btuh (1172 tons), or 453 SF/ton
Option B2 peak cooling coil load: 8,902,318 Btuh (742 tons), or 715 SF/ton

Option B1 peak heating coil load: 7,536,648 Btuh , or 14.2 Btuh/SF
Option B2 peak heating coil load: 4,250,623 Btuh, or 8.0 Btuh/SF

High Performance Hospital – Scheme B1   Baseline - Perforated   DOE-2.2-47b   4/12/2010   18:54:49   BDL RUN 1

REPORT- SS-D Building HVAC Load Summary   WEATHER FILE- Seattle   WA TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	1.73952	14	12	53.F	52.F	313.883	-3942.232	1	7	28.F	27.F	-7479.781	932482.	1551.258
FEB	65.06468	21	14	65.F	50.F	4724.800	-3196.446	28	24	36.F	33.F	-7024.408	842091.	1555.700
MAR	192.18140	29	17	70.F	53.F	7217.949	-3387.727	1	4	35.F	32.F	-7315.649	932621.	1561.085
APR	425.81995	29	17	71.F	61.F	10178.996	-3030.469	9	7	39.F	36.F	-6738.325	902559.	1557.972
MAY	1370.47620	7	16	71.F	62.F	11323.125	-2528.828	18	5	44.F	42.F	-5400.396	933516.	1564.508
JUN	2252.49463	18	17	82.F	67.F	12292.794	-2207.035	13	3	46.F	45.F	-4710.612	904032.	1565.359
JUL	3833.53369	15	15	71.F	63.F	12294.860	-2108.317	2	5	54.F	48.F	-4237.264	934991.	1572.463
AUG	4436.95215	21	16	70.F	64.F	12682.443	-2099.871	17	7	57.F	56.F	-3851.517	934790.	1572.409
SEP	2405.02344	2	16	98.F	69.F	14058.157	-2293.010	18	7	44.F	41.F	-4961.040	904264.	1593.228
OCT	786.56732	9	16	71.F	60.F	9948.713	-2817.919	30	5	36.F	36.F	-5597.368	932673.	1565.587
NOV	158.07936	4	15	66.F	58.F	7644.681	-3490.454	28	5	33.F	27.F	-7536.648	902337.	1556.442
DEC	5.03563	31	14	55.F	52.F	670.196	-3759.595	11	7	26.F	24.F	-7087.649	932351.	1550.472
TOTAL	15932.950						-34861.898						10988772.	
MAX						14058.157						-7536.648		1593.228

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 234312.240 (KBTU)

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- Seattle WA TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	73.29943	27	16	53.F	47.F	317.494	-1862.980	1	7	28.F	27.F	-4250.623	750048.	1345.112
FEB	116.69254	21	14	65.F	50.F	2497.017	-1461.433	15	7	31.F	28.F	-3564.255	666111.	1316.460
MAR	184.12357	29	17	70.F	53.F	4289.371	-1574.298	1	7	33.F	30.F	-3808.380	727910.	1284.858
APR	284.13812	29	17	71.F	61.F	5430.362	-1355.234	9	7	39.F	36.F	-3546.577	691692.	1253.110
MAY	792.82422	6	14	75.F	64.F	6615.944	-1060.868	18	7	42.F	41.F	-2440.366	695897.	1248.991
JUN	1222.00757	18	17	82.F	67.F	8045.304	-915.493	13	7	47.F	45.F	-1961.373	664413.	1253.985
JUL	1981.13635	24	16	87.F	66.F	7810.158	-870.234	2	7	54.F	48.F	-1583.286	687464.	1262.647
AUG	2186.36035	6	17	83.F	66.F	7724.833	-862.455	21	21	62.F	61.F	-1709.009	688773.	1257.748
SEP	1287.20215	2	16	98.F	69.F	8902.318	-932.872	18	7	44.F	41.F	-2160.903	678439.	1269.821
OCT	456.59052	9	16	71.F	60.F	5143.505	-1136.018	30	6	36.F	36.F	-2603.168	714417.	1277.024
NOV	145.19637	4	15	66.F	58.F	3895.796	-1556.603	29	6	24.F	23.F	-4039.557	716338.	1344.452
DEC	88.67204	31	14	55.F	52.F	518.318	-1716.201	11	6	26.F	24.F	-3945.971	750226.	1344.780
TOTAL	8818.241						-15304.707						8431732.	
MAX						8902.318						-4250.623		1345.112

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 127712.616 (KBTU)

Building Daylighting Reports (LS-I)

The LS-I report shows the building-wide lighting savings due to daylighting controls. Daylighting, as modeled in Option B2, is predicted to save 14% of the lighting energy predicted to be used in Option B1.

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High Performance Hospital – Scheme B2   Target 100 - Perforated              DOE-2.2-47b    4/14/2010     9:57:51  BDL RUN  1

REPORT- LS-I Energy Reduction By Daylight   Building                                    WEATHER FILE- Seattle      WA TMY2
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*** BUILDING ***

HOUR OF DAY

MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	ALL HOURS
JAN	0	0	0	0	0	0	0	0	8	17	20	21	21	21	18	13	3	0	0	0	0	0	0	0	8
FEB	0	0	0	0	0	0	0	4	15	20	24	23	24	24	22	20	14	2	0	0	0	0	0	0	11
MAR	0	0	0	0	0	0	5	15	21	23	25	25	25	25	24	22	19	11	1	0	0	0	0	0	14
APR	0	0	0	0	0	4	15	20	24	25	25	26	26	26	26	25	22	19	8	0	0	0	0	0	16
MAY	0	0	0	0	1	12	18	22	24	25	26	26	27	26	26	25	22	21	13	2	0	0	0	0	17
JUN	0	0	0	0	4	17	21	23	25	25	26	26	26	26	26	25	23	22	20	10	0	0	0	0	19
JUL	0	0	0	0	1	13	19	22	24	25	26	26	26	26	25	25	23	22	18	7	0	0	0	0	18
AUG	0	0	0	0	0	7	17	20	24	25	25	26	25	25	26	25	22	20	12	1	0	0	0	0	17
SEP	0	0	0	0	0	1	11	18	22	23	24	25	25	24	24	22	20	13	2	0	0	0	0	0	14
OCT	0	0	0	0	0	0	2	12	18	22	24	23	24	23	22	19	12	2	0	0	0	0	0	0	12
NOV	0	0	0	0	0	0	0	4	14	20	23	23	23	22	20	14	3	0	0	0	0	0	0	0	10
DEC	0	0	0	0	0	0	0	0	8	16	20	20	21	19	16	9	0	0	0	0	0	0	0	0	8
ANNUAL	0	0	0	0	1	5	10	14	19	22	24	24	24	24	23	20	15	10	6	2	0	0	0	0	14

PERCENT LIGHTING ENERGY REDUCTION BY DAYLIGHT

NOTE- THE ENTRIES IN THIS REPORT ARE NOT
SUBJECT TO THE DAYLIGHTING REPORT SCHEDULE

Plant Equipment Loads and Energy Use Summary (PS-C)

The PS-C report shows a summary of the predicted loading for all simulated plant equipment in each Option, including peak loads, annualized load, hours of operation at various part load conditions, and annual energy used. The loads represented in the PS-C report include coil loads, potable water heating loads, distribution system losses, and enhanced heat recovery loads (for Option B3).

Note that the majority of the potable water heating loads for all three options are reported as loads imposed on the boilers, heat pumps, or other primary heat generation equipment (rather than the potable water heaters).

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High Performance Hospital – Scheme B1   Baseline - Perforated                    DOE-2.2-47b    4/12/2010    18:54:49  BDL RUN  1

REPORT- PS-C Equipment Loads and Energy Use                                                 WEATHER FILE- Seattle      WA TMY2
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            COOL LOAD   HEAT LOAD   ELEC USE    FUEL USE      --------  Number of hours within each PART LOAD range  --------- TOTAL
      SUM    (MBTU)      (MBTU)      (KWH)       (MBTU)           00    10    20    30    40    50    60    70    80    90   100   RUN
MON  PEAK   (KBTU/HR)   (KBTU/HR)     (KW)      (KBTU/HR)         10    20    30    40    50    60    70    80    90   100     +  HOURS
---  ----   ----------  ----------  ----------  ----------      ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----

B-1
      SUM               -49882.1    125406.3     60627.3 LOAD   0     0     0     0   523  2271  2041  1735  1312   878     0  8760
     PEAK                -8229.4        14.3     10039.8 ELEC8760     0     0     0     0     0     0     0     0     0     0  8760
  MON/DAY                   7/24        1/ 1        7/24 FUEL   0     0     0     0   565  2295  2036  1730  1273   861     0  8760

B-2
      SUM                -6115.9     18424.4      7427.4 LOAD   0     0     0     0     0   875   368    44     0     0     0  1287
     PEAK                -6416.4        14.3      7796.0 ELEC1287     0     0     0     0     0     0     0     0     0     0  1287
  MON/DAY                   1/ 1        1/ 1        1/ 1 FUEL   0     0     0     0    19   868   363    37     0     0     0  1287

B-3
      SUM                    0.0         0.0         0.0 LOAD   0     0     0     0     0     0     0     0     0     0     0     0
     PEAK                    0.0         0.0         0.0 ELEC   0     0     0     0     0     0     0     0     0     0     0     0
  MON/DAY                   0/ 0        0/ 0        0/ 0 FUEL   0     0     0     0     0     0     0     0     0     0     0     0

CH-1
      SUM     7307.3         0.0    434913.2             LOAD 347   315   227   176   162   185   120   100   110    68     0  1810
     PEAK    10656.3         0.0       496.8             ELEC   0     0   270   428   301   198   225   127   109    93    59  1810
  MON/DAY       7/24        0/ 0        7/24

CH-2
      SUM     6549.1         0.0    374938.7             LOAD 264   210   147   137   139   192   114    96   105    70     0  1474
     PEAK    10644.8         0.0       496.5             ELEC   0     0   221   288   208   147   241   119    91    96    63  1474
  MON/DAY       8/ 4        0/ 0        8/ 4

CH-3
      SUM     3995.7         0.0    251902.3             LOAD 282   209   113   111   106   166    53    35    37    22     0  1134
     PEAK    10600.2         0.0       494.8             ELEC   0     0   216   293   172   113   198    58    32    30    22  1134
  MON/DAY       4/29        0/ 0        4/29

CT-1
      SUM     9039.5                  3278.4             LOAD   0     0     0   152  1345   186   104    23     0     0     0  1810
     PEAK    12452.0                     6.6             ELEC1670   696    83     7     0     0     0     0     0     0     0  2456
  MON/DAY       7/24                    8/ 6

CT-2
      SUM     8030.6                  3106.5             LOAD   0     0     0   126  1025   180   109    33     1     0     0  1474
     PEAK    12455.5                     8.7             ELEC1511   631    97    11     1     0     0     0     0     0     0  2251
  MON/DAY       8/ 4                    9/ 2

CT-3
      SUM     5010.4                  2093.0             LOAD   0     0     0    98   846   125    58     6     1     0     0  1134
     PEAK    12425.2                     8.7             ELEC1436   400    41     2     1     0     0     0     0     0     0  1880
  MON/DAY       4/29                    9/ 2

DHW HX
      SUM                 -435.9       947.2       560.5 LOAD   0     0     0     0  2555  2920  1156  1034   426   669     0  8760
     PEAK                  -81.9         0.1       103.2 ELEC   0     0     0     0     0     0     0     0     0     0  8760  8760
  MON/DAY                   4/29        1/ 1        1/ 1 FUEL   0     0     0     0  2190  3285  1095   886   454   730   120  8760
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SCHWP-1/2/3														
SUM	85085.0	FLOW	2062	1243	784	136	0	0	0	0	0	0	0	4225
PEAK	48.8	RPM	0	0	0	0	0	0	0	2521	1559	145	0	4225
MON/DAY	9/ 3	ELEC	1379	2170	658	18	0	0	0	0	0	0	0	4225
Pseudo Pump														
SUM	26470.5	FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK	3.0	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
CWP-1														
SUM	44112.3	FLOW	0	0	0	0	0	0	23	127	94	77	1489	1810
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	1810	1810
MON/DAY	1/14	ELEC	0	0	0	0	0	0	0	0	141	180	1489	1810
DHW Pump														
SUM	2534.8	FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK	0.3	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
PCHWP-1														
SUM	33118.3	FLOW	0	0	0	0	0	0	0	0	0	1810	0	1810
PEAK	18.3	RPM	0	0	0	0	0	0	0	0	0	0	1810	1810
MON/DAY	1/14	ELEC	0	0	0	0	0	0	0	0	0	1810	0	1810
PCHWP-2														
SUM	26970.4	FLOW	0	0	0	0	0	0	0	0	0	1474	0	1474
PEAK	18.3	RPM	0	0	0	0	0	0	0	0	0	0	1474	1474
MON/DAY	1/27	ELEC	0	0	0	0	0	0	0	0	0	1474	0	1474
HWP-5/6														
SUM	285231.9	FLOW	0	0	0	0	0	0	0	8760	0	0	0	8760
PEAK	32.6	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	8760	0	0	8760
HWP-1/2/3/4														
SUM	98094.5	FLOW	0	0	0	0	5906	0	0	0	0	0	0	5906
PEAK	16.6	RPM	0	0	0	0	0	0	0	0	0	0	5906	5906
MON/DAY	1/ 1	ELEC	0	0	0	0	5906	0	0	0	0	0	0	5906
PCHWP-3														
SUM	20749.3	FLOW	0	0	0	0	0	0	0	0	0	1134	0	1134
PEAK	18.3	RPM	0	0	0	0	0	0	0	0	0	0	1134	1134
MON/DAY	2/ 3	ELEC	0	0	0	0	0	0	0	0	0	1134	0	1134
CWP-2														
SUM	35937.3	FLOW	0	0	0	0	0	0	18	107	76	41	1232	1474
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	1474	1474
MON/DAY	1/27	ELEC	0	0	0	0	0	0	0	0	107	135	1232	1474
CWP-3														
SUM	27545.9	FLOW	0	0	0	0	0	0	6	87	108	53	880	1134
PEAK	24.8	RPM	0	0	0	0	0	0	0	0	0	0	1134	1134
MON/DAY	2/ 3	ELEC	0	0	0	0	0	0	0	0	86	168	880	1134

REPORT- PS-C Equipment Loads and Energy Use   WEATHER FILE- Seattle   WA TMY2

MON SUM PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		Number of hours within each PART LOAD range 00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
CH-1																	
SUM	2047.6	0.0	106117.2		LOAD	0	0	0	0	0	116	145	36	7	2	0	306
PEAK	9191.0	0.0	493.4		ELEC	0	0	0	0	0	0	4	125	118	45	14	306
MON/DAY	9/ 2	0/ 0	9/ 2														
HC-1																	
SUM	0.0	-22221.0	1378762.0		LOAD	0	0	1119	2155	1634	1267	869	468	602	251	15	8380
PEAK	0.0	-5157.3	310.6		ELEC	0	0	731	1822	1897	1386	1106	541	673	224	0	8380
MON/DAY	0/ 0	10/16	4/26														
HC-2																	
SUM	9695.1	-2113.5	651045.9		LOAD	4736	1507	483	275	223	187	192	207	200	177	267	8454
PEAK	6357.4	-6704.8	383.2		ELEC	4316	1809	499	287	211	154	160	158	224	319	317	8454
MON/DAY	5/ 5	1/ 3	8/ 4														
HC-3																	
SUM	0.0	-17.1	1051.9		LOAD	0	0	0	0	0	0	5	0	0	0	0	5
PEAK	0.0	-3548.4	218.4		ELEC	0	0	0	0	0	0	5	0	0	0	0	5
MON/DAY	0/ 0	1/ 1	1/ 1														
DHW Heater																	
SUM		-84.0	7393.7		LOAD	3047	2428	336	759	368	607	243	244	426	302	0	8760
PEAK		-36.7	3.1		ELEC	2555	2800	335	880	306	610	302	214	395	304	59	8760
MON/DAY		3/29	2/ 1														
DHW Booster Htr																	
SUM		-975.6	0.0	1129.1	LOAD	2555	2800	243	972	245	641	270	215	426	393	0	8760
PEAK		-398.8	0.0	422.3	ELEC	0	0	0	0	0	0	0	0	0	0	0	0
MON/DAY		4/29	0/ 0	1/ 1	FUEL	2510	2347	618	986	232	615	357	198	401	496	0	8760
GCHX																	
SUM	5859.4	-10567.0															
PEAK	9827.4	-5751.9															
MON/DAY	9/ 2	3/ 1															
SCHP-1/2/3																	
SUM			98327.2		FLOW	7551	922	284	3	0	0	0	0	0	0	0	8760
PEAK			34.6		RPM	0	0	0	0	0	0	0	0	8123	637	0	8760
MON/DAY			9/ 2		ELEC	0	8171	584	4	1	0	0	0	0	0	0	8760
SHWP-1/2/3																	
SUM			56907.1		FLOW	5927	2747	86	0	0	0	0	0	0	0	0	8760
PEAK			11.5		RPM	0	0	0	0	0	0	0	8396	364	0	0	8760
MON/DAY			1/ 1		ELEC	4259	4501	0	0	0	0	0	0	0	0	0	8760
DHW Loop Pump																	
SUM			1782.3		FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK			0.2		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY			1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760

PCHP-1														
SUM	5287.6	FLOW	0	0	0	0	0	0	0	0	0	306	0	306
PEAK	17.3	RPM	0	0	0	0	0	0	0	0	0	0	306	306
MON/DAY	5/ 5	ELEC	0	0	0	0	0	0	0	0	0	306	0	306
PCHP-2														
SUM	79332.6	FLOW	0	0	0	0	0	0	0	0	0	0	8358	8358
PEAK	9.5	RPM	0	0	0	0	0	0	0	0	0	0	8358	8358
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8358	8358
PCHP-3														
SUM	80243.8	FLOW	0	0	0	0	0	0	0	0	0	0	8454	8454
PEAK	9.5	RPM	0	0	0	0	0	0	0	0	0	0	8454	8454
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8454	8454
GLP-1/2/3														
SUM	91020.5	FLOW	0	2025	3171	1051	404	1803	306	0	0	0	0	8760
PEAK	21.1	RPM	0	0	0	0	0	0	0	0	7376	1381	3	8760
MON/DAY	5/ 5	ELEC	0	3308	2244	918	1984	306	0	0	0	0	0	8760
CWP-1														
SUM	5326.8	FLOW	0	0	0	0	0	0	0	0	0	0	306	306
PEAK	17.4	RPM	0	0	0	0	0	0	0	0	0	0	306	306
MON/DAY	5/ 5	ELEC	0	0	0	0	0	0	0	0	0	0	306	306
PCHP-4														
SUM	47.5	FLOW	0	0	0	0	0	0	0	0	0	0	5	5
PEAK	9.5	RPM	0	0	0	0	0	0	0	0	0	0	5	5
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	5	5
PHWP-1														
SUM	76116.6	FLOW	0	0	0	0	0	0	0	0	0	0	8380	8380
PEAK	9.1	RPM	0	0	0	0	0	0	0	0	0	0	8380	8380
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8380	8380
PHWP-2														
SUM	76788.7	FLOW	0	0	0	0	0	0	0	0	0	0	8454	8454
PEAK	9.1	RPM	0	0	0	0	0	0	0	0	0	0	8454	8454
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8454	8454
PHWP-3														
SUM	45.4	FLOW	0	0	0	0	0	0	0	0	0	0	5	5
PEAK	9.1	RPM	0	0	0	0	0	0	0	0	0	0	5	5
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	5	5
Pump 13														
SUM	316.8	FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK	0.0	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY	1/ 1	ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760

REPORT- PS-C Equipment Loads and Energy Use   WEATHER FILE- Seattle   WA TMY2

MON SUM PEAK	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
Blr-1																	
SUM		-1627.3	2056.0	1877.3	LOAD	1293	327	164	79	62	214	232	251	174	154	11	2961
PEAK		-1779.7	1.8	1952.4	ELEC	2961	0	0	0	0	0	0	0	0	0	0	2961
MON/DAY		11/ 9	11/ 9	11/ 9	FUEL	1278	346	162	79	61	202	240	242	190	154	7	2961
Blr-2																	
SUM		-1382.2	1400.6	1551.2	LOAD	64	157	136	40	39	266	235	217	146	113	9	1422
PEAK		-1779.7	1.8	1952.4	ELEC	1422	0	0	0	0	0	0	0	0	0	0	1422
MON/DAY		11/ 9	11/ 9	11/ 9	FUEL	45	173	131	46	41	249	231	221	161	117	7	1422
Blr-3																	
SUM		-1363.8	1469.4	1523.2	LOAD	113	177	208	194	180	287	201	155	110	57	1	1683
PEAK		-1759.1	1.7	1930.1	ELEC	1683	0	0	0	0	0	0	0	0	0	0	1683
MON/DAY		11/ 8	11/ 8	11/ 8	FUEL	112	180	210	194	177	281	180	175	119	55	0	1683
Blr-4																	
SUM		-841.9	1045.6	944.0	LOAD	142	255	230	156	126	106	71	78	61	56	0	1281
PEAK		-1753.5	1.7	1936.5	ELEC	1281	0	0	0	0	0	0	0	0	0	0	1281
MON/DAY		2/26	5/25	5/25	FUEL	144	235	246	162	124	105	59	81	65	59	1	1281
CH-1																	
SUM	3168.3	0.0	152645.8		LOAD	0	0	37	476	193	26	3	0	0	0	0	735
PEAK	6780.3	0.0	308.0		ELEC	0	0	0	61	338	266	67	3	0	0	0	735
MON/DAY	9/ 2	0/ 0	9/ 2														
HC-1																	
SUM	13432.7	-19316.3	2789992.8		LOAD	0	463	4147	2381	728	378	197	181	158	127	0	8760
PEAK	4710.1	-4868.7	326.3		ELEC	0	0	0	0	0	0	0	0	334	7414	1012	8760
MON/DAY	8/22	4/14	7/17														
HC-2																	
SUM	241.4	0.0	34898.9		LOAD	0	0	0	0	0	91	18	0	0	0	0	109
PEAK	2344.3	0.0	322.9		ELEC	0	0	0	0	0	0	0	0	0	109	0	109
MON/DAY	9/ 2	0/ 0	9/13														
CT-3																	
SUM	4583.7		1764.9		LOAD	0	0	0	0	8601	50	0	0	0	109	0	8760
PEAK	5691.2		6.9		ELEC	1596	610	9	37	49	8	3	1	0	0	0	2313
MON/DAY	9/ 2		9/ 2														
CT-2																	
SUM	3769.2		2002.1		LOAD	0	0	0	0	734	1	0	0	0	0	0	735
PEAK	7971.0		4.4		ELEC	0	730	5	0	0	0	0	0	0	0	0	735
MON/DAY	9/ 2		9/ 2														
DHW Heater																	
SUM		-84.0	7393.7		LOAD	3047	2428	336	759	368	607	243	244	426	302	0	8760
PEAK		-36.7	3.1		ELEC	2555	2800	335	880	306	610	302	214	395	304	59	8760

DHW Booster Hx																
SUM	-975.6	0.0	1129.1	LOAD	2555	2800	243	972	245	641	270	215	426	393	0	8760
PEAK	-398.8	0.0	422.3	ELEC	0	0	0	0	0	0	0	0	0	0	0	0
MON/DAY	4/29	0/ 0	1/ 1	FUEL	2510	2347	618	986	232	615	357	198	401	496	0	8760
SCHP-1/2/3																
SUM		104900.0		FLOW	7593	1042	125	0	0	0	0	0	0	0	0	8760
PEAK		27.5		RPM	0	0	0	0	0	0	0	0	8339	421	0	8760
MON/DAY		9/ 2		ELEC	0	8377	382	1	0	0	0	0	0	0	0	8760
DHW Loop Pump																
SUM		1782.3		FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK		0.2		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
PCHP-3																
SUM		12700.5		FLOW	0	0	0	0	0	0	0	0	0	735	0	735
PEAK		17.3		RPM	0	0	0	0	0	0	0	0	0	0	735	735
MON/DAY		3/29		ELEC	0	0	0	0	0	0	0	0	0	735	0	735
PCHP-1																
SUM		63683.8		FLOW	0	0	0	0	0	0	0	0	8760	0	0	8760
PEAK		7.3		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	8760	0	8760
PCHP-2																
SUM		792.4		FLOW	0	0	0	0	0	0	0	0	109	0	0	109
PEAK		7.3		RPM	0	0	0	0	0	0	0	0	0	0	109	109
MON/DAY		3/29		ELEC	0	0	0	0	0	0	0	0	0	109	0	109
Pump 13																
SUM		316.8		FLOW	0	0	0	0	0	0	0	0	0	0	8760	8760
PEAK		0.0		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	8760	8760
CWP-1																
SUM		12533.6		FLOW	0	0	0	0	0	0	0	0	0	0	735	735
PEAK		17.1		RPM	0	0	0	0	0	0	0	0	0	0	735	735
MON/DAY		3/29		ELEC	0	0	0	0	0	0	0	0	0	0	735	735
SHWP-1/2/3																
SUM		54317.9		FLOW	7448	1312	0	0	0	0	0	0	0	0	0	8760
PEAK		8.9		RPM	0	0	0	0	0	0	0	2415	6345	0	0	8760
MON/DAY		1/ 1		ELEC	0	8760	0	0	0	0	0	0	0	0	0	8760
WHP-1/2																
SUM		70587.0		FLOW	0	0	0	0	8651	0	0	0	109	0	0	8760
PEAK		10.9		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		3/29		ELEC	0	0	0	0	0	0	0	8651	0	109	0	8760
BP-1																
SUM		4916.1		FLOW	0	0	0	0	0	0	0	0	0	2961	0	2961
PEAK		1.7		RPM	0	0	0	0	0	0	0	0	0	0	2961	2961
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	2961	2961
BP-2																
SUM		2360.9		FLOW	0	0	0	0	0	0	0	0	0	1422	0	1422
PEAK		1.7		RPM	0	0	0	0	0	0	0	0	0	0	1422	1422
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	1422	1422

BP-3																
SUM		2794.3		FLOW	0	0	0	0	0	0	0	0	0	1683	0	1683
PEAK		1.7		RPM	0	0	0	0	0	0	0	0	0	0	1683	1683
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	1683	1683
BP-4																
SUM		2126.8		FLOW	0	0	0	0	0	0	0	0	0	1281	0	1281
PEAK		1.7		RPM	0	0	0	0	0	0	0	0	0	0	1281	1281
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	0	1281	1281
PHWP-1																
SUM		50599.3		FLOW	0	0	0	0	0	0	0	0	8760	0	0	8760
PEAK		5.8		RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
MON/DAY		1/ 1		ELEC	0	0	0	0	0	0	0	0	0	8760	0	8760
PHWP-2																
SUM		629.6		FLOW	0	0	0	0	0	0	0	0	109	0	0	109
PEAK		5.8		RPM	0	0	0	0	0	0	0	0	0	0	109	109
MON/DAY		3/29		ELEC	0	0	0	0	0	0	0	0	0	109	0	109

Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Appendix 4.0

Cost Results

TBD Consultants

with support from

Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

University of Washington's Integrated Design Lab
NBBJ Architects
Solarc Architecture and Engineering
TBD Consultants
Cameron MacAllister
Mahlum Architects
Mortenson Construction

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON

PROGRAM STUDY
8 April 2010

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Prepared For:

University of Washington
Integrated Design Lab | Puget Sound

CONTENTS

PROJECT DESCRIPTION

The project consists of a new hospital and medical office building, looking at 6 schemes for a study into high performance hospitals. The six schemes are as defined in the conceptual documentation.

REFERENCE DOCUMENTATION

This Construction Cost Estimate was produced from the conceptual design documentation prepared for the high performance hospital study.

BASIS FOR PRICING

This estimate reflects the fair construction value for this project and should not be construed as a prediction of low bid. Prices are based on local **(Seattle)** prevailing wage construction costs at the time the estimate was prepared. Pricing assumes a procurement process with competitive bidding for all sub-trades of the construction work, which is to mean a minimum of 3 bids for all subcontractors and materials/equipment suppliers. If fewer bids are solicited or received, prices can be expected to be higher. The project pricing is for a stable market assuming normal rates. With the current market conditions / economic climate pricing could vary significantly.

Subcontractor's markups have been included in each line item unit price. Markups cover the cost of field overhead, home office overhead and subcontractor's profit.

General Contractor's general conditions, overhead and fees are based on a percentage of the total direct costs and ***are included in the unit rates.***

Unless identified otherwise, the cost of such items as overtime, shift premiums and construction phasing are not included in the line item unit price.

This cost estimate is based on standard industry practice, professional experience and knowledge of the local construction market costs. TBD Consultants have no control over the material and labor costs, contractors methods of establishing prices or the market and bidding conditions at the time of bid. Therefore TBD Consultants do not guarantee that the bids received will not vary from this cost estimate.

CONTINGENCY

Design Contingency	*0%*	*Not included - assume as built rates*

The Design Contingency is carried to cover scope that lacks definition and scope that is *anticipated* to be added to the Design. As the Design becomes more complete the Design Contingency will reduce.

Construction Contingency	*0%*	*Carried elsewhere in owners budget*

The Construction Contingency is carried to cover the unforeseen during construction execution and risks that do not currently have mitigation plans. As risks are mitigated, Construction Contingency can be reduce, but should not be eliminated.

An owners project contingency has not been included in this construction cost estimate, but it is advised that the owner carry additional contingency to cover scope change, bidding conditions, claims and

BASIS OF ESTIMATE

ESCALATION

Escalation to reflect the anticipated increases in labor and materials up until the mid point of construction is excluded from this estimate. ***Pricing is current for Spring 2010 in Seattle.***

This estimate is based on the fair market value of the project, assuming a normal competitive market, not the current recessionary market conditions.

EXCLUSIONS

- Land acquisition, feasibility studies, financing costs and all other owner costs
- Washington State Sales Tax
- Structured or Site Parking
- Site Preparation such as building demolition or site grading
- Site development such as Landscaping or architectural paving
- All professional fees and insurance
- Site surveys, existing condition reports and soils investigation costs
- Items identified in the design as Not In Contract [NIC]
- Hazardous materials investigations and abatement
- Utility company back charges, including work required off-site and utilities rates
- Work to City streets and sidewalks.
- Items defined as Vendor / Owner supplied and Vendor / Owner installed
- Permits by owner
- Owners contingency
- Construction or occupancy phasing or off hours' work.
- All loose furniture
- Tel/data, security and AV networks, equipment or software (unless identified otherwise)
- Rock excavation; special foundations (unless indicated by design engineers)
- Escalation to mid-point of construction
- Owner Furnished medical equipment

ITEMS THAT MAY AFFECT THIS ESTIMATE

Such items include, but are not limited to the following:

- Modifications to the scope of work subsequent to the preparation of this estimate
- Unforeseen subsurface conditions
- Special requirements for site access, off-hour work or phasing activities
- Restrictive technical specifications, excessive contract or non-competitive bid conditions
- Sole source specifications for materials or products
- Bid approvals delayed beyond the anticipated project schedule

COST SUMMARY

Ref.	Building Section	Option A1	Option A2	Option A3	Option B1	Option B2	Option B3
	BUILDING SF	524,902			524,710		
A10	FOUNDATIONS	10,444,137	10,444,137	10,444,137	11,639,164	11,639,164	11,639,164
A20	BASEMENT CONSTRUCTION	3,951,626	3,951,626	3,951,626	5,501,592	5,501,592	5,501,592
B10	SUPERSTRUCTURE	24,230,370	23,746,566	23,746,566	25,993,542	25,496,058	25,496,058
B20	EXTERIOR CLOSURE	16,299,979	17,685,879	17,685,879	25,804,737	28,541,260	28,541,260
B30	ROOFING	3,252,153	3,314,694	3,314,694	3,917,673	3,987,631	3,987,631
C10	INTERIOR CONSTRUCTION	34,321,356	34,057,094	34,057,094	33,051,218	32,631,373	32,631,373
C20	STAIRCASES	1,397,800	1,397,800	1,397,800	1,325,880	1,325,880	1,325,880
C30	INTERIOR FINISHES	17,029,480	17,029,480	17,029,480	17,026,139	17,026,139	17,026,139
D10	CONVEYING SYSTEMS	2,635,520	2,635,520	2,635,520	3,424,320	3,424,320	3,424,320
D15	MECHANICAL	56,939,964	61,377,968	59,018,919	60,284,699	64,362,739	61,625,421
D50	ELECTRICAL	37,761,788	38,694,904	38,800,304	38,093,830	39,081,647	39,079,795
E10	EQUIPMENT	1,674,437	1,674,437	1,674,437	1,673,825	1,673,825	1,673,825
E20	FURNISHINGS	3,126,349	2,879,805	2,879,805	3,234,870	2,751,534	2,751,534
F10	SPECIAL CONSTRUCTION	0	0	0	0	0	0
F20	SELECTIVE BUILDING DEMOLITION	0	0	0	0	0	0
G	BUILDING SITE WORK	0	0	0	0	0	0
	ESTIMATE TOTAL	**$213,064,958**	**$218,889,910**	**$216,636,261**	**$230,971,488**	**$237,443,160**	**$234,703,991**
	COST /SF	**$406**	**$417**	**$413**	**$440**	**$453**	**$447**
	PERCENT INCREASE	**-**	**3%**	**2%**	**-**	**3%**	**2%**

SCHEME A COMPARISON

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study
SEATTLE, WASHINGTON						
SCHEME A - BASELINE GEOMETRY					Dates:	April 8, 2010
COMPARISON TABLE					By:	GEC/SS/AH/TV/OF

El.	Section	SCHEME A1	SCHEME A2	DELTA A2-A1	SCHEME A3	DELTA A3-A1
	UNIFORMAT SUMMARY					
A	**SUBSTRUCTURE**					
A10	FOUNDATIONS	10,444,137	10,444,137		10,444,137	
A20	BASEMENT CONSTRUCTION	3,951,626	3,951,626		3,951,626	
B	**SHELL**					
B10	SUPERSTRUCTURE	24,230,370	23,746,566	(483,804)	23,746,566	(483,804)
B20	EXTERIOR CLOSURE	16,299,979	17,685,879	1,385,900	17,685,879	1,385,900
B30	ROOFING	3,252,153	3,314,694	62,541	3,314,694	62,541
C	**INTERIORS**					
C10	INTERIOR CONSTRUCTION	34,321,356	34,057,094	(264,262)	34,057,094	(264,262)
C20	STAIRCASES	1,397,800	1,397,800		1,397,800	
C30	INTERIOR FINISHES	17,029,480	17,029,480		17,029,480	
D	**SERVICES**					
D10	CONVEYING SYSTEMS	2,635,520	2,635,520		2,635,520	
D15	MECHANICAL	56,939,964	61,377,968	4,438,004	59,018,919	2,078,955
D50	ELECTRICAL	37,761,788	38,694,904	933,116	38,800,304	1,038,516
E	**EQUIPMENT & FURNISHING**					
E10	EQUIPMENT	1,674,437	1,674,437		1,674,437	
E20	FURNISHINGS	3,126,349	2,879,805	(246,544)	2,879,805	(246,544)
F	**SPECIAL CONSTRUCTION/DEMOLITION**					
F10	SPECIAL CONSTRUCTION					
F20	SELECTIVE BUILDING DEMOLITION					
	BUILDING COST	**213,064,958**	**218,889,910**	5,824,953	**216,636,261**	**3,571,303**
G	**BUILDING SITEWORK**			**NOT INCLUDED**		
	SITE PREPARATION			**NOT INCLUDED**		
	SITE IMPROVEMENT			**NOT INCLUDED**		
	SITE/MECHANICAL UTILITIES			**NOT INCLUDED**		
	SITE ELECTRICAL UTILITIES			**NOT INCLUDED**		
	OTHER SITE CONSTRUCTION			**NOT INCLUDED**		
	TOTAL DIRECT COSTS					
	GENERAL CONDITIONS, OH & P			**INCLUDED IN RATES**		
	DESIGN CONTINGENCY			**NOT INCLUDED**		
	ESCALATION			**NOT INCLUDED**		
	ESTIMATE TOTAL					

SCHEME B COMPARISON

HIGH PERFORMANCE HOSPITAL | **Estimate:** Program Study
SEATTLE, WASHINGTON | **Floor Area** 524,710
SCHEME B - PERFORATED GEOMETRY | **Date:** 4/8/2010

COMPARISON TABLE | **By:** GEC/SS/AH/TV/OF

El.	Section	SCHEME B1	SCHEME B2	DELTA B2-B1	SCHEME B3	DELTA B3-B1
	UNIFORMAT SUMMARY					
A	**SUBSTRUCTURE**					
A10	FOUNDATIONS	11,639,164	11,639,164		11,639,164	
A20	BASEMENT CONSTRUCTION	5,501,592	5,501,592		5,501,592	
B	**SHELL**					
B10	SUPERSTRUCTURE	25,993,542	25,496,058	(497,485)	25,496,058	(497,485)
B20	EXTERIOR CLOSURE	25,804,737	28,541,260	2,736,523	28,541,260	2,736,523
B30	ROOFING	3,917,673	3,987,631	69,958	3,987,631	69,958
C	**INTERIORS**					
C10	INTERIOR CONSTRUCTION	33,051,218	32,631,373	(419,845)	32,631,373	(419,845)
C20	STAIRCASES	1,325,880	1,325,880		1,325,880	
C30	INTERIOR FINISHES	17,026,139	17,026,139		17,026,139	
D	**SERVICES**					
D10	CONVEYING SYSTEMS	3,424,320	3,424,320		3,424,320	
D15	MECHANICAL	60,284,699	64,362,739	4,078,040	61,625,421	1,340,722
D50	ELECTRICAL	38,093,830	39,081,647	987,817	39,079,795	985,965
E	**EQUIPMENT & FURNISHING**					
E10	EQUIPMENT	1,673,825	1,673,825		1,673,825	
E20	FURNISHINGS	3,234,870	2,751,534	(483,336)	2,751,534	(483,336)
F	**SPECIAL CONSTRUCTION/DEMOLITION**					
F10	SPECIAL CONSTRUCTION					
F20	SELECTIVE BUILDING DEMOLITION					
	BUILDING COST	**230,971,488**	**237,443,160**	**6,471,673**	**234,703,991**	**3,732,503**
G	**BUILDING SITEWORK**		**NOT INCLUDED**			
	SITE PREPARATION		**NOT INCLUDED**			
	SITE IMPROVEMENT		**NOT INCLUDED**			
	SITE/MECHANICAL UTILITIES		**NOT INCLUDED**			
	SITE ELECTRICAL UTILITIES		**NOT INCLUDED**			
	OTHER SITE CONSTRUCTION		**NOT INCLUDED**			
	TOTAL DIRECT COSTS					
	GENERAL CONDITIONS, OH & P		**INCLUDED IN RATES**			
	DESIGN CONTINGENCY		**NOT INCLUDED**			
	ESCALATION		**NOT INCLUDED**			
	ESTIMATE TOTAL					

SCHEME A1 - BASELINE GEOMETRY - BASELINE ENERGY

COST SUMMARY - SCHEME A1

HIGH PERFORMANCE HOSPITAL				**Estimate:**	**Program Study**
SEATTLE, WASHINGTON				**Floor Area:**	**524,902 SF**
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY				**Dates:**	**April 8, 2010**
				By:	

El.	**Section**	**Totals**		**Costs/SF**	
	UNIFORMAT SUMMARY				
A	**SUBSTRUCTURE**		14,395,763		27.43
A10	FOUNDATIONS	10,444,137		19.90	
A20	BASEMENT CONSTRUCTION	3,951,626		7.53	
B	**SHELL**		43,782,502		83.41
B10	SUPERSTRUCTURE	24,230,370		46.16	
B20	EXTERIOR CLOSURE	16,299,979		31.05	
B30	ROOFING	3,252,153		6.20	
C	**INTERIORS**		52,748,635		100.49
C10	INTERIOR CONSTRUCTION	34,321,356		65.39	
C20	STAIRCASES	1,397,800		2.66	
C30	INTERIOR FINISHES	17,029,480		32.44	
D	**SERVICES**		97,337,272		185.44
D10	CONVEYING SYSTEMS	2,635,520		5.02	
D15	MECHANICAL	56,939,964		108.48	
D50	ELECTRICAL	37,761,788		71.94	
E	**EQUIPMENT & FURNISHING**		4,800,786		9.15
E10	EQUIPMENT	1,674,437		3.19	
E20	FURNISHINGS	3,126,349		5.96	
F	**SPECIAL CONSTRUCTION/DEMOLITION**				
F10	SPECIAL CONSTRUCTION				
F20	SELECTIVE BUILDING DEMOLITION				
	BUILDING COST		213,064,958		405.91
G	**BUILDING SITEWORK**				
	SITE PREPARATION				
	SITE IMPROVEMENT				
	SITE/MECHANICAL UTILITIES				
	SITE ELECTRICAL UTILITIES				
	OTHER SITE CONSTRUCTION				
	TOTAL DIRECT COSTS		213,064,958		405.91
	GENERAL CONDITIONS, OH & P	Included above			
	DESIGN CONTINGENCY	Included above			
	ESCALATION to mid point of construction	Not Included			
	ESTIMATE TOTAL		213,064,958		405.91

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY						Date:	8-Apr-10	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	225 BED PROGRAM							
A10	**FOUNDATIONS**				-			
					-			
	FOUNDATIONS				-			
	Allowance for standard footings	107,830	SF	38.50	4,151,216	44.66	4,815,411	
	SPECIAL FOUNDATIONS				-			
	Allowance for special footings, if needed	107,830	SF	33.00	3,558,390	38.28	4,127,732	
	SLAB ON GRADE				-			
	Slab on grade, pits, etc.	107,830	SF	12.00	1,293,960	13.92	1,500,994	
	FOUNDATIONS				9,003,566		10,444,137	4.90%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION							
	Excavation and disposal	44,859	CY	40.00	1,794,369	46.40	2,081,468	
	Shoring to basement excavation	17,913	SF	35.00	626,969	40.60	727,284	
	BASEMENT WALLS				-			
	Concrete basement retaining walls	17,913	SF	48.00	859,843	55.68	997,418	
	Waterproofing	17,913	SF	7.00	125,394	8.12	145,457	
	BASEMENT CONSTRUCTION				3,406,574		3,951,626	1.86%
B10	**SUPERSTRUCTURE**							
					-			
	FLOOR CONSTRUCTION				-			
	Allowance for floor structures	417,072	SF	40.00	16,682,880	46.40	19,352,141	
	ROOF CONSTRUCTION				-			
	Allowance for roof structures	107,830	SF	39.00	4,205,370	45.24	4,878,229	
	SUPERSTRUCTURE				20,888,250		24,230,370	11.38%
B20	**EXTERIOR CLOSURE**							
					-			
	EXTERIOR WALLS				-			
	Exterior walling	100,099	SF	70.00	7,006,930	81.20	8,128,039	
	Canopies, soffits, etc	524,902	GFA	5.00	2,624,510	5.80	3,044,432	
	EXTERIOR WINDOWS				-			
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	2,340	SF	70.00	163,800	81.20	190,008	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	5,520	SF	70.00	386,400	81.20	448,224	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	22,320	SF	70.00	1,562,400	81.20	1,812,384	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	7,490	SF	70.00	524,300	81.20	608,188	
	Type E (Storefront) - Kawneer System 2250 w/ Solarban 60 glass	5,376	SF	80.00	430,080	92.80	498,893	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY						Date:	8-Apr-10	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Parapet front & back finish	7,464	SF	80.00	597,158	92.80	692,704	
	Testing building for air-tightness	1	LS	100,000	100,000	116,000	116,000	
	Retractable exterior shades		N/A		-			
	EXTERIOR DOORS				-			
	Allowance for exterior doors	524,902	GFA	1.25	656,128	1.45	761,108	
	EXTERIOR CLOSURE				14,051,706		16,299,979	7.65%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-21 insulation	107,830	SF	26.00	2,803,580	30.16	3,252,153	
	ROOF OPENINGS							
	Allowance for skylights (not required)				-			
	ROOFING				2,803,580		3,252,153	1.53%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	859,152	SF	10.00	8,591,520	11.60	9,966,163	
	INTERIOR DOORS				-			
	Allowance for interior doors	524,902	GFA	11.00	5,773,922	12.76	6,697,750	
	SPECIALTIES				-			
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
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SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY					Date:	8-Apr-10	
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Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellaneous	4,900	SF	2.00	9,800	2.32	11,368	
	INTERIOR CONSTRUCTION				29,587,376		34,321,356	16.11%
C20	**STAIRCASES**				-			
					-			
	STAIR CONSTRUCTION				-			
	East end of tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	Middle of tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	West end of bed tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	SE corner of main block	2	FLTS	35,000.00	70,000	40,600.00	81,200	
	SW corner of main block	2	FLTS	35,000.00	70,000	40,600.00	81,200	
	North end of MOB	4	FLTS	33,000.00	132,000	38,280.00	153,120	
	South end of MOB	4	FLTS	33,000.00	132,000	38,280.00	153,120	
	Stair to MOB & Hospital roof	2	EA	33,000.00	66,000	38,280.00	76,560	
	STAIR FINISHES				-			
	Included above				-			
	STAIRCASES				1,205,000		1,397,800	0.66%
C30	**INTERIOR FINISHES**							
	WALL FINISHES				-			
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	

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					By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	FLOOR FINISHES				-			
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	

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Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	
	EKG	480	SF	15.00	7,200	17.40	8,352	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	CEILING FINISHES				-			
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	

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Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public Waiting Areas	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellaneous	4,900	SF	3.00	14,700	3.48	17,052	
	INTERIOR FINISHES				14,680,586		17,029,480	8.00%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY						Date:	8-Apr-10	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
D10	**CONVEYING SYSTEMS**				-			
					-			
	ELEVATORS & LIFTS				-			
	East end of bed tower (Public)	14	ST	48,000.00	672,000	55,680.00	779,520	
	Middle of bed tower (Staff & Materials)	16	ST	52,000.00	832,000	60,320.00	965,120	
	West end of bed tower (Staff)	6	ST	48,000.00	288,000	55,680.00	334,080	
	MOB (Staff & Public)	8	ST	48,000.00	384,000	55,680.00	445,440	
	Elevator to the roof MOB & Hospital	2	ST	48,000.00	96,000	55,680.00	111,360	
	ESCALATORS & MOVING WALKS				-			
	Not required				-			
	OTHER CONVEYING SYSTEMS				-			
	Not required				-			
	CONVEYING SYSTEMS				2,272,000		2,635,520	1.24%
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing*(Includes instantaneous steam fired portable water heaters)*	524,902	GFA	28.00	14,697,256	32.48	17,048,817	
					-			
	HVAC				-			
	Wet Side -				-			
	Energy supply;				-			
	Boilers (steam) 300 bhp, total load 19,361 btu/hr	3	EA	255,022	765,067	295,825.98	887,478	
	Feedwater system	1	LS	112,210	112,210	130,163.43	130,163	
	Steam to HW Ht Exchanger	3	EA	153,013	459,040	177,495.59	532,487	
	Potable Water heater	7	EA	22,442	157,094	26,032.69	182,229	
	Associated equipment. 19no. Pumps, Tanks, Separators etc	1	LS	183,616	183,616	212,994.70	212,995	
	Chiller, 800 ton	3	EA	355,000	1,065,000	411,800.00	1,235,400	
	Cooling tower	3	EA	204,018	612,054	236,660.78	709,982	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	280,525	280,525	325,408.57	325,409	
	Distribution & Auxiliary equipment:			-	-			
	Distribution piping including equipment connections*(Approximate distribution quantity 50,000 LF)*	524,902	GFA	8.55	4,487,912	9.92	5,205,978	
				-	-			
	Dry Side -			-	-			
	Air handling systems	543,020	CFM	10.00	5,430,200	11.60	6,299,032	
	Packaged split A/C systems	1	LS	40,804	40,804	47,332.16	47,332	
	Terminal VAV boxes	1,100	EA	760.00	836,000	881.60	969,760	
	Exhaust systems	524,902	GFA	2.09	1,097,045	2.42	1,272,572	
	Miscellaneous systems	524,902	GFA	0.62	325,439	0.72	377,510	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY						**Date:**	**8-Apr-10**	
						By:	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Distribution systems *(1.85 lbs / sf)*	524,902	GFA	21.57	11,319,512	25.02	13,130,633	
	Control , BMS & Sensing & monitoring *(3360 control points)*	524,902	GFA	6.80	3,569,334	7.89	4,140,427	
					-			
	HVAC related items-				-			
	Balancing, Testing	524,902	GFA	1.00	524,902	1.16	608,886	
	Supervision associated with commissioning	524,902	GFA	0.45	236,206	0.52	273,999	
	HVAC, seismic, gen conditions, engineering, etc	524,902	GFA	1.00	524,902	1.16	608,886	
					-			
	<u>FIRE PROTECTION</u>				-			
	Fire sprinklers, standpipe & specialties	524,902	GFA	4.50	2,362,059	5.22	2,739,988	
	MECHANICAL				49,086,176		56,939,964	26.73%
D50	**ELECTRICAL**							
					-			
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,902	GFA	2.00	1,049,804	2.32	1,217,773	
	Busway risers	524,902	GFA	2.00	1,049,804	2.32	1,217,773	
	Branch panelboards, feeders	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Distribution conduit, feeders	524,902	GFA	6.00	3,149,412	6.96	3,653,318	
	Emergency generators/paralleling switchgear	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Automatic transfer switches, feeders	524,902	GFA	0.50	262,451	0.58	304,443	
	Step down transformers, feeders	524,902	GFA	1.00	524,902	1.16	608,886	
	Central UPS distribution	524,902	GFA	1.00	524,902	1.16	608,886	
	Grounding/Lightning protection	524,902	GFA	0.35	183,716	0.41	213,110	
	LIGHTING and CONTROLS							
	Supply, install light fixtures	524,902	GFA	10.00	5,249,020	11.60	6,088,863	
	Lighting controls, line voltage/low voltage	524,902	GFA	1.50	787,353	1.74	913,329	
	CONVENIENCE POWER							
	Convenience outlet, surface mounted raceway	524,902	GFA	3.50	1,837,157	4.06	2,131,102	
	EQUIPMENT CONNECTIONS							
	Connect boilers	3	EA	2,255.25	6,766	2,616	7,848	
	Connect heat exchangers	3	EA	2,255.25	6,766	2,616	7,848	
	Connect water heaters	7	EA	902.10	6,315	1,046	7,325	
	Connect misc. pumps	19	EA	2,255.25	42,850	2,616	49,706	
	Connect 800 ton chiller	3	EA	36,084.00	108,252	41,857	125,572	
	Connect cooling tower	3	EA	4,510.50	13,532	5,232	15,697	
	Connect misc. pumps, cooling system	1	LS	40,594.50	40,595	47,090	47,090	
	Connect VAV boxes	1,100	EA	315.74	347,309	366.25	402,878	
	Connect exhaust systems	532,560	SF	0.90	480,422	1.05	557,290	

HIGH PERFORMANCE HOSPITAL | **Estimate:** | **Program Study**
SEATTLE, WASHINGTON | **Floor Area:** | **524,902 SF**
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY | **Date:** | **8-Apr-10**
By: | **GEC/SS/AH/TV/OF**

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Air handling system connections:							
	Connect S1	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S2	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S3	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S4	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S6	1	EA	4,400.00	4,400	5,104	5,104	
	Connect S8	1	EA	4,400.00	4,400	5,104	5,104	
	Connect S9	1	EA	4,400.00	4,400	5,104	5,104	
	Connect S10	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S11	1	EA	4,500.00	4,500	5,220	5,220	
	Connect S12	1	EA	3,750.00	3,750	4,350	4,350	
	Connect S13	1	EA	1,050.00	1,050	1,218	1,218	
	Connect S14	1	EA	2,885.00	2,885	3,347	3,347	
	Connect S15	1	EA	1,380.00	1,380	1,601	1,601	
	Cxonnect S16	1	EA	3,750.00	3,750	4,350	4,350	
	Connect S17	1	EA	3,750.00	3,750	4,350	4,350	
	Connect AC1	1	EA	1,050.00	1,050	1,218	1,218	
	Connect elevators	8	EA	4,961.55	39,692	5,755	46,043	
	Connections to medical equipment	524,902	GFA	1.24	648,714	1.43	752,509	
	Raceways, equipment connections in Procedure rooms	4	EA	53,404	213,617	61,949	247,796	
	Connections to OR equipment	10	EA	9,833	98,329	11,406	114,062	
	FIRE ALARM							
	Complete system	524,902	GFA	2.50	1,312,255	2.90	1,522,216	
	NURSE CALL							
	Complete system	524,902	GFA	3.75	1,968,383	4.35	2,283,324	
	ACCESS CONTROL							
	Complete system	524,902	GFA	1.00	524,902	1.16	608,886	
	CCTV							
	Complete system	524,902	GFA	0.50	262,451	0.58	304,443	
	TELEPHONE/DATA							
	Boxes, empty conduits	524,902	GFA	1.00	524,902	1.16	608,886	
	Faceplates, cabling, terminations, testing	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	CABLE TRAY	524,902	GFA	1.00	524,902	1.16	608,886	
	OVERHEAD PAGING							
	Complete system	524,902	GFA	0.80	419,922	0.93	487,109	
	DEPARTMENTAL INTERCOM							
	Complete system	524,902	GFA	0.50	262,451	0.58	304,443	
	CLOCKS							
	Master clock, remote clocks, ET clocks, reset switches etc.	524,902	GFA	0.25	131,226	0.29	152,222	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY						**Date:**	**8-Apr-10**	
						By:	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	PATIENT ENTRAINMENT SYSTEM							
	Complete system	524,902	GFA	0.25	131,226	0.29	152,222	
	AUDIO/VISUAL SYSTEMS							
	Boxes, empty conduits only	524,902	GFA	0.25	131,226	0.29	152,222	
	INFORMATION TECHNOLOGY							
	Two way radio	524,902	GFA	0.30	157,471	0.35	182,666	
	Distributed antenna system	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Wireless telemetry	524,902	GFA	0.75	393,677	0.87	456,665	
	Time and Attendance	524,902	GFA	0.10	52,490	0.12	60,889	
	Digital signage and Way finding	524,902	GFA	0.50	262,451	0.58	304,443	
	Central Dictation	524,902	GFA	0.15	78,735	0.17	91,333	
	Teleconferencing	524,902	GFA	0.15	78,735	0.17	91,333	
	Medical Alert	524,902	GFA	0.25	131,226	0.29	152,222	
	Telemedicine technology	524,902	GFA	0.25	131,226	0.29	152,222	
	Radio paging	524,902	GFA	0.15	78,735	0.17	91,333	
	Video conferencing	524,902	GFA	0.15	78,735	0.17	91,333	
	Patient controlled video visitation	524,902	GFA	0.40	209,961	0.46	243,555	
	OR room status cameras	524,902	GFA	0.10	52,490	0.12	60,889	
	Radiation detection	524,902	GFA	0.10	52,490	0.12	60,889	
	Chemical Bio Detection	524,902	GFA	0.10	52,490	0.12	60,889	
	Asset tracking system	524,902	GFA	0.20	104,980	0.23	121,777	
	Patient wandering/tracking	524,902	GFA	0.20	104,980	0.23	121,777	
	Personnel tracking	524,902	GFA	0.20	104,980	0.23	121,777	
	Infant protection	524,902	GFA	0.20	104,980	0.23	121,777	
	MISC ELECTRICAL							
	Testing, commissioning	1	LS	210,102	210,102	243,718	243,718	
	Coordination, documentation	1	LS	504,061	504,061	584,710	584,710	
	Start-up	1	LS	386,109	386,109	447,886	447,886	
	ELECTRICAL				32,553,266		37,761,788	17.73%
E10	**EQUIPMENT**							
					-			
	EQUIPMENT				-			
	Allowance for equipment	524,902	GFA	2.75	1,443,481	3.19	1,674,437	
	EQUIPMENT				1,443,481		1,674,437	0.79%
E20	**FURNISHINGS**				-			
					-			
	FIXED FURNISHINGS				-			
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,902	GFA	5.00	2,624,510	5.30	2,781,981	
	Mechoshades	43,046	SF			8.00	344,368	
	MOVABLE FURNISHINGS				-			
	Excluded				-			
	FURNISHINGS				2,624,510		3,126,349	1.43%

HIGH PERFORMANCE HOSPITAL		Estimate:	Program Study	
SEATTLE, WASHINGTON		Floor Area:	524,902	SF
SCHEME A1 - BASELINE GEOMETRY, BASELINE ENERGY		Date:	8-Apr-10	
		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES				-			
	Not required				-			
	OTHER SPECIAL CONSTRUCTION				-			
	Not required				-			
	RECORDING INSTRUMENTATION				-			
	Not required				-			
	BUILDING AUTOMATION SYSTEMS				-			
	Not required				-			
	OTHER SPECIAL CONTROLS				-			
	Not required				-			
	SPECIAL CONSTRUCTION				-			
F20	**SELECTIVE BUILDING DEMOLITION**							
	BUILDING DEMOLITION				-			
	Not required							
	HAZARDOUS COMPONENTS ABATEMENT				-			
	Not required							
	SELECTIVE BUILDING DEMOLITION				-			
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK				-			
	TOTAL DIRECT COSTS w/GC markups				183,606,069		213,064,958	100.00%

SCHEME A2 - BASELINE GEOMETRY - TARGET 100

HIGH PERFORMANCE HOSPITAL				**Estimate: Program Study**	
SEATTLE, WASHINGTON				**Floor Area 524,902 SF**	
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY				**Date: April 8, 2010**	
				By:	
El.	**Section**	**Totals**		**Costs/SF**	
	UNIFORMAT SUMMARY				
A	**SUBSTRUCTURE**		14,395,763		27.43
A10	FOUNDATIONS	10,444,137		19.90	
A20	BASEMENT CONSTRUCTION	3,951,626		7.53	
B	**SHELL**		44,747,140		85.25
B10	SUPERSTRUCTURE	23,746,566		45.24	
B20	EXTERIOR CLOSURE	17,685,879		33.69	
B30	ROOFING	3,314,694		6.31	
C	**INTERIORS**		52,484,373		99.99
C10	INTERIOR CONSTRUCTION	34,057,094		64.88	
C20	STAIRCASES	1,397,800		2.66	
C30	INTERIOR FINISHES	17,029,480		32.44	
D	**SERVICES**		102,708,392		195.67
D10	CONVEYING SYSTEMS	2,635,520		5.02	
D15	MECHANICAL	61,377,968		116.93	
D50	ELECTRICAL	38,694,904		73.72	
E	**EQUIPMENT & FURNISHING**		4,554,242		8.68
E10	EQUIPMENT	1,674,437		3.19	
E20	FURNISHINGS	2,879,805		5.49	
F	**SPECIAL CONSTRUCTION/DEMOLITION**				
F10	SPECIAL CONSTRUCTION				
F20	SELECTIVE BUILDING DEMOLITION				
	BUILDING COST		218,889,910		417.01
G	**BUILDING SITEWORK**				
	SITE PREPARATION				
	SITE IMPROVEMENT				
	SITE/MECHANICAL UTILITIES				
	SITE ELECTRICAL UTILITIES				
	OTHER SITE CONSTRUCTION				
	TOTAL DIRECT COSTS		218,889,910		417.01
	GENERAL CONDITIONS, OH & P	Included above			
	DESIGN CONTINGENCY	Included above			
	ESCALATION to mid point of construction	Not Included			
	CONSTRUCTION CONTINGENCY				
	DESIGN FEES				
	PERMITS, LICENSES, FEES				
	ESTIMATE TOTAL		218,889,910		417.01

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate:	**Program Study**
Floor Area:	**524,902 SF**
Date:	**8-Apr-10**
By:	**0**

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	225 BED PROGRAM							
A10	**FOUNDATIONS**							
	FOUNDATIONS							
	Allowance for standard footings	107,830	SF	38.50	4,151,216	44.66	4,815,411	
	SPECIAL FOUNDATIONS							
	Allowance for special footings, if needed	107,830	SF	33.00	3,558,390	38.28	4,127,732	
	SLAB ON GRADE							
	Slab on grade, pits, etc.	107,830	SF	12.00	1,293,960	13.92	1,500,994	
	FOUNDATIONS				9,003,566		10,444,137	4.77%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION					-		
	Excavation and disposal	44,859	CY	40.00	1,794,369	46.40	2,081,468	
	Shoring to basement excavation	17,913	SF	35.00	626,969	40.60	727,284	
	BASEMENT WALLS				-	-		
	Concrete basement retaining walls	17,913	SF	48.00	859,843	55.68	997,418	
	Waterproofing	17,913	SF	7.00	125,394	8.12	145,457	
	BASEMENT CONSTRUCTION				3,406,574		3,951,626	1.80%
B10	**SUPERSTRUCTURE**							
	FLOOR CONSTRUCTION							
	Allowance for floor structures*(lower floor to floor heights)*	417,072	SF	39.00	16,265,808	45.24	18,868,337	
	ROOF CONSTRUCTION							
	Allowance for roof structures	107,830	SF	39.00	4,205,370	45.24	4,878,229	
	SUPERSTRUCTURE				20,471,178		23,746,566	10.84%
B20	**EXTERIOR CLOSURE**							
	EXTERIOR WALLS							
	Exterior walling*(Lower floor to floor heights)*	95,075	SF	70.00	6,655,264	81.20	7,720,106	
	Canopies, soffits, etc	524,902	GFA	5.00	2,624,510	5.80	3,044,432	
	EXTERIOR WINDOWS			-				
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	2,340	SF	70.00	163,800	81.20	190,008	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	5,520	SF	70.00	386,400	81.20	448,224	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	22,320	SF	70.00	1,562,400	81.20	1,812,384	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	7,490	SF	70.00	524,300	81.20	608,188	
	Type E (Storefront) - Kawneer Trifab 451 with Solarban 60	5,376	SF	80.00	430,080	92.80	498,893	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						**Date:**	**8-Apr-10**	
						By:	**0**	

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Parapet front & back finish	7,914	SF	80.00	633,158	92.80	734,464	
	Testing building for air-tightness	1	LS	100,000.00	100,000	116,000.00	116,000	
	Retractable exterior shades (E, S & W)	30,818	SF	45.00	1,386,810	52.20	1,608,700	
	Premium for 5-1/2" batt insulation	95,075	SF	0.80	76,060	0.93	88,230	
	Premium for 2-1/2" rigid insulation	95,075	SF	0.50	47,538	0.58	55,144	
	EXTERIOR DOORS							
	Allowance for exterior doors	524,902	GFA	1.25	656,128	1.45	761,108	
	EXTERIOR CLOSURE				15,246,448		17,685,879	8.07%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-30 insulation	107,830	SF	26.50	2,857,495	30.74	3,314,694	
	ROOF OPENINGS							
	Allowance for skylights (not required)							
	ROOFING				2,857,495		3,314,694	1.51%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	836,371	SF	10.00	8,363,708	11.60	9,701,901	
	INTERIOR DOORS			-				
	Allowance for interior doors	524,902	GFA	11.00	5,773,922	12.76	6,697,750	
	SPECIALTIES							
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellaneous	4,900	SF	2.00	9,800	2.32	11,368	
	INTERIOR CONSTRUCTION				29,359,564		34,057,094	15.55%
C20	**STAIRCASES**							
	STAIR CONSTRUCTION							
	East end of tower	7	FLTS	35,000	245,000	40,600	284,200	
	Middle of tower	7	FLTS	35,000	245,000	40,600	284,200	
	West end of bed tower	7	FLTS	35,000	245,000	40,600	284,200	
	SE corner of main block	2	FLTS	35,000	70,000	40,600	81,200	
	SW corner of main block	2	FLTS	35,000	70,000	40,600	81,200	
	North end of MOB	4	FLTS	33,000	132,000	38,280	153,120	
	South end of MOB	4	FLTS	33,000	132,000	38,280	153,120	
	Stair to MOB & Hospital roof	2	EA	33,000	66,000	38,280	76,560	
	STAIR FINISHES							
	Included above							
	STAIRCASES				1,205,000		1,397,800	0.64%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
C30	**INTERIOR FINISHES**							
	WALL FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	FLOOR FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	
	EKG	480	SF	15.00	7,200	17.40	8,352	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	

SCHEME A2

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	CEILING FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	

SCHEME A2

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						**Date:**	**8-Apr-10**	
						By:	**0**	

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public Waiting Areas	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellaneous	4,900	SF	3.00	14,700	3.48	17,052	
	INTERIOR FINISHES				14,680,586		17,029,480	7.77%
D10	**CONVEYING SYSTEMS**							
	ELEVATORS & LIFTS							
	East end of bed tower (Public)	14	ST	48,000	672,000	55,680	779,520	
	Middle of bed tower (Staff & Materials)	16	ST	52,000	832,000	60,320	965,120	
	West end of bed tower (Staff)	6	ST	48,000	288,000	55,680	334,080	
	MOB (Staff & Public)	8	ST	48,000	384,000	55,680	445,440	
	Elevator to the roof MOB & Hospital	2	ST	48,000	96,000	55,680	111,360	
	ESCALATORS & MOVING WALKS							
	Not required							
	OTHER CONVEYING SYSTEMS							
	Not required							
	CONVEYING SYSTEMS				2,272,000		2,635,520	1.20%
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing	524,902	GFA	28.00	14,697,256	32.48	17,048,817	
						-		
	Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separat waste & vent system also required from shower drains and selected hot water waste drains	524,902	GFA	0.48	250,307	0.55	290,357	
						-		
	HVAC					-		
	Wet Side -					-		
	Energy supply (Closed Loop);					-		
	Geo thermal field, 416 bores @ 300 ft deep	124,800	LF	15.20	1,896,960	17.63	2,200,474	
	Geo thermal field, headers	26,500	LF	15.11	400,283	17.52	464,328	
	Utility from field to building (150 l/ft allowance)	1	LS	40,804	40,804	47,332.16	47,332	
	Heat pumps, 400 ton Approx ($900 per ton + GC markups)	3	EA	367,232	1,101,697	425,989.41	1,277,968	
	Chiller, 800 ton	1	EA	355,000	355,000	411,800.00	411,800	
	Cooling tower	1	EA	204,017	204,017	236,659.72	236,660	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY					Date:	8-Apr-10	
					By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Associated Pumps 27 no., 482 hp total	1	LS	222,000	222,000	257,520.00	257,520	
	Associated equipment - Tanks, Separators etc	1	LS	30,603	30,603	35,499.12	35,499	
	Steam boiler (standby), 90 hp	2	EA	102,009	204,018	118,330.39	236,661	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	51,004	51,004	59,165.20	59,165	
	Distribution & Auxiliary equipment:			-		-		
	Distribution piping including equipment connections *(Approximate distribution quantity; 70,000 l/ft)*	524,902	GFA	13.00	6,823,726	15.08	7,915,522	
				-		-		
	Dry Side -			-		-		
	Air handling / heat recovery systems	373,600	CFM	10.93	4,081,580	12.67	4,734,633	
	Packaged split A/C systems	1	LS	40,803.58	40,804	47,332.16	47,332	
	Fan coil units, four pipe	727	EA	6,630.58	4,820,433	7,691.48	5,591,702	
	Terminal VAV boxes	269	EA	760.00	204,440	881.60	237,150	
	Exhaust systems *(heat recovery ventilators to function as primary exhaust)*	524,902	GFA	1.62	847,717	1.87	983,351	
	Miscellaneous systems	524,902	GFA	0.62	325,439	0.72	377,510	
	Distribution systems *(Approximate duct poundage; 1.44 lb/sf)*	524,902	GFA	15.10	7,926,020	17.52	9,194,183	
						-		
	Control , BMS & Sensing & monitoring *(5221 control points)*	524,902	GFA	8.30	4,356,687	9.63	5,053,756	
						-		
	HVAC related items-					-		
	Balancing, Testing	524,902	GFA	1.25	656,128	1.45	761,108	
	Supervision associated with commissioning	524,902	GFA	0.45	236,206	0.52	273,999	
	HVAC, seismic, gen condition, engineering etc	524,902	GFA	1.48	776,855	1.72	901,152	
						-		
	FIRE PROTECTION					-		
	Fire sprinklers	524,902	GFA	4.50	2,362,059	5.22	2,739,988	
	MECHANICAL				52,912,041		61,377,968	28.02%
D50	**ELECTRICAL**							
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,902	GFA	2.00	1,047,120	2.32	1,214,659	
	Busway risers	524,902	GFA	2.00	1,047,120	2.32	1,214,659	
	Branch panelboards, feeders	524,902	GFA	3.00	1,570,680	3.48	1,821,989	
	Distribution conduit, feeders	524,902	GFA	6.00	3,141,360	6.96	3,643,978	
	Emergency generators/paralleling switchgear	524,902	GFA	3.00	1,570,680	3.48	1,821,989	

SCHEME A2

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area: 524,902 SF
Date: 8-Apr-10
By: 0

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Automatic transfer switches, feeders	524,902	GFA	0.50	261,780	0.58	303,665	
	Step down transformers, feeders	524,902	GFA	1.00	523,560	1.16	607,330	
	Central UPS distribution	524,902	GFA	1.00	523,560	1.16	607,330	
	Grounding/Lightning protection	524,902	GFA	0.35	183,246	0.41	212,565	
	LIGHTING and CONTROLS			-				
	Supply, install light fixtures	524,902	GFA	10.00	5,235,600	11.60	6,073,296	
	Premium for high efficiency lamps, dimming ballasts	524,902	GFA	0.50	261,780	0.58	303,665	
	Lighting controls, line voltage/low voltage	524,902	GFA	1.50	785,340	1.74	910,994	
	Premium for daylight sensing, dimming etc.	524,902	GFA	0.41	217,260	0.48	252,021	
	CONVENIENCE POWER							
	Convenience outlets, surface mounted raceways	524,902	GFA	3.50	1,832,460	4.06	2,125,654	
	EQUIPMENT CONNECTIONS							
	Connect heat pumps, 400 ton	3	EA	23,656	70,967	27,440.48	82,321	
	Connect misc. pumps	30	EA	2,255	67,658	2,616.09	78,483	
	Connect 800 ton chiller	1	EA	36,084	36,084	41,857.44	41,857	
	Connect cooling tower	1	EA	4,511	4,511	5,232.18	5,232	
	Connect VAV boxes	300	EA	315.74	94,721	366.25	109,876	
	Connect exhaust systems	524,902	SF	0.90	472,303	1.05	547,872	
	Connect steam boilers	2	EA	2,957	5,914	3,430.06	6,860	
	Connect misc equipment	1	LS	23,656	23,656	27,440.48	27,440	
	Connect fan coil units	696	EA	768.81	535,089	891.82	620,704	
	Connect elevators	8	EA	4,962	39,692	5,755.40	46,043	
	Connect operable louvers	351	EA	574.83	201,766	666.80	234,048	
	Connections to medical equipment	524,902	GFA	1.24	647,056	1.43	750,585	
	Raceways, equipment connections in Procedure rooms	4	EA	53,404	213,617	61,949.01	247,796	
	Connections to OR equipment	10	EA	9,833	98,329	11,406.15	114,062	
	FIRE ALARM							
	Complete system	524,902	GFA	2.50	1,308,900	2.90	1,518,324	
	NURSE CALL							
	Complete system	524,902	GFA	3.75	1,963,350	4.35	2,277,486	
	ACCESS CONTROL							
	Complete system	524,902	GFA	1.00	523,560	1.16	607,330	
	CCTV							
	Complete system	524,902	GFA	0.50	261,780	0.58	303,665	
	TELEPHONE/DATA							
	Boxes, empty conduits	524,902	GFA	1.00	523,560	1.16	607,330	
	Faceplates, cabling, terminations, testing	524,902	GFA	3.00	1,570,680	3.48	1,821,989	
	CABLE TRAY	524,902	GFA	1.00	523,560	1.16	607,330	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,902	SF
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY					Date:	8-Apr-10	
					By:	0	

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	OVERHEAD PAGING							
	Complete system	524,902	GFA	0.80	418,848	0.93	485,864	
	DEPARTMENTAL INTERCOM							
	Complete system	524,902	GFA	0.50	261,780	0.58	303,665	
	CLOCKS							
	Master clock, remote clocks, ET clocks, reset switches etc.	524,902	GFA	0.25	130,890	0.29	151,832	
	PATIENT ENTRAINMENT SYSTEM							
	Complete system	524,902	GFA	0.25	130,890	0.29	151,832	
	AUDIO/VISUAL SYSTEMS							
	Boxes, empty conduits only	524,902	GFA	0.25	130,890	0.29	151,832	
	INFORMATION TECHNOLOGY							
	Two way radio	524,902	GFA	0.30	157,068	0.35	182,199	
	Distributed antenna system	524,902	GFA	3.00	1,570,680	3.48	1,821,989	
	Wireless telemetry	524,902	GFA	0.75	392,670	0.87	455,497	
	Time and Attendance	524,902	GFA	0.10	52,356	0.12	60,733	
	Digital signage and Wayfinding	524,902	GFA	0.50	261,780	0.58	303,665	
	Central Dictation	524,902	GFA	0.15	78,534	0.17	91,099	
	Teleconferencing	524,902	GFA	0.15	78,534	0.17	91,099	
	Medical Alert	524,902	GFA	0.25	130,890	0.29	151,832	
	Telemedicine technology	524,902	GFA	0.25	130,890	0.29	151,832	
	Radio paging	524,902	GFA	0.15	78,534	0.17	91,099	
	Video conferencing	524,902	GFA	0.15	78,534	0.17	91,099	
	Patient controlled video visitation	524,902	GFA	0.40	209,424	0.46	242,932	
	OR room status cameras	524,902	GFA	0.10	52,356	0.12	60,733	
	Radiation detection	524,902	GFA	0.10	52,356	0.12	60,733	
	Chemical Bio Detection	524,902	GFA	0.10	52,356	0.12	60,733	
	Asset tracking system	524,902	GFA	0.20	104,712	0.23	121,466	
	Patient wandering/tracking	524,902	GFA	0.20	104,712	0.23	121,466	
	Personnel tracking	524,902	GFA	0.20	104,712	0.23	121,466	
	Infant protection	524,902	GFA	0.20	104,712	0.23	121,466	
	MISC ELECTRICAL							
	Testing, commissioning	1	LS	210,102	210,102	243,718.32	243,718	
	Coordination, documentation	1	LS	504,061	504,061	584,710.18	584,710	
	Start-up	1	LS	386,109	386,109	447,885.86	447,886	
	ELECTRICAL				33,357,676		38,694,904	17.66%
E10	**EQUIPMENT**							
	EQUIPMENT							
	Allowance for equipment	524,902	GFA	2.75	1,443,481	3.19	1,674,437	
	EQUIPMENT				1,443,481		1,674,437	0.76%

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A2 - BASELINE GEOMETRY, TARGET 100 ENERGY						**Date:**	**8-Apr-10**	
						By:	**0**	

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
E20	**FURNISHINGS**							
	FIXED FURNISHINGS							
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,902	GFA	5.00	2,624,510	5.30	2,781,981	
	Mechoshades (North side only)	12,228	SF			8.00	97,824	
	MOVABLE FURNISHINGS							
	Excluded							
	FURNISHINGS				2,624,510		2,879,805	1.39%
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES							
	Not required							
	OTHER SPECIAL CONSTRUCTION							
	Not required							
	RECORDING INSTRUMENTATION							
	Not required							
	BUILDING AUTOMATION SYSTEMS							
	Not required							
	OTHER SPECIAL CONTROLS							
	Not required							
	SPECIAL CONSTRUCTION							0.00%
F20	**SELECTIVE BUILDING DEMOLITION**							
	BUILDING DEMOLITION							
	Not required							
	HAZARDOUS COMPONENTS ABATEMENT							
	Not required							
	SELECTIVE BUILDING DEMOLITION							0.00%
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK							0.00%
	TOTAL DIRECT COSTS w/GC markups				188,840,118		218,889,910	100.00%

SCHEME A3 - BASELINE GEOMETRY - TARGET 100

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area 524,902 SF
Date: April 8, 2010
By:

El.	Section		Totals		Costs/SF	
	UNIFORMAT SUMMARY					
A	**SUBSTRUCTURE**			14,395,763		27.43
A10	FOUNDATIONS		10,444,137		19.90	
A20	BASEMENT CONSTRUCTION		3,951,626		7.53	
B	**SHELL**			44,747,140		85.25
B10	SUPERSTRUCTURE		23,746,566		45.24	
B20	EXTERIOR CLOSURE		17,685,879		33.69	
B30	ROOFING		3,314,694		6.31	
C	**INTERIORS**			52,484,373		99.99
C10	INTERIOR CONSTRUCTION		34,057,094		64.88	
C20	STAIRCASES		1,397,800		2.66	
C30	INTERIOR FINISHES		17,029,480		32.44	
D	**SERVICES**			100,454,743		191.38
D10	CONVEYING SYSTEMS		2,635,520		5.02	
D15	MECHANICAL		59,018,919		112.44	
D50	ELECTRICAL		38,800,304		73.92	
E	**EQUIPMENT & FURNISHING**			4,554,242		8.68
E10	EQUIPMENT		1,674,437		3.19	
E20	FURNISHINGS		2,879,805		5.49	
F	**SPECIAL CONSTRUCTION/DEMOLITION**					
F10	SPECIAL CONSTRUCTION					
F20	SELECTIVE BUILDING DEMOLITION					
	BUILDING COST			216,636,261		412.72
G	**BUILDING SITEWORK**					
	SITE PREPARATION					
	SITE IMPROVEMENT					
	SITE/MECHANICAL UTILITIES					
	SITE ELECTRICAL UTILITIES					
	OTHER SITE CONSTRUCTION					
	TOTAL DIRECT COSTS			216,636,261		412.72
	GENERAL CONDITIONS, OH & P	Included above				
	DESIGN CONTINGENCY	Included above				
	ESCALATION to mid point of construction	Not Included				
	CONSTRUCTION CONTINGENCY					
	DESIGN FEES					
	PERMITS, LICENSES, FEES					
	ESTIMATE TOTAL			216,636,261		412.72

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area: 524,902 SF
Date: 8-Apr-10
By:

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	225 BED PROGRAM							
A10	**FOUNDATIONS**							
	FOUNDATIONS							
	Allowance for standard footings	107,830	SF	38.50	4,151,216	44.66	4,815,411	
	SPECIAL FOUNDATIONS							
	Allowance for special footings, if needed	107,830	SF	33.00	3,558,390	38.28	4,127,732	
	SLAB ON GRADE							
	Slab on grade, pits, etc.	107,830	SF	12.00	1,293,960	13.92	1,500,994	
	FOUNDATIONS				9,003,566		10,444,137	4.82%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION					-		
	Excavation and disposal	44,859	CY	40.00	1,794,369	46.40	2,081,468	
	Shoring to basement excavation	17,913	SF	35.00	626,969	40.60	727,284	
	BASEMENT WALLS				-	-		
	Concrete basement retaining walls	17,913	SF	48.00	859,843	55.68	997,418	
	Waterproofing	17,913	SF	7.00	125,394	8.12	145,457	
	BASEMENT CONSTRUCTION				3,406,574		3,951,626	1.82%
B10	**SUPERSTRUCTURE**							
	FLOOR CONSTRUCTION							
	Allowance for floor structures*(lower floor to floor heights)*	417,072	SF	39.00	16,265,808	45.24	18,868,337	
	ROOF CONSTRUCTION							
	Allowance for roof structures	107,830	SF	39.00	4,205,370	45.24	4,878,229	
	SUPERSTRUCTURE				20,471,178		23,746,566	10.95%
B20	**EXTERIOR CLOSURE**							
	EXTERIOR WALLS							
	Exterior walling*(Lower floor to floor heights)*	95,075	SF	70.00	6,655,264	81.20	7,720,106	
	Canopies, soffits, etc	524,902	GFA	5.00	2,624,510	5.80	3,044,432	
	EXTERIOR WINDOWS			-				
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	2,340	SF	70.00	163,800	81.20	190,008	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	5,520	SF	70.00	386,400	81.20	448,224	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	22,320	SF	70.00	1,562,400	81.20	1,812,384	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	7,490	SF	70.00	524,300	81.20	608,188	
	Type E (Storefront) - Kawneer Trifab 451 with Solarban 60	5,376	SF	80.00	430,080	92.80	498,893	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:		

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Parapet front & back finish	7,914	SF	80.00	633,158	92.80	734,464	
	Testing building for air-tightness	1	LS	100,000.00	100,000	116,000.00	116,000	
	Retractable exterior shades (E, S & W)	30,818	SF	45.00	1,386,810	52.20	1,608,700	
	Premium for 5-1/2" batt insulation	95,075	SF	0.80	76,060	0.93	88,230	
	Premium for 2-1/2" rigid insulation	95,075	SF	0.50	47,538	0.58	55,144	
	EXTERIOR DOORS							
	Allowance for exterior doors	524,902	GFA	1.25	656,128	1.45	761,108	
	EXTERIOR CLOSURE				15,246,448		17,685,879	8.16%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-30 insulation	107,830	SF	26.50	2,857,495	30.74	3,314,694	
	ROOF OPENINGS							
	Allowance for skylights (not required)							
	ROOFING				2,857,495		3,314,694	1.53%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	836,371	SF	10.00	8,363,708	11.60	9,701,901	
	INTERIOR DOORS			-				
	Allowance for interior doors	524,902	GFA	11.00	5,773,922	12.76	6,697,750	
	SPECIALTIES							
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,902**	**SF**
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY						**Date:**	**8-Apr-10**	
						By:		

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellaneous	4,900	SF	2.00	9,800	2.32	11,368	
	INTERIOR CONSTRUCTION				29,359,564		34,057,094	15.71%
C20	**STAIRCASES**							
	STAIR CONSTRUCTION							
	East end of tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	Middle of tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	West end of bed tower	7	FLTS	35,000.00	245,000	40,600.00	284,200	
	SE corner of main block	2	FLTS	35,000.00	70,000	40,600.00	81,200	
	SW corner of main block	2	FLTS	35,000.00	70,000	40,600.00	81,200	
	North end of MOB	4	FLTS	33,000.00	132,000	38,280.00	153,120	
	South end of MOB	4	FLTS	33,000.00	132,000	38,280.00	153,120	
	Stair to MOB & Hospital roof	2	EA	33,000.00	66,000	38,280.00	76,560	
	STAIR FINISHES							
	Included above							
	STAIRCASES				1,205,000		1,397,800	0.64%

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HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:		

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
C30	INTERIOR FINISHES							
	WALL FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	

HIGH PERFORMANCE HOSPITAL | **Estimate:** Program Study
SEATTLE, WASHINGTON | **Floor Area:** 524,902 SF
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY | **Date:** 8-Apr-10
By:

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	FLOOR FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	
	EKG	480	SF	15.00	7,200	17.40	8,352	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	

HIGH PERFORMANCE HOSPITAL								
SEATTLE, WASHINGTON					Estimate:	Program Study		
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY					Floor Area:	524,902	SF	
					Date:	8-Apr-10		
					By:			

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellaneous	4,900	SF	6.00	29,400	6.96	34,104	
	CEILING FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area: 524,902 SF
Date: 8-Apr-10
By:

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public Waiting Areas	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellaneous	4,900	SF	3.00	14,700	3.48	17,052	
	INTERIOR FINISHES				14,680,586		17,029,480	7.85%
D10	**CONVEYING SYSTEMS**							
	ELEVATORS & LIFTS							
	East end of bed tower (Public)	14	ST	48,000	672,000	55,680.00	779,520	
	Middle of bed tower (Staff & Materials)	16	ST	52,000	832,000	60,320.00	965,120	
	West end of bed tower (Staff)	6	ST	48,000	288,000	55,680.00	334,080	
	MOB (Staff & Public)	8	ST	48,000	384,000	55,680.00	445,440	
	Elevator to the roof MOB & Hospital	2	ST	48,000	96,000	55,680.00	111,360	
	ESCALATORS & MOVING WALKS							
	Not required							
	OTHER CONVEYING SYSTEMS							
	Not required							
	CONVEYING SYSTEMS				2,272,000		2,635,520	1.22%

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area: 524,902 SF
Date: 8-Apr-10
By:

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing	524,902	GFA	28.00	14,697,256	32.48	17,048,817	
	Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separate waste & vent system also required from shower drains and selected hot water waste drains	524,902	GFA	0.48	250,307	0.55	290,357	
	HVAC							
	Wet Side -							
	Boiler (condensing), 2,000 mbh	4	EA	35,000	140,000	40,600	162,400	
	Back up fuel storage - Propane system	1	EA	12,000	12,000	13,920	13,920	
	Chiller (multistack - ht harvester), 400 ton	2	EA	280,000	560,000	324,800	649,600	
	Chiller, 800 ton	1	EA	355,000	355,000	411,800	411,800	
	Heat pump, 400 ton *($900 per ton + GC markups)*	1	EA	367,232	367,232	425,989	425,989	
	Cooling tower, @ 400 ton	2	EA	110,000	220,000	127,600	255,200	
	Cooling tower, @ 800 ton	1	EA	204,017	204,017	236,660	236,660	
	Associated Pumps 27 no., 482 hp total	1	LS	222,000	222,000	257,520	257,520	
	Associated equipment - Tanks, Separators etc	1	LS	30,603	30,603	35,499	35,499	
	Steam boiler (standby), 90 hp	2	EA	102,009	204,018	118,330	236,661	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	51,004	51,004	59,165	59,165	
	Distribution & Auxiliary equipment:							
	Distribution piping including equipment connections *(Approximate distribution quantity; 70,000 l/ft)*	524,902	GFA	13.20	6,928,706	15.31	8,037,299	
	Dry Side -							
	Air handling / heat recovery systems	373,600	CFM	10.93	4,083,448	12.68	4,736,800	
	Packaged split A/C systems	1	LS	40,804	40,804	47,332	47,332	
	Fan coil units, four pipe	727	EA	6,631	4,820,433	7,691	5,591,702	
	Terminal VAV boxes	269	EA	760.00	204,440	881.60	237,150	
	Exhaust systems *(heat recovery ventilators to function as primary exhaust)*	524,902	GFA	1.62	847,717	1.87	983,351	

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
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Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Miscellaneous systems	524,902	GFA	0.62	325,439	0.72	377,510	
	Distribution systems *(Approximate duct poundage; 1.44 lb/sf)*	524,902	GFA	15.10	7,926,020	17.52	9,194,183	
	Control , BMS & Sensing & monitoring *(5221 control points)*	524,902	GFA	8.30	4,356,687	9.63	5,053,756	
	HVAC related items-							
	Balancing, Testing	524,902	GFA	1.25	656,128	1.45	761,108	
	Supervision associated with commissioning	524,902	GFA	0.45	236,206	0.52	273,999	
	HVAC, seismic, gen condition, engineering etc	524,902	GFA	1.48	776,855	1.72	901,152	
	FIRE PROTECTION							
	Fire sprinklers	524,902	GFA	4.50	2,362,059	5.22	2,739,988	
	MECHANICAL				50,878,379		59,018,919	27.22%
D50	**ELECTRICAL**							
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,902	GFA	2.00	1,049,804	2.32	1,217,773	
	Busway risers	524,902	GFA	2.00	1,049,804	2.32	1,217,773	
	Branch panelboards, feeders	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Distribution conduit, feeders	524,902	GFA	6.00	3,149,412	6.96	3,653,318	
	Emergency generators/paralleling switchgear	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Automatic transfer switches, feeders	524,902	GFA	0.50	262,451	0.58	304,443	
	Step down transformers, feeders	524,902	GFA	1.00	524,902	1.16	608,886	
	Central UPS distribution	524,902	GFA	1.00	524,902	1.16	608,886	
	Grounding/Lightning protection	524,902	GFA	0.35	183,716	0.41	213,110	
						-		
	LIGHTING and CONTROLS					-		
	Supply, install light fixtures	524,902	GFA	10.00	5,249,020	11.60	6,088,863	
	Premium for high efficiency lamps, dimming ballasts	524,902	GFA	0.50	262,451	0.58	304,443	
	Lighting controls, line voltage/low voltage	524,902	GFA	1.50	787,353	1.74	913,329	
	Premium for daylight sensing, dimming etc.	524,902	GFA	0.41	217,816	0.48	252,667	
						-		
	CONVENIENCE POWER					-		
	Convenience outlets, surface mounted raceways	524,902	GFA	3.50	1,837,157	4.06	2,131,102	

HIGH PERFORMANCE HOSPITAL
SEATTLE, WASHINGTON
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY

Estimate: Program Study
Floor Area: 524,902 SF
Date: 8-Apr-10
By:

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
						-		
	EQUIPMENT CONNECTIONS					-		
	Connect heat pumps, 400 ton	1	EA	15,040.00	15,040	17,446.40	17,446	
	Connect misc. pumps	27	EA	2,255.25	60,892	2,616.09	70,634	
	Connect cooling tower, 400 ton	2	EA	2,385.00	4,770	2,766.60	5,533	
	Connect 800 ton chiller	1	EA	36,084.00	36,084	41,857.44	41,857	
	Connect cooling tower, 800 ton	1	EA	5,913.90	5,914	6,860.12	6,860	
	Connect VAV boxes	269	EA	315.74	84,934	366.26	98,524	
	Connect exhaust systems	524,902	SF	0.90	472,412	1.04	547,998	
	Connect steam boilers	2	EA	2,956.95	5,914	3,430.06	6,860	
	Connect condensing boiilers	4	EA	1,050.00	4,200	1,218.00	4,872	
	Connect fan coil units	727	EA	768.81	558,925	891.82	648,353	
	Connect misc equipment	1	LS	23,655.59	23,656	27,440.48	27,440	
	Air handling system connections:					-		
	Connect S1	1	EA	4,500.00	4,500	5,220.00	5,220	
	Connect S2	1	EA	3,060.00	3,060	3,549.60	3,550	
	Connect S3	1	EA	4,200.00	4,200	4,872.00	4,872	
	Connect ERU-1/2	2	EA	935.00	1,870	1,084.60	2,169	
	Connect S5	1	EA	4,200.00	4,200	4,872.00	4,872	
	Connect S6	1	EA	4,200.00	4,200	4,872.00	4,872	
	Connect ERU 3/4/5/6	4	EA	935.00	3,740	1,084.60	4,338	
	Connect S12	1	EA	3,750.00	3,750	4,350.00	4,350	
	Connect S13	1	EA	1,050.00	1,050	1,218.00	1,218	
	Connect S14	1	EA	2,885.00	2,885	3,346.60	3,347	
	Connect S15	1	EA	1,050.00	1,050	1,218.00	1,218	
	Connect ERU7	1	EA	1,050.00	1,050	1,218.00	1,218	
	Connect AC1	1	EA	1,050.00	1,050	1,218.00	1,218	
	Connect elevators	8	EA	6,505.29	52,042	7,546.13	60,369	
	Connect operable louvers	351	EA	574.83	201,766	666.80	234,048	
	Connections to medical equipment	524,902	GFA	1.24	650,878	1.44	755,019	
	Raceways, equipment connections in Procedure rooms	4	EA	53,404.32	213,617	61,949.01	247,796	
	Connections to OR equipment	10	EA	9,832.89	98,329	11,406.15	114,062	
						-		
	FIRE ALARM					-		
	Complete system	524,902	GFA	2.50	1,312,255	2.90	1,522,216	
						-		
	NURSE CALL					-		
	Complete system	524,902	GFA	3.75	1,968,383	4.35	2,283,324	
						-		
	ACCESS CONTROL					-		
	Complete system	524,902	GFA	1.00	524,902	1.16	608,886	
						-		
	CCTV					-		
	Complete system	524,902	GFA	0.50	262,451	0.58	304,443	
						-		
	TELEPHONE/DATA					-		
	Boxes, empty conduits	524,902	GFA	1.00	524,902	1.16	608,886	
	Faceplates, cabling, terminations, testing	524,902	GFA	3.00	1,574,706	3.48	1,826,659	

HIGH PERFORMANCE HOSPITAL	**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON	**Floor Area:**	**524,902**	**SF**
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY	**Date:**	**8-Apr-10**	
	By:		

Ref.	**Section**	**System Quantity**	**Unit**	**$/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
						-		
	CABLE TRAY	524,902	GFA	1.00	524,902	1.16	608,886	
						-		
	OVERHEAD PAGING					-		
	Complete system	524,902	GFA	0.80	419,922	0.93	487,109	
						-		
	DEPARTMENTAL INTERCOM					-		
	Complete system	524,902	GFA	0.50	262,451	0.58	304,443	
						-		
	CLOCKS					-		
	Master clock, remote clocks, ET clocks, reset switches etc.	524,902	GFA	0.25	131,226	0.29	152,222	
						-		
	PATIENT ENTRAINMENT SYSTEM					-		
	Complete system	524,902	GFA	0.25	131,226	0.29	152,222	
						-		
	AUDIO/VISUAL SYSTEMS					-		
	Boxes, empty conduits only	524,902	GFA	0.25	131,226	0.29	152,222	
						-		
	INFORMATION TECHNOLOGY					-		
	Two way radio	524,902	GFA	0.30	157,471	0.35	182,666	
	Distributed antenna system	524,902	GFA	3.00	1,574,706	3.48	1,826,659	
	Wireless telemetry	524,902	GFA	0.75	393,677	0.87	456,665	
	Time and Attendance	524,902	GFA	0.10	52,490	0.12	60,889	
	Digital signage and Wayfinding	524,902	GFA	0.50	262,451	0.58	304,443	
	Central Dictation	524,902	GFA	0.15	78,735	0.17	91,333	
	Teleconferencing	524,902	GFA	0.15	78,735	0.17	91,333	
	Medical Alert	524,902	GFA	0.25	131,226	0.29	152,222	
	Telemedicine technology	524,902	GFA	0.25	131,226	0.29	152,222	
	Radio paging	524,902	GFA	0.15	78,735	0.17	91,333	
	Video conferencing	524,902	GFA	0.15	78,735	0.17	91,333	
	Patient controlled video visitation	524,902	GFA	0.40	209,961	0.46	243,555	
	OR room status cameras	524,902	GFA	0.10	52,490	0.12	60,889	
	Radiation detection	524,902	GFA	0.10	52,490	0.12	60,889	
	Chemical Bio Detection	524,902	GFA	0.10	52,490	0.12	60,889	
	Asset tracking system	524,902	GFA	0.20	104,980	0.23	121,777	
	Patient wandering/tracking	524,902	GFA	0.20	104,980	0.23	121,777	
	Personnel tracking	524,902	GFA	0.20	104,980	0.23	121,777	
	Infant protection	524,902	GFA	0.20	104,980	0.23	121,777	
						-		
	MISC ELECTRICAL					-		
	Testing, commissioning	1	LS	210,102.00	210,102	243,718.32	243,718	
	Coordination, documentation	1	LS	504,060.50	504,061	584,710.18	584,710	
	Start-up	1	LS	386,108.50	386,109	447,885.86	447,886	
	ELECTRICAL				33,448,538		38,800,304	17.90%
E10	**EQUIPMENT**							
	EQUIPMENT							
	Allowance for equipment	524,902	GFA	2.75	1,443,481	3.19	1,674,437	
	EQUIPMENT				1,443,481		1,674,437	0.77%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,902	SF
SCHEME A3 - BASELINE GEOMETRY, TARGET 100 ENERGY						Date:	8-Apr-10	
						By:		

Ref.	Section	System Quantity	Unit	$/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
E20	**FURNISHINGS**							
	FIXED FURNISHINGS							
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,902	GFA	5.00	2,624,510	5.30	2,781,981	
	Mechoshades (North side only)	12,228	SF			8.00	97,824	
	MOVABLE FURNISHINGS							
	Excluded							
	FURNISHINGS				2,624,510		2,879,805	1.40%
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES							
	Not required							
	OTHER SPECIAL CONSTRUCTION							
	Not required							
	RECORDING INSTRUMENTATION							
	Not required							
	BUILDING AUTOMATION SYSTEMS							
	Not required							
	OTHER SPECIAL CONTROLS							
	Not required							
	SPECIAL CONSTRUCTION							
F20	**SELECTIVE BUILDING DEMOLITION**							
	BUILDING DEMOLITION							
	Not required							
	HAZARDOUS COMPONENTS ABATEMENT							
	Not required							
	SELECTIVE BUILDING DEMOLITION							
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK							
	TOTAL DIRECT COSTS w/GC markups				186,897,317		216,636,261	100.00%

SCHEME B1 - PERFORATED GEOMETRY - BASELINE ENERGY

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HIGH PERFORMANCE HOSPITAL				**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**Floor Area**	**524,710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY				**Date:**	**April 8, 2010**	
				By:	**GEC/SS/AH/TV/OF**	

El.	**Section**		**Totals**		**Costs/SF**	
	UNIFORMAT SUMMARY					
A	**SUBSTRUCTURE**			17,140,755		32.67
A10	FOUNDATIONS		11,639,164		22.18	
A20	BASEMENT CONSTRUCTION		5,501,592		10.49	
B	**SHELL**			55,715,951		106.18
B10	SUPERSTRUCTURE		25,993,542		49.54	
B20	EXTERIOR CLOSURE		25,804,737		49.18	
B30	ROOFING		3,917,673		7.47	
C	**INTERIORS**			51,403,237		97.97
C10	INTERIOR CONSTRUCTION		33,051,218		62.99	
C20	STAIRCASES		1,325,880		2.53	
C30	INTERIOR FINISHES		17,026,139		32.45	
D	**SERVICES**			101,802,849		194.02
D10	CONVEYING SYSTEMS		3,424,320		6.53	
D15	MECHANICAL		60,284,699		114.89	
D50	ELECTRICAL		38,093,830		72.60	
E	**EQUIPMENT & FURNISHING**			4,908,695		9.36
E10	EQUIPMENT		1,673,825		3.19	
E20	FURNISHINGS		3,234,870		6.17	
F	**SPECIAL CONSTRUCTION/DEMOLITION**					
F10	SPECIAL CONSTRUCTION					
F20	SELECTIVE BUILDING DEMOLITION					
	BUILDING COST			230,971,488		440.19
G	**BUILDING SITEWORK**					
	SITE PREPARATION					
	SITE IMPROVEMENT					
	SITE/MECHANICAL UTILITIES					
	SITE ELECTRICAL UTILITIES					
	OTHER SITE CONSTRUCTION					
	TOTAL DIRECT COSTS			230,971,488		440.19
	GENERAL CONDITIONS, OH & P	Included above				
	DESIGN CONTINGENCY	Included above				
	ESCALATION to mid point of construction	Not Included				
	ESTIMATE TOTAL			230,971,488		440.19

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	225 BED PROGRAM							
A10	**FOUNDATIONS**							
	FOUNDATIONS							
	Allowance for standard footings	120,168	SF	38.50	4,626,202	44.66	5,366,394	
	SPECIAL FOUNDATIONS							
	Allowance for special footings, if needed	120,168	SF	33.00	3,965,544	38.28	4,600,031	
	SLAB ON GRADE							
	Slab on grade, pits, etc.	120,168	SF	12.00	1,442,016	13.92	1,672,739	
	FOUNDATIONS				10,033,762		11,639,164	5.04%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION							
	Excavation and disposal	44,876	CY	40.00	1,795,053	46.40	2,082,262	
	Shoring to basement excavation	28,899	SF	39.00	1,127,061	45.24	1,307,391	
	BASEMENT WALLS							
	Concrete basement retaining walls	28,899	SF	55.00	1,589,445	63.80	1,843,756	
	Waterproofing	28,899	SF	8.00	231,192	9.28	268,183	
	BASEMENT CONSTRUCTION				4,742,751		5,501,592	2.38%
B10	**SUPERSTRUCTURE**							
	FLOOR CONSTRUCTION							
	Allowance for floor structures	428,866	SF	41.00	17,583,506	47.56	20,396,867	
	ROOF CONSTRUCTION							
	Allowance for roof structures	120,618	SF	40.00	4,824,720	46.40	5,596,675	
	SUPERSTRUCTURE				22,408,226		25,993,542	11.26%
B20	**EXTERIOR CLOSURE**							
	Exterior walling	176,811	SF	70.00	12,376,735	81.20	14,357,013	
	Canopies, soffits, etc	524,710	GFA	5.00	2,623,550	5.80	3,043,318	
	EXTERIOR WINDOWS							
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	3,680	SF	70.00	257,600	81.20	298,816	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	16,416	SF	70.00	1,149,120	81.20	1,332,979	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	13,968	SF	70.00	977,760	81.20	1,134,202	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Type E (Storefront) - Kawneer System 2250 w/ Solarban 60 glass	6,804	SF	80.00	544,320	92.80	631,411	
	Type F (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	6,150	SF	70.00	430,500	81.20	499,380	
	Type G (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	2,268	SF	70.00	158,760	81.20	184,162	
	Type H (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	1,080	SF	70.00	75,600	81.20	87,696	
	Type I (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	11,172	SF	70.00	782,040	81.20	907,166	
	Type J (Unknown) - Kawneer System 2250 w/ Solarban 60 glass	14,877	SF	70.00	1,041,390	81.20	1,208,012	
	Parapet front & back finish	13,403	SF	80.00	1,072,200	92.80	1,243,752	
	Testing building for air-tightness	1	LS	100000.00	100,000	116000.00	116,000	
	Retractable exterior shades		N/A	70.00				
	EXTERIOR DOORS							
	Allowance for exterior doors	524,710	GFA	1.25	655,888	1.45	760,830	
	EXTERIOR CLOSURE				22,245,463		25,804,737	11.18%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-21 insulation	120,618	SF	28.00	3,377,304	32.48	3,917,673	
	ROOF OPENINGS							
	Allowance for skylights (not required)							
	ROOFING				3,377,304		3,917,673	1.70%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	749,907	SF	10.00	7,499,070	11.60	8,698,921	
	INTERIOR DOORS							
	Allowance for interior doors	524,710	GFA	11.00	5,771,810	12.76	6,695,300	
	SPECIALTIES							
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	

SCHEME B1

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellenous	4,708	SF	2.00	9,416	2.32	10,923	
			SF	16.00		18.56		
	INTERIOR CONSTRUCTION				28,492,430		33,051,218	14.32%

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SCHEME B1

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524710	SF
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
C20	**STAIRCASES**							
	STAIR CONSTRUCTION							
	East end of middle tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	East end of north tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	West end of south bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of middle bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of north bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	East end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	
	West end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	
	Stair to MOB & Hospital roof	2	EA	33000.00	66,000	38280.00	76,560	
	STAIR FINISHES							
	Included above							
	STAIRCASES				1,143,000		1,325,880	0.57%
C30	**INTERIOR FINISHES**							
	WALL FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	FLOOR FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	
	EKG	480	SF	15.00	7,200	17.40	8,352	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	CEILING FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	

SCHEME B1

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524710	SF
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public Waiting Areas	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellenous	4,708	SF	3.00	14,124	3.48	16,384	
	INTERIOR FINISHES				14,677,706		17,026,139	7.38%
D10	**CONVEYING SYSTEMS**							
	ELEVATORS & LIFTS							
	East end of middle tower (Staff & Materials)	12	ST	51000.00	612,000	59160.00	709,920	
	East end of north tower (Staff & Materials)	12	ST	51000.00	612,000	59160.00	709,920	
	West end of south tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	West end of middle tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	West end of north tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	MOB elevators (Public & Staff)	4	ST	48000.00	192,000	55680.00	222,720	
	Elevator to the roof MOB & Hospital	2	ST	48000.00	96,000	55680.00	111,360	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524710	SF
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	ESCALATORS & MOVING WALKS							
	Not required							
	OTHER CONVEYING SYSTEMS							
	Not required							
	CONVEYING SYSTEMS				2,952,000		3,424,320	1.48%
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing *(Additional distribution over Scheme A1)*	524,710	GFA	29.50	15,478,945	34.22	17,955,576	
	HVAC							
	Wet Side -							
	Energy supply;							
	Boilers (steam) 300 bhp, total load 20,860 btu/hr	3	EA	255,022	765,067	295,826	887,478	
	Feedwater system	1	LS	112,210	112,210	130,163	130,163	
	Steam to HW Ht Exchanger	3	EA	153,013	459,040	177,496	532,487	
	Potable Water heater	7	EA	22,442	157,094	26,033	182,229	
	Associated equipment. 19no. Pumps, Tanks, Separators etc	1	LS	183,616	183,616	212,995	212,995	
	Chiller, 800 ton	3	EA	355,000	1,065,000	411,800	1,235,400	
	Cooling tower	3	EA	204,018	612,054	236,661	709,982	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	280,525	280,525	325,409	325,409	
	Distribution & Auxiliary equipment:			-		-		
	Distribution piping including equipment connections *(Additional distribution required due to horizontal mass -over A1 Approximate Distribution quantity 55,000 LF)*	524,710	GFA	9.42	4,940,145	10.92	5,730,568	
	Dry Side -							
	Air handling systems *(two additional air handling required over Scheme A1)*	580,700	CFM	11.40	6,619,980	13.22	7,679,177	
	Packaged split A/C systems	1	LS	40,804	40,804	47,332	47,332	
	Terminal VAV boxes	1,100	EA	760.00	836,000	881.60	969,760	
	Exhaust systems	524,710	GFA	2.09	1,096,644	2.42	1,272,107	
	Miscellaneous systems	524,710	GFA	0.62	325,320	0.72	377,371	
	Distribution systems *(Additional ductwork required over Scheme A1 - approx 1.97 lbs/sf)*	524,710	GFA	22.20	11,648,562	25.75	13,512,332	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Control , BMS & Sensing & monitoring *(3690 control points)*	524,710	GFA	6.86	3,596,887	7.95	4,172,389	
	HVAC related items-							
	Balancing, Testing	524,710	GFA	1.00	524,710	1.16	608,664	
	Supervision associated with commissioning	524,710	GFA	0.45	236,120	0.52	273,899	
	HVAC, seismic, gen conditions, engineering, etc	524,710	GFA	1.00	524,710	1.16	608,664	
	<u>FIRE PROTECTION</u>							
	Fire sprinklers, standpipe & specialties	524,710	GFA	4.70	2,466,137	5.45	2,860,719	
	MECHANICAL				51,969,569		60,284,699	26.12%
D50	**ELECTRICAL**							
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Busway risers	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Branch panelboards, feeders	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Distribution conduit, feeders	524,710	GFA	6.00	3,148,260	6.96	3,651,982	
	Emergency generators/paralleling switchgear	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Automatic transfer switches, feeders	524,710	GFA	0.50	262,355	0.58	304,332	
	Step down transformers, feeders	524,710	GFA	1.00	524,710	1.16	608,664	
	Central UPS distribution	524,710	GFA	1.00	524,710	1.16	608,664	
	Grounding/Lightning protection	524,710	GFA	0.35	183,649	0.41	213,032	
	Premium for distributing power through Perforated geometry	524,710	GFA	0.50	262,355	0.58	304,332	
	LIGHTING and CONTROLS							
	Supply, install light fixtures	524,710	GFA	10.00	5,247,100	11.60	6,086,636	
	Lighting controls, line voltage/low voltage	524,710	GFA	1.50	787,065	1.74	912,995	
	CONVENIENCE POWER							
	Convenience outlets, surface mounted raceways	524,710	GFA	3.50	1,836,485	4.06	2,130,323	
	EQUIPMENT CONNECTIONS							
	Connect boilers	3	EA	2255.25	6,766	2616.09	7,848	
	Connect heat exchangers	3	EA	2255.25	6,766	2616.09	7,848	
	Connect water heaters	7	EA	902.10	6,315	1046.44	7,325	
	Connect misc. pumps	19	EA	2255.25	42,850	2616.09	49,706	

SCHEME B1

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524710	SF
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Connect 800 ton chiller	3	EA	36084.00	108,252	41857.44	125,572	
	Connect cooling tower	3	EA	4510.50	13,532	5232.18	15,697	
	Connect misc. pumps, cooling system	1	LS	40594.50	40,595	47089.62	47,090	
	Connect VAV boxes	1,100	EA	315.74	347,309	366.25	402,878	
	Connect exhaust systems	524,710	SF	0.90	473,341	1.05	549,075	
	Air handling system connections:							
	Connect S1	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S2	1	EA	4850.00	4,850	5626.00	5,626	
	Connect S3	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S4A	1	EA	4500.00	4,500	5220.00	5,220	
	Connect S4B	1	EA	3750.00	3,750	4350.00	4,350	
	Connect S5	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S6	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S7	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S8	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S9	1	EA	4200.00	4,200	4872.00	4,872	
	Connect S10	1	EA	3750.00	3,750	4350.00	4,350	
	Connect S11	1	EA	3750.00	3,750	4350.00	4,350	
	Connect S11B	1	EA	3750.00	3,750	4350.00	4,350	
	Connect S12	1	EA	3750.00	3,750	4350.00	4,350	
	Connect S13	1	EA	1050.00	1,050	1218.00	1,218	
	Connect S14	1	EA	2885.00	2,885	3346.60	3,347	
	Connect S15	1	EA	1380.00	1,380	1600.80	1,601	
	Connect S16	1	EA	3060.00	3,060	3549.60	3,550	
	Connect S17	1	EA	3060.00	3,060	3549.60	3,550	
	Connect AC1	1	EA	1050.00	1,050	1218.00	1,218	
	Connect elevators	14	EA	4961.55	69,462	5755.40	80,576	
	Connections to medical equipment	524,710	GFA	1.24	648,477	1.43	752,233	
	Raceways, equipment connections in Procedure rooms	4	EA	53404.32	213,617	61949.01	247,796	
	Connections to OR equipment	10	EA	9832.89	98,329	11406.15	114,062	
	FIRE ALARM							
	Complete system	524,710	GFA	2.50	1,311,775	2.90	1,521,659	
	NURSE CALL							
	Complete system	524,710	GFA	3.75	1,967,663	4.35	2,282,489	
	ACCESS CONTROL							
	Complete system	524,710	GFA	1.00	524,710	1.16	608,664	
	CCTV							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	TELEPHONE/DATA							
	Boxes, empty conduits	524,710	GFA	1.00	524,710	1.16	608,664	
	Faceplates, cabling, terminations, testing	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	CABLE TRAY	524,710	GFA	1.00	524,710	1.16	608,664	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524710	SF
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	OVERHEAD PAGING							
	Complete system	524,710	GFA	0.80	419,768	0.93	486,931	
	DEPARTMENTAL INTERCOM							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	CLOCKS							
	Master clock, remote clocks, ET clocks, reset switches etc.	524,710	GFA	0.25	131,178	0.29	152,166	
	PATIENT ENTRAINMENT SYSTEM							
	Complete system	524,710	GFA	0.25	131,178	0.29	152,166	
	AUDIO/VISUAL SYSTEMS							
	Boxes, empty conduits only	524,710	GFA	0.25	131,178	0.29	152,166	
	INFORMATION TECHNOLOGY							
	Two way radio	524,710	GFA	0.30	157,413	0.35	182,599	
	Distributed antenna system	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Wireless telemetry	524,710	GFA	0.75	393,533	0.87	456,498	
	Time and Attendance	524,710	GFA	0.10	52,471	0.12	60,866	
	Digital signage and Way finding	524,710	GFA	0.50	262,355	0.58	304,332	
	Central Dictation	524,710	GFA	0.15	78,707	0.17	91,300	
	Teleconferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Medical Alert	524,710	GFA	0.25	131,178	0.29	152,166	
	Telemedicine technology	524,710	GFA	0.25	131,178	0.29	152,166	
	Radio paging	524,710	GFA	0.15	78,707	0.17	91,300	
	Video conferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Patient controlled video visitation	524,710	GFA	0.40	209,884	0.46	243,465	
	OR room status cameras	524,710	GFA	0.10	52,471	0.12	60,866	
	Radiation detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Chemical Bio Detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Asset tracking system	524,710	GFA	0.20	104,942	0.23	121,733	
	Patient wandering/tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Personnel tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Infant protection	524,710	GFA	0.20	104,942	0.23	121,733	
	MISC ELECTRICAL							
	Testing, commissioning	1	LS	210,102	210,102	243718.32	243,718	
	Coordination, documentation	1	LS	504,061	504,061	584710.18	584,710	
	Start-up	1	LS	386,109	386,109	447885.86	447,886	
	ELECTRICAL				32,839,508		38,093,830	16.51%
E10	**EQUIPMENT**							
	EQUIPMENT							
	Allowance for equipment	524,710	GFA	2.75	1,442,953	3.19	1,673,825	
	EQUIPMENT				1,442,953		1,673,825	0.73%

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HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524710**	**SF**
SCHEME B1 - PERFORATED GEOMETRY, BASELINE ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
E20	**FURNISHINGS**							
	FIXED FURNISHINGS							
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,710	GFA	5.00	2,623,550	5.00	2,623,550	
	Mechoshades	76,415	SF			8.00	611,320	
	MOVABLE FURNISHINGS							
	Excluded							
	FURNISHINGS				2,623,550		3,234,870	1.32%
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES							
	Not required							
	OTHER SPECIAL CONSTRUCTION							
	Not required							
	RECORDING INSTRUMENTATION							
	Not required							
	BUILDING AUTOMATION SYSTEMS							
	Not required							
	OTHER SPECIAL CONTROLS							
	Not required							
	SPECIAL CONSTRUCTION							
F20	**SELECTIVE BUILDING DEMOLITION**							
	BUILDING DEMOLITION							
	Not required							
	HAZARDOUS COMPONENTS ABATEMENT							
	Not required							
	SELECTIVE BUILDING DEMOLITION							
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK							
	TOTAL DIRECT COSTS w/GC markups				198,948,220		230,971,488	100.00%

SCHEME B2 - PERFORATED GEOMETRY - TARGET 100

COST SUMMARY - SCHEME B2

HIGH PERFORMANCE HOSPITAL			**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON			**Floor Area**	**524,710**	**SF**
SCHEME B2 - PERFORATED GEOMETRY, BASELINE ENERGY			**Date:**	**April 8, 2010**	
			By:	**GEC/SS/AH/TV/OF**	

El.	Section	Totals		Costs/SF	
	UNIFORMAT SUMMARY				
A	**SUBSTRUCTURE**		17,140,755		32.67
A10	FOUNDATIONS	11,639,164		22.18	
A20	BASEMENT CONSTRUCTION	5,501,592		10.49	
B	**SHELL**		58,024,948		110.58
B10	SUPERSTRUCTURE	25,496,058		48.59	
B20	EXTERIOR CLOSURE	28,541,260		54.39	
B30	ROOFING	3,987,631		7.60	
C	**INTERIORS**		50,983,392		97.16
C10	INTERIOR CONSTRUCTION	32,631,373		62.19	
C20	STAIRCASES	1,325,880		2.53	
C30	INTERIOR FINISHES	17,026,139		32.45	
D	**SERVICES**		106,868,706		203.67
D10	CONVEYING SYSTEMS	3,424,320		6.53	
D15	MECHANICAL	64,362,739		122.66	
D50	ELECTRICAL	39,081,647		74.48	
E	**EQUIPMENT & FURNISHING**		4,425,359		8.43
E10	EQUIPMENT	1,673,825		3.19	
E20	FURNISHINGS	2,751,534		5.24	
F	**SPECIAL CONSTRUCTION/DEMOLITION**				
F10	SPECIAL CONSTRUCTION				
F20	SELECTIVE BUILDING DEMOLITION				
	BUILDING COST		237,443,160		452.52
G	**BUILDING SITEWORK**				
	SITE PREPARATION				
	SITE IMPROVEMENT				
	SITE/MECHANICAL UTILITIES				
	SITE ELECTRICAL UTILITIES				
	OTHER SITE CONSTRUCTION				
	TOTAL DIRECT COSTS		237,443,160		452.52
	GENERAL CONDITIONS, OH & P	Included above			
	DESIGN CONTINGENCY	Included above			
	ESCALATION to mid point of construction	Not Included			
	ESTIMATE TOTAL		237,443,160		452.52

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	225 BED PROGRAM							
A10	**FOUNDATIONS**							
	FOUNDATIONS							
	Allowance for standard footings	120,168	SF	38.50	4,626,202	44.66	5,366,394	
	SPECIAL FOUNDATIONS							
	Allowance for special footings, if needed	120,168	SF	33.00	3,965,544	38.28	4,600,031	
	SLAB ON GRADE							
	Slab on grade, pits, etc.	120,168	SF	12.00	1,442,016	13.92	1,672,739	
	FOUNDATIONS				10,033,762		11,639,164	4.90%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION							
	Excavation and disposal	44,876	CY	40.00	1,795,053	46.40	2,082,262	
	Shoring to basement excavation	28,899	SF	39.00	1,127,061	45.24	1,307,391	
	BASEMENT WALLS							
	Concrete basement retaining walls	28,899	SF	55.00	1,589,445	63.80	1,843,756	
	Waterproofing	28,899	SF	8.00	231,192	9.28	268,183	
	BASEMENT CONSTRUCTION				4,742,751		5,501,592	2.31%
B10	**SUPERSTRUCTURE**							
	FLOOR CONSTRUCTION							
	Allowance for floor structures *(lower floor to floor heights)*	428,866	SF	40.00	17,154,640	46.40	19,899,382	
	ROOF CONSTRUCTION							
	Allowance for roof structures	120,618	SF	40.00	4,824,720	46.40	5,596,675	
	SUPERSTRUCTURE				21,979,360		25,496,058	10.72%
B20	**EXTERIOR CLOSURE**							
	Exterior walling	168,409	SF	70.00	11,788,630	81.20	13,674,811	
	Canopies, soffits, etc	524,710	GFA	5.00	2,623,550	5.80	3,043,318	
	EXTERIOR WINDOWS							
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	3,680	SF	70.00	257,600	81.20	298,816	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	16,416	SF	70.00	1,149,120	81.20	1,332,979	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	13,968	SF	70.00	977,760	81.20	1,134,202	
	Type E (Storefront) - Kawneer Trifab 451 with Solarban 60	6,804	SF	80.00	544,320	92.80	631,411	
	Type F (Unknown) - Kawneer Trifab 451 with Solarban 60	6,150	SF	70.00	430,500	81.20	499,380	
	Type G (Unknown) - Kawneer Trifab 451 with Solarban 60	2,268	SF	70.00	158,760	81.20	184,162	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Type H (Unknown) - Kawneer Trifab 451 with Solarban 60	1,080	SF	70.00	75,600	81.20	87,696	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	11,172	SF	70.00	782,040	81.20	907,166	
	Type J (Unknown) - Kawneer Trifab 451 with Solarban 60	14,877	SF	70.00	1,041,390	81.20	1,208,012	
	Parapet front & back finish	13,521	SF	80.00	1,081,680	92.80	1,254,749	
	Testing building for air-tightness	1	LS	100000.00	100,000	116000.00	116,000	
	Retractable exterior shades (E, S & W)	60,417	SF	45.00	2,718,765	52.20	3,153,767	
	Premium for 5-1/2" batt insulation	168,409	SF	0.80	134,727	0.93	156,284	
	Premium for 2-1/2" rigid insulation	168,409	SF	0.50	84,205	0.58	97,677	
	EXTERIOR DOORS							
	Allowance for exterior doors	524,710	GFA	1.25	655,888	1.45	760,830	
	EXTERIOR CLOSURE				24,604,534		28,541,260	12.01%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-30 insulation	120,618	SF	28.50	3,437,613	33.06	3,987,631	
	ROOF OPENINGS							
	Allowance for skylights (not required)							
	ROOFING				3,437,613		3,987,631	1.68%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	713,713	SF	10.00	7,137,135	11.60	8,279,076	
	INTERIOR DOORS							
	Allowance for interior doors	524,710	GFA	11.00	5,771,810	12.76	6,695,300	
	SPECIALTIES							
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellenous	4,708	SF	2.00	9,416	2.32	10,923	
			SF	16.00		18.56		
	INTERIOR CONSTRUCTION				28,130,494		32,631,373	13.73%
C20	**STAIRCASES**							
	STAIR CONSTRUCTION							
	East end of middle tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	East end of north tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	West end of south bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of middle bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of north bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	East end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,710**	**SF**
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
						By:	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	West end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	
	Stair to MOB & Hospital roof	2	EA	33000.00	66,000	38280.00	76,560	
	STAIR FINISHES							
	Included above							
	STAIRCASES				1,143,000		1,325,880	0.56%
C30	**INTERIOR FINISHES**							
	WALL FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	

SCHEME B2

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY					Date:	April 8, 2010	
					By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	FLOOR FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	
	EKG	480	SF	15.00	7,200	17.40	8,352	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	

SCHEME B2

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY					Date:	April 8, 2010	
					By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	CEILING FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON						**Floor Area:**	**524,710**	**SF**
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
						By:	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public Waiting Areas	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellenous	4,708	SF	3.00	14,124	3.48	16,384	
	INTERIOR FINISHES				14,677,706		17,026,139	7.16%
D10	**CONVEYING SYSTEMS**							
	ELEVATORS & LIFTS							
	East end of middle tower (Staff & Materials)	12	ST	51000.00	612,000	59160.00	709,920	
	East end of north tower (Staff & Materials)	12	ST	51000.00	612,000	59160.00	709,920	
	West end of south tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	West end of middle tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	West end of north tower (Public)	10	ST	48000.00	480,000	55680.00	556,800	
	MOB elevators (Public & Staff)	4	ST	48000.00	192,000	55680.00	222,720	
	Elevator to the roof MOB & Hospital	2	ST	48000.00	96,000	55680.00	111,360	
	ESCALATORS & MOVING WALKS							
	Not required							
	OTHER CONVEYING SYSTEMS							
	Not required							
	CONVEYING SYSTEMS				2,952,000		3,424,320	1.44%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing *(Additional distribution over Scheme A2)*	524,710	GFA	29.50	15,478,945	34.22	17,955,576	
	Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separate waste & vent system also required from shower drains and selected hot water waste drains *(Additional Distribution required due to horizontal mass)*	524,710	GFA	0.56	293,838	0.65	340,852	
	HVAC							
	Wet Side -							
	Energy supply;							
	Geo thermal field, 416 bores @ 300 ft deep	124,800	LF	15.20	1,896,960	17.63	2,200,474	
	Geo thermal field, headers	26,500	LF	15.11	400,283	17.52	464,328	
	Utility from field to building (150 l/ft allowance)	1	LS	40,804	40,804	47332.16	47,332	
	Heat pumps, 500 ton *(Approx $900 per ton + GC markups)*	3	EA	459,040	1,377,121	532486.76	1,597,460	
	Chiller, 800 ton	1	EA	355,000	355,000	411800.00	411,800	
	Cooling tower	1	EA	204,017	204,017	236659.72	236,660	
	Associated Pumps 30 no., 555 hp total	1	LS	255,022	255,022	295825.98	295,826	
	Associated equipment - Tanks, Separators etc	1	LS	30,603	30,603	35499.12	35,499	
	Steam boiler (standby), 90 hp	2	EA	102,009	204,018	118330.39	236,661	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	51,004	51,004	59165.20	59,165	
	Distribution & Auxiliary equipment:							
	Distribution piping including equipment connections *(Additional distribution over Scheme A2 required due to horizontal mass increase - Approximate distribution quantity; 75,000 l/ft)*	524,710	GFA	13.98	7,335,446	16.22	8,509,117	
	Dry Side -							
	Air handling / heat recovery systems	373,600	CFM	10.93	4,081,580	12.67	4,734,633	
	Packaged split A/C systems	1	LS	40,804	40,804	47332.16	47,332	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY					Date:	April 8, 2010	
					By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Fan coil units, four pipe	672	EA	6,631	4,455,751	7691.48	5,168,671	
	Terminal VAV boxes *(less required than A1)*	226	EA	760.00	171,760	881.60	199,242	
	Exhaust systems *(heat recovery ventilators to function as primary exhaust)*	524,710	GFA	1.62	847,407	1.87	982,992	
	Miscellaneous systems	524,710	GFA	0.62	324,008	0.72	375,850	
	Distribution systems *(Additional ductwork over option two required due to horizontal mass increase - Approximate duct poundage; 1.62 lb/sf)*	524,710	GFA	16.86	8,846,611	19.56	10,262,068	
	Control , BMS & Sensing & monitoring *(5621 Control Points)*	524,710	GFA	8.88	4,659,425	10.30	5,404,933	
	HVAC related items-							
	Balancing, Testing	524,710	GFA	1.25	655,888	1.45	760,830	
	Supervision associated with commissioning	524,710	GFA	0.45	236,120	0.52	273,899	
	HVAC, seismic, gen conditions, engineering, etc	524,710	GFA	1.48	776,571	1.72	900,822	
	FIRE PROTECTION							
	Fire sprinklers	524,710	GFA	4.70	2,466,137	5.45	2,860,719	
	MECHANICAL				55,485,120		64,362,739	27.07%
D50	**ELECTRICAL**							
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Busway risers	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Branch panelboards, feeders	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Distribution conduit, feeders	524,710	GFA	6.00	3,148,260	6.96	3,651,982	
	Emergency generators/paralleling switchgear	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Automatic transfer switches, feeders	524,710	GFA	0.50	262,355	0.58	304,332	
	Step down transformers, feeders	524,710	GFA	1.00	524,710	1.16	608,664	
	Central UPS distribution	524,710	GFA	1.00	524,710	1.16	608,664	
	Grounding/Lightning protection	524,710	GFA	0.35	183,649	0.41	213,032	
	Premium for distributing power through Perforated geometry	524,710	GFA	0.50	262,355	0.58	304,332	
	LIGHTING and CONTROLS							
	Supply, install light fixtures	524,710	GFA	10.00	5,247,100	11.60	6,086,636	
	Premium for high efficiency lamps, dimming ballasts	524,710	GFA	0.50	262,355	0.58	304,332	
	Lighting controls, line voltage/low voltage	524,710	GFA	1.50	787,065	1.74	912,995	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON					Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY					Date:	April 8, 2010	
					By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Premium for daylight sensing, dimming etc.	524,710	GFA	0.41	217,737	0.48	252,575	
	CONVENIENCE POWER							
	Convenience outlets, surface mounted raceways	524,710	GFA	3.50	1,836,485	4.06	2,130,323	
	EQUIPMENT CONNECTIONS							
	Connect heat pumps, 500 ton	3	EA	23,656	70,967	27,440	82,321	
	Connect misc. pumps	30	EA	2,255	67,658	2,616	78,483	
	Connect 800 ton chiller	1	EA	36,084	36,084	41,857	41,857	
	Connect cooling tower	1	EA	4,511	4,511	5,232	5,232	
	Connect VAV boxes	216	EA	315.74	68,199	366.25	79,111	
	Connect exhaust systems	524,710	SF	0.90	473,341	1.05	549,075	
	Connect steam boilers	2	EA	2,957	5,914	3,430	6,860	
	Connect misc equipment	1	LS	23,656	23,656	27,440	27,440	
	Connect fan coil units	696	EA	768.81	535,089	891.82	620,704	
	Connect elevators	14	EA	4,962	69,462	5,755	80,576	
	Connect operable louvers	351	EA	574.83	201,766	666.80	234,048	
	Connections to medical equipment	524,710	GFA	1.24	648,477	1.43	752,233	
	Raceways, equipment connections in Procedure rooms	4	EA	53,404	213,617	61,949	247,796	
	Connections to OR equipment	10	EA	9,833	98,329	11,406	114,062	
	FIRE ALARM							
	Complete system	524,710	GFA	2.50	1,311,775	2.90	1,521,659	
	NURSE CALL							
	Complete system	524,710	GFA	3.75	1,967,663	4.35	2,282,489	
	ACCESS CONTROL							
	Complete system	524,710	GFA	1.00	524,710	1.16	608,664	
	CCTV							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	TELEPHONE/DATA							
	Boxes, empty conduits	524,710	GFA	1.00	524,710	1.16	608,664	
	Faceplates, cabling, terminations, testing	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	CABLE TRAY	524,710	GFA	1.00	524,710	1.16	608,664	
	OVERHEAD PAGING							
	Complete system	524,710	GFA	0.80	419,768	0.93	486,931	
	DEPARTMENTAL INTERCOM							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	CLOCKS							
	Master clock, remote clocks, ET clocks, reset switches etc.	524,710	GFA	0.25	131,178	0.29	152,166	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	PATIENT ENTRAINMENT SYSTEM							
	Complete system	524,710	GFA	0.25	131,178	0.29	152,166	
	AUDIO/VISUAL SYSTEMS							
	Boxes, empty conduits only	524,710	GFA	0.25	131,178	0.29	152,166	
	INFORMATION TECHNOLOGY							
	Two way radio	524,710	GFA	0.30	157,413	0.35	182,599	
	Distributed antenna system	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Wireless telemetry	524,710	GFA	0.75	393,533	0.87	456,498	
	Time and Attendance	524,710	GFA	0.10	52,471	0.12	60,866	
	Digital signage and Way finding	524,710	GFA	0.50	262,355	0.58	304,332	
	Central Dictation	524,710	GFA	0.15	78,707	0.17	91,300	
	Teleconferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Medical Alert	524,710	GFA	0.25	131,178	0.29	152,166	
	Telemedicine technology	524,710	GFA	0.25	131,178	0.29	152,166	
	Radio paging	524,710	GFA	0.15	78,707	0.17	91,300	
	Video conferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Patient controlled video visitation	524,710	GFA	0.40	209,884	0.46	243,465	
	OR room status cameras	524,710	GFA	0.10	52,471	0.12	60,866	
	Radiation detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Chemical Bio Detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Asset tracking system	524,710	GFA	0.20	104,942	0.23	121,733	
	Patient wandering/tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Personnel tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Infant protection	524,710	GFA	0.20	104,942	0.23	121,733	
	MISC ELECTRICAL							
	Testing, commissioning	1	LS	210,102	210,102	243,718	243,718	
	Coordination, documentation	1	LS	504,061	504,061	584,710	584,710	
	Start-up	1	LS	386,109	386,109	447,886	447,886	
	ELECTRICAL				33,691,075		39,081,647	16.44%
E10	**EQUIPMENT**							
	EQUIPMENT							
	Allowance for equipment	524,710	GFA	2.75	1,442,953	3.19	1,673,825	
	EQUIPMENT				1,442,953		1,673,825	0.70%
E20	**FURNISHINGS**							
	FIXED FURNISHINGS							
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,710	GFA	5.00	2,623,550	5.00	2,623,550	
	Mechoshades (North side only)	15,998	SF			8.00	127,984	
	MOVABLE FURNISHINGS							
	Excluded							
	FURNISHINGS				2,623,550		2,751,534	1.28%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON						Floor Area:	524,710	SF
SCHEME B2 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
						By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES							
	Not required							
	OTHER SPECIAL CONSTRUCTION							
	Not required							
	RECORDING INSTRUMENTATION							
	Not required							
	BUILDING AUTOMATION SYSTEMS							
	Not required							
	OTHER SPECIAL CONTROLS							
	Not required							
	SPECIAL CONSTRUCTION							
F20	**SELECTIVE BUILDING DEMOLITION**							
	BUILDING DEMOLITION							
	Not required							
	HAZARDOUS COMPONENTS ABATEMENT							
	Not required							
	SELECTIVE BUILDING DEMOLITION							
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK							
	TOTAL DIRECT COSTS w/GC markups				204,943,917		237,443,160	100.00%

SCHEME B3 - PERFORATED GEOMETRY - TARGET 100

COST SUMMARY - SCHEME B3

HIGH PERFORMANCE HOSPITAL			**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON			**Floor Area**	**524,710**	**SF**
SCHEME B3 - PERFORATED GEOMETRY, BASELINE ENERGY			**Date:**	**April 8, 2010**	
			By:	**GEC/SS/AH/TV/OF**	

El.	**Section**		**Totals**		**Costs/SF**	
	UNIFORMAT SUMMARY					
A	**SUBSTRUCTURE**			17,140,755		32.67
A10	FOUNDATIONS		11,639,164		22.18	
A20	BASEMENT CONSTRUCTION		5,501,592		10.49	
B	**SHELL**			58,024,948		110.58
B10	SUPERSTRUCTURE		25,496,058		48.59	
B20	EXTERIOR CLOSURE		28,541,260		54.39	
B30	ROOFING		3,987,631		7.60	
C	**INTERIORS**			50,983,392		97.16
C10	INTERIOR CONSTRUCTION		32,631,373		62.19	
C20	STAIRCASES		1,325,880		2.53	
C30	INTERIOR FINISHES		17,026,139		32.45	
D	**SERVICES**			104,129,536		198.45
D10	CONVEYING SYSTEMS		3,424,320		6.53	
D15	MECHANICAL		61,625,421		117.45	
D50	ELECTRICAL		39,079,795		74.48	
E	**EQUIPMENT & FURNISHING**			4,425,359		8.43
E10	EQUIPMENT		1,673,825		3.19	
E20	FURNISHINGS		2,751,534		5.24	
F	**SPECIAL CONSTRUCTION/DEMOLITION**					
F10	SPECIAL CONSTRUCTION					
F20	SELECTIVE BUILDING DEMOLITION					
	BUILDING COST			234,703,991		447.30
G	**BUILDING SITEWORK**					
	SITE PREPARATION					
	SITE IMPROVEMENT					
	SITE/MECHANICAL UTILITIES					
	SITE ELECTRICAL UTILITIES					
	OTHER SITE CONSTRUCTION					
	TOTAL DIRECT COSTS			234,703,991		447.30
	GENERAL CONDITIONS, OH & P	Included above				
	DESIGN CONTINGENCY	Included above				
	ESCALATION to mid point of construction	Not Included				
	ESTIMATE TOTAL			234,703,991		447.30

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524,710**	**SF**
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
	225 BED PROGRAM							
A10	**FOUNDATIONS**							
	FOUNDATIONS							
	Allowance for standard footings	120,168	SF	38.50	4,626,202	44.66	5,366,394	
	SPECIAL FOUNDATIONS							
	Allowance for special footings, if needed	120,168	SF	33.00	3,965,544	38.28	4,600,031	
	SLAB ON GRADE							
	Slab on grade, pits, etc.	120,168	SF	12.00	1,442,016	13.92	1,672,739	
	FOUNDATIONS				10,033,762		11,639,164	4.95%
A20	**BASEMENT CONSTRUCTION**							
	BASEMENT EXCAVATION							
	Excavation and disposal	44,876	CY	40.00	1,795,053	46.40	2,082,262	
	Shoring to basement excavation	28,899	SF	39.00	1,127,061	45.24	1,307,391	
	BASEMENT WALLS							
	Concrete basement retaining walls	28,899	SF	55.00	1,589,445	63.80	1,843,756	
	Waterproofing	28,899	SF	8.00	231,192	9.28	268,183	
	BASEMENT CONSTRUCTION				4,742,751		5,501,592	2.34%
B10	**SUPERSTRUCTURE**							
	FLOOR CONSTRUCTION							
	Allowance for floor structures *(lower floor to floor heights)*	428,866	SF	40.00	17,154,640	46.40	19,899,382	
	ROOF CONSTRUCTION							
	Allowance for roof structures	120,618	SF	40.00	4,824,720	46.40	5,596,675	
	SUPERSTRUCTURE				21,979,360		25,496,058	10.85%
B20	**EXTERIOR CLOSURE**							
	Exterior walling	168,409	SF	70.00	11,788,630	81.20	13,674,811	
	Canopies, soffits, etc	524,710	GFA	5.00	2,623,550	5.80	3,043,318	
	EXTERIOR WINDOWS							
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	3,680	SF	70.00	257,600	81.20	298,816	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	16,416	SF	70.00	1,149,120	81.20	1,332,979	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	13,968	SF	70.00	977,760	81.20	1,134,202	
	Type E (Storefront) - Kawneer Trifab 451 with Solarban 60	6,804	SF	80.00	544,320	92.80	631,411	
	Type F (Unknown) - Kawneer Trifab 451 with Solarban 60	6,150	SF	70.00	430,500	81.20	499,380	
	Type G (Unknown) - Kawneer Trifab 451 with Solarban 60	2,268	SF	70.00	158,760	81.20	184,162	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Type H (Unknown) - Kawneer Trifab 451 with Solarban 60	1,080	SF	70.00	75,600	81.20	87,696	
	Type I (Unknown) - Kawneer Trifab 451 with Solarban 60	11,172	SF	70.00	782,040	81.20	907,166	
	Type J (Unknown) - Kawneer Trifab 451 with Solarban 60	14,877	SF	70.00	1,041,390	81.20	1,208,012	
	Parapet front & back finish	13,521	SF	80.00	1,081,680	92.80	1,254,749	
	Testing building for air-tightness	1	LS	100000.00	100,000	116000.00	116,000	
	Retractable exterior shades (E, S & W)	60,417	SF	45.00	2,718,765	52.20	3,153,767	
	Premium for 5-1/2" batt insulation	168,409	SF	0.80	134,727	0.93	156,284	
	Premium for 2-1/2" rigid insulation	168,409	SF	0.50	84,205	0.58	97,677	
	EXTERIOR DOORS							
	Allowance for exterior doors	524,710	GFA	1.25	655,888	1.45	760,830	
	EXTERIOR CLOSURE				24,604,534		28,541,260	12.15%
B30	**ROOFING**							
	ROOF COVERINGS							
	Flat roof coverings and roof specialties - white single ply w/R-30 insulation	120,618	SF	28.50	3,437,613	33.06	3,987,631	
	ROOF OPENINGS							
	Allowance for skylights (not required)							
	ROOFING				3,437,613		3,987,631	1.70%
C10	**INTERIOR CONSTRUCTION**							
	PARTITIONS							
	Interior partitions	713,713	SF	10.00	7,137,135	11.60	8,279,076	
	INTERIOR DOORS							
	Allowance for interior doors	524,710	GFA	11.00	5,771,810	12.76	6,695,300	
	SPECIALTIES							
	Critical Care Unit (ICU/CCU)	22,828	SF	45.00	1,027,260	52.20	1,191,622	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	44.00	396,176	51.04	459,564	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	44.00	608,256	51.04	705,577	
	Acute Care Med/Surg Unit	35,068	SF	44.00	1,542,992	51.04	1,789,871	
	Labor & Delivery	13,824	SF	41.00	566,784	47.56	657,469	
	Acute Care Post Partum Unit	8,767	SF	44.00	385,748	51.04	447,468	
	Newborn Nursery	9,004	SF	45.00	405,180	52.20	470,009	
	NICU Level II	9,004	SF	50.00	450,200	58.00	522,232	
	Clinical Laboratory	12,000	SF	50.00	600,000	58.00	696,000	
	Emergency Department	20,461	SF	35.00	716,135	40.60	830,717	

HIGH PERFORMANCE HOSPITAL					Estimate:	Program Study	
SEATTLE, WASHINGTON			524,710	SF	Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY					Date:	April 8, 2010	
			GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Diagnostic Imaging	18,634	SF	45.00	838,530	52.20	972,695	
	Interventional Imaging	9,582	SF	45.00	431,190	52.20	500,180	
	Pathology	3,697	SF	40.00	147,880	46.40	171,541	
	Operating Rooms	31,025	SF	50.00	1,551,250	58.00	1,799,450	
	Procedure Rooms	4,000	SF	45.00	180,000	52.20	208,800	
	Recovery (PACU)	10,695	SF	45.00	481,275	52.20	558,279	
	Inpatient Pharmacy	4,800	SF	35.00	168,000	40.60	194,880	
	Respiratory Services	1,811	SF	44.00	79,684	51.04	92,433	
	Sterile Processing	6,400	SF	35.00	224,000	40.60	259,840	
	EKG	480	SF	30.00	14,400	34.80	16,704	
	Hospital Based Physicians	841	SF	15.00	12,615	17.40	14,633	
	Rehabilitation Therapy	11,352	SF	15.00	170,280	17.40	197,525	
	Chapel/Meditation	513	SF	20.00	10,260	23.20	11,902	
	Provider Sleep Rooms	2,320	SF	12.00	27,840	13.92	32,294	
	Admitting	2,785	SF	30.00	83,550	34.80	96,918	
	Medical Records	800	SF	45.00	36,000	52.20	41,760	
	Hospital Conference Rooms	1,745	SF	40.00	69,800	46.40	80,968	
	Administration	2,320	SF	16.00	37,120	18.56	43,059	
	Lobby & Gift Shop	4,900	SF	30.00	147,000	34.80	170,520	
	Undefined Administration	2,386	SF	16.00	38,176	18.56	44,284	
	Biomedical Engineering	1,600	SF	5.00	8,000	5.80	9,280	
	Cafeteria and Servery	5,955	SF	80.00	476,400	92.80	552,624	
	Nutritional Services & Dietary	11,319	SF	50.00	565,950	58.00	656,502	
	Linen Services	2,000	SF	5.00	10,000	5.80	11,600	
	Materials Management	6,600	SF	5.00	33,000	5.80	38,280	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	4.00	8,400	4.64	9,744	
	Bed Repair and Storage	400	SF	4.00	1,600	4.64	1,856	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	4.00	2,680	4.64	3,109	
	Medical Office Building	44,872	SF	15.00	673,080	17.40	780,773	
	Building Main Telecom	3,250	SF	2.25	7,313	2.61	8,483	
	Storage	6,400	SF	3.00	19,200	3.48	22,272	
	Building Circulation and Public Waiting Areas	88,150	SF	3.00	264,450	3.48	306,762	
	Mechanical	32,920	SF	2.00	65,840	2.32	76,374	
	Miscellenous	4,708	SF	2.00	9,416	2.32	10,923	
	INTERIOR CONSTRUCTION				28,130,494		32,631,373	13.89%

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524,710**	**SF**
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
C20	**STAIRCASES**							
	STAIR CONSTRUCTION							
	East end of middle tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	East end of north tower	6	FLTS	35000.00	210,000	40600.00	243,600	
	West end of south bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of middle bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	West end of north bed tower	5	FLTS	35000.00	175,000	40600.00	203,000	
	East end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	
	West end of MOB	2	FLTS	33000.00	66,000	38280.00	76,560	
	Stair to MOB & Hospital roof	2	EA	33000.00	66,000	38280.00	76,560	
	STAIR FINISHES							
	Included above							
	STAIRCASES				1,143,000		1,325,880	0.56%
C30	**INTERIOR FINISHES**							
	WALL FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	9.00	205,452	10.44	238,324	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.50	76,534	9.86	88,779	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Med/Surg Unit	35,068	SF	8.50	298,078	9.86	345,770	
	Labor & Delivery	13,824	SF	8.50	117,504	9.86	136,305	
	Acute Care Post Partum Unit	8,767	SF	8.50	74,520	9.86	86,443	
	Newborn Nursery	9,004	SF	11.00	99,044	12.76	114,891	
	NICU Level II	9,004	SF	9.00	81,036	10.44	94,002	
	Clinical Laboratory	12,000	SF	13.00	156,000	15.08	180,960	
	Emergency Department	20,461	SF	8.50	173,919	9.86	201,745	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	12.00	372,300	13.92	431,868	
	Procedure Rooms	4,000	SF	10.00	40,000	11.60	46,400	
	Recovery (PACU)	10,695	SF	8.50	90,908	9.86	105,453	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	8.50	15,394	9.86	17,856	
	Sterile Processing	6,400	SF	8.50	54,400	9.86	63,104	
	EKG	480	SF	8.50	4,080	9.86	4,733	
	Hospital Based Physicians	841	SF	6.00	5,046	6.96	5,853	
	Rehabilitation Therapy	11,352	SF	8.50	96,492	9.86	111,931	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	8.00	12,800	9.28	14,848	
	Cafeteria and Servery	5,955	SF	10.00	59,550	11.60	69,078	
	Nutritional Services & Dietary	11,319	SF	10.00	113,190	11.60	131,300	
	Linen Services	2,000	SF	7.00	14,000	8.12	16,240	
	Materials Management	6,600	SF	7.00	46,200	8.12	53,592	
	Loading Dock	400	SF	3.00	1,200	3.48	1,392	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	6.00	19,500	6.96	22,620	
	Storage	6,400	SF	6.00	38,400	6.96	44,544	
	Building Circulation and Public Waiting Areas	88,150	SF	9.00	793,350	10.44	920,286	
	Mechanical	32,920	SF	6.00	197,520	6.96	229,123	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	FLOOR FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	8.00	182,624	9.28	211,844	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	8.00	110,592	9.28	128,287	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	8.00	72,032	9.28	83,557	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	12.00	165,888	13.92	192,430	
	Acute Care Med/Surg Unit	35,068	SF	8.00	280,544	9.28	325,431	
	Labor & Delivery	13,824	SF	11.00	152,064	12.76	176,394	
	Acute Care Post Partum Unit	8,767	SF	11.00	96,437	12.76	111,867	
	Newborn Nursery	9,004	SF	9.00	81,036	10.44	94,002	
	NICU Level II	9,004	SF	8.00	72,032	9.28	83,557	
	Clinical Laboratory	12,000	SF	14.00	168,000	16.24	194,880	
	Emergency Department	20,461	SF	13.00	265,993	15.08	308,552	
	Diagnostic Imaging	18,634	SF	10.00	186,340	11.60	216,154	
	Interventional Imaging	9,582	SF	10.00	95,820	11.60	111,151	
	Pathology	3,697	SF	10.00	36,970	11.60	42,885	
	Operating Rooms	31,025	SF	15.00	465,375	17.40	539,835	
	Procedure Rooms	4,000	SF	15.00	60,000	17.40	69,600	
	Recovery (PACU)	10,695	SF	10.00	106,950	11.60	124,062	
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	15.00	27,165	17.40	31,511	
	Sterile Processing	6,400	SF	15.00	96,000	17.40	111,360	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	EKG	480	SF	15.00	7,200	17.40	8,352	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	10.00	113,520	11.60	131,683	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	8.00	18,560	9.28	21,530	
	Lobby & Gift Shop	4,900	SF	8.00	39,200	9.28	45,472	
	Undefined Administration	2,386	SF	8.00	19,088	9.28	22,142	
	Biomedical Engineering	1,600	SF	7.00	11,200	8.12	12,992	
	Cafeteria and Servery	5,955	SF	11.00	65,505	12.76	75,986	
	Nutritional Services & Dietary	11,319	SF	11.00	124,509	12.76	144,430	
	Linen Services	2,000	SF	3.00	6,000	3.48	6,960	
	Materials Management	6,600	SF	3.00	19,800	3.48	22,968	
	Loading Dock	400	SF	0.50	200	0.58	232	
	Environmental Services	2,100	SF	8.00	16,800	9.28	19,488	
	Bed Repair and Storage	400	SF	7.00	2,800	8.12	3,248	
	Staff Amenities	1,844	SF	8.00	14,752	9.28	17,112	
	Communications	670	SF	8.00	5,360	9.28	6,218	
	Medical Office Building	44,872	SF	8.00	358,976	9.28	416,412	
	Building Main Telecom	3,250	SF	7.00	22,750	8.12	26,390	
	Storage	6,400	SF	5.00	32,000	5.80	37,120	
	Building Circulation and Public Waiting Areas	88,150	SF	10.00	881,500	11.60	1,022,540	
	Mechanical	32,920	SF	5.00	164,600	5.80	190,936	
	Miscellenous	4,708	SF	6.00	28,248	6.96	32,768	
	CEILING FINISHES							
	Critical Care Unit (ICU/CCU)	22,828	SF	10.00	228,280	11.60	264,805	
	Acute Care Med/Surg Unit - Ortho/Neuro	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - Oncology	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - Cardiac	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit - General Medicine	9,004	SF	9.00	81,036	10.44	94,002	
	Acute Care Med/Surg Unit - General Surgery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Med/Surg Unit	35,068	SF	9.00	315,612	10.44	366,110	
	Labor & Delivery	13,824	SF	9.00	124,416	10.44	144,323	
	Acute Care Post Partum Unit	8,767	SF	9.00	78,903	10.44	91,527	
	Newborn Nursery	9,004	SF	10.00	90,040	11.60	104,446	
	NICU Level II	9,004	SF	10.00	90,040	11.60	104,446	
	Clinical Laboratory	12,000	SF	10.00	120,000	11.60	139,200	
	Emergency Department	20,461	SF	9.00	184,149	10.44	213,613	
	Diagnostic Imaging	18,634	SF	11.00	204,974	12.76	237,770	
	Interventional Imaging	9,582	SF	11.00	105,402	12.76	122,266	
	Pathology	3,697	SF	8.00	29,576	9.28	34,308	
	Operating Rooms	31,025	SF	20.00	620,500	23.20	719,780	
	Procedure Rooms	4,000	SF	20.00	80,000	23.20	92,800	
	Recovery (PACU)	10,695	SF	8.00	85,560	9.28	99,250	

SCHEME B3

HIGH PERFORMANCE HOSPITAL — **Estimate:** Program Study
SEATTLE, WASHINGTON — **524,710 SF** — **Floor Area:** 524,710 SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY — **Date:** April 8, 2010
GEC/SS/AH/TV/OF — **By:** GEC/SS/AH/TV/OF

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Inpatient Pharmacy	4,800	SF	8.00	38,400	9.28	44,544	
	Respiratory Services	1,811	SF	20.00	36,220	23.20	42,015	
	Sterile Processing	6,400	SF	20.00	128,000	23.20	148,480	
	EKG	480	SF	20.00	9,600	23.20	11,136	
	Hospital Based Physicians	841	SF	8.00	6,728	9.28	7,804	
	Rehabilitation Therapy	11,352	SF	8.00	90,816	9.28	105,347	
	Chapel/Meditation	513	SF	8.00	4,104	9.28	4,761	
	Provider Sleep Rooms	2,320	SF	8.00	18,560	9.28	21,530	
	Admitting	2,785	SF	8.00	22,280	9.28	25,845	
	Medical Records	800	SF	8.00	6,400	9.28	7,424	
	Hospital Conference Rooms	1,745	SF	8.00	13,960	9.28	16,194	
	Administration	2,320	SF	4.00	9,280	4.64	10,765	
	Lobby & Gift Shop	4,900	SF	10.00	49,000	11.60	56,840	
	Undefined Administration	2,386	SF	4.00	9,544	4.64	11,071	
	Biomedical Engineering	1,600	SF	4.00	6,400	4.64	7,424	
	Cafeteria and Servery	5,955	SF	7.00	41,685	8.12	48,355	
	Nutritional Services & Dietary	11,319	SF	6.00	67,914	6.96	78,780	
	Linen Services	2,000	SF	1.00	2,000	1.16	2,320	
	Materials Management	6,600	SF	1.00	6,600	1.16	7,656	
	Loading Dock	400	SF	2.00	800	2.32	928	
	Environmental Services	2,100	SF	7.00	14,700	8.12	17,052	
	Bed Repair and Storage	400	SF	5.00	2,000	5.80	2,320	
	Staff Amenities	1,844	SF	7.00	12,908	8.12	14,973	
	Communications	670	SF	7.00	4,690	8.12	5,440	
	Medical Office Building	44,872	SF	7.00	314,104	8.12	364,361	
	Building Main Telecom	3,250	SF	5.00	16,250	5.80	18,850	
	Storage	6,400	SF	4.00	25,600	4.64	29,696	
	Building Circulation and Public	88,150	SF	13.00	1,145,950	15.08	1,329,302	
	Mechanical	32,920	SF	3.00	98,760	3.48	114,562	
	Miscellenous	4,708	SF	3.00	14,124	3.48	16,384	
	INTERIOR FINISHES				14,677,706		17,026,139	7.25%
D10	**CONVEYING SYSTEMS**							
	ELEVATORS & LIFTS							
	East end of middle tower (Staff & Materials)	12	ST	51000.00	612,000	59,160	709,920	
	East end of north tower (Staff & Materials)	12	ST	51000.00	612,000	59,160	709,920	
	West end of south tower (Public)	10	ST	48000.00	480,000	55,680	556,800	
	West end of middle tower (Public)	10	ST	48000.00	480,000	55,680	556,800	
	West end of north tower (Public)	10	ST	48000.00	480,000	55,680	556,800	
	MOB elevators (Public & Staff)	4	ST	48000.00	192,000	55,680	222,720	
	Elevator to the roof MOB & Hospital	2	ST	48000.00	96,000	55,680	111,360	
	ESCALATORS & MOVING WALKS							
	Not required							
	OTHER CONVEYING SYSTEMS							
	Not required							
	CONVEYING SYSTEMS				2,952,000		3,424,320	1.46%

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON				524,710	SF	Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
				GEC/SS/AH/TV/OF		By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
D15	**MECHANICAL**							
	PLUMBING							
	Allowance for plumbing *(Additional distribution over Scheme A2)*	524,710	GFA	29.50	15,478,945	34.22	17,955,576	
	Potable water heating for the proposed gravity film heat recovery (GFX) and modular plate heat exchangers via heat pumps. Separate waste & vent system also required from shower drains and selected hot water waste drains *(Additional Distribution required due to horizontal mass)*	524,710	GFA	0.56	293,838	0.65	340,852	
	HVAC							
	Wet Side -							
	Boiler (condensing), 2,000 mbh	4	EA	35,000	140,000	40,600	162,400	
	Back up fuel storage - Propane system	1	EA	12,000	12,000	13,920	13,920	
	Chiller (multistack - ht harvester), 400 ton	2	EA	280,000	560,000	324,800	649,600	
	Chiller, 800 ton	1	EA	355,000	355,000	411,800	411,800	
	Heat pump, 400 ton (*$900 per ton + GC markups)*	1	EA	367,232	367,232	425,989	425,989	
	Cooling tower, @ 400 ton	2	EA	110,000	220,000	127,600	255,200	
	Cooling tower, @ 800 ton	1	EA	204,017	204,017	236,660	236,660	
	Associated Pumps 27 no., 482 hp total	1	LS	222,000	222,000	257,520	257,520	
	Associated equipment - Tanks, Separators etc	1	LS	30,603	30,603	35,499	35,499	
	Steam boiler (standby), 90 hp	2	EA	102,009	204,018	118,330	236,661	
	Associated equipment. Pumps, Tanks, Separators etc	1	LS	51,004	51,004	59,165	59,165	
	Distribution & Auxiliary equipment:							
	Distribution piping including equipment connections *(Additional distribution over Scheme A2 required due to horizontal mass increase - Approximate distribution quantity; 75,000 l/ft)*	524,710	GFA	14.15	7,424,647	16.41	8,612,590	
	Dry Side -							
	Air handling / heat recovery systems	373,600	CFM	10.93	4,081,580	12.67	4,734,633	
	Packaged split A/C systems	1	LS	40,804	40,804	47,332	47,332	

HIGH PERFORMANCE HOSPITAL						Estimate:	Program Study	
SEATTLE, WASHINGTON		524,710		SF		Floor Area:	524,710	SF
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						Date:	April 8, 2010	
		GEC/SS/AH/TV/OF				By:	GEC/SS/AH/TV/OF	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	Fan coil units, four pipe	672	EA	6,631	4,455,751	7,691	5,168,671	
	Terminal VAV boxes *(less required than A1)*	226	EA	760.00	171,760	881.60	199,242	
	Exhaust systems *(heat recovery ventilators to function as primary exhaust)*	524,710	GFA	1.62	847,407	1.87	982,992	
	Miscellaneous systems	524,710	GFA	0.62	324,008	0.72	375,850	
	Distribution systems *(Additional ductwork over option two required due to horizontal mass increase - Approximate duct poundage; 1.62 lb/sf)*	524,710	GFA	16.86	8,846,611	19.56	10,262,068	
	Control , BMS & Sensing & monitoring *(5621 Control Points)*	524,710	GFA	8.88	4,659,425	10.30	5,404,933	
	HVAC related items-							
	Balancing, Testing	524,710	GFA	1.25	655,888	1.45	760,830	
	Supervision associated with commissioning	524,710	GFA	0.45	236,120	0.52	273,899	
	HVAC, seismic, gen conditions, engineering, etc	524,710	GFA	1.48	776,571	1.72	900,822	
	FIRE PROTECTION							
	Fire sprinklers	524,710	GFA	4.70	2,466,137	5.45	2,860,719	
	MECHANICAL				53,125,363		61,625,421	26.22%
D50	**ELECTRICAL**							
	ELECTRICAL DISTRIBUTION							
	Switchgear	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Busway risers	524,710	GFA	2.00	1,049,420	2.32	1,217,327	
	Branch panelboards, feeders	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Distribution conduit, feeders	524,710	GFA	6.00	3,148,260	6.96	3,651,982	
	Emergency generators/paralleling switchgear	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Automatic transfer switches, feeders	524,710	GFA	0.50	262,355	0.58	304,332	
	Step down transformers, feeders	524,710	GFA	1.00	524,710	1.16	608,664	
	Central UPS distribution	524,710	GFA	1.00	524,710	1.16	608,664	
	Grounding/Lightning protection	524,710	GFA	0.35	183,649	0.41	213,032	
	Premium for distributing power through Perforated geometry	524,710	GFA	0.50	262,355	0.58	304,332	
	LIGHTING and CONTROLS							
	Supply, install light fixtures	524,710	GFA	10.00	5,247,100	11.60	6,086,636	
	Premium for high efficiency lamps, dimming ballasts	524,710	GFA	0.50	262,355	0.58	304,332	
	Lighting controls, line voltage/low voltage	524,710	GFA	1.50	787,065	1.74	912,995	
	Premium for daylight sensing, dimming etc.	524,710	GFA	0.41	217,737	0.48	252,575	

SCHEME B3

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524,710**	**SF**
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	CONVENIENCE POWER							
	Convenience outlets, surface	524,710	GFA	3.50	1,836,485	4.06	2,130,323	
	EQUIPMENT CONNECTIONS							
	Connect heat pumps, 400 ton	1	EA	23,656	23,656	27,440	27,440	
	Connect misc. pumps	27	EA	2,255	60,892	2,616	70,634	
	Connect 800 ton chiller	1	EA	36,084	36,084	41,857	41,857	
	Connect 400 ton chiller	2	EA	15,040	30,080	17,446	34,893	
	Connect cooling tower, 800 ton	1	EA	5,914	5,914	6,860	6,860	
	Connect VAV boxes	226	EA	315.74	71,356	366.25	82,773	
	Connect exhaust systems	524,710	SF	0.90	473,341	1.05	549,075	
	Connect boilers (condensing)	4	EA	1,050	4,200	1,218	4,872	
	Connect misc equipment	1	LS	23,656	23,656	27,440	27,440	
	Connect fan coil units	672	EA	769	516,638	892	599,300	
	Air handling system connections:							
	Connect S1	1	EA	4,200	4,200	4,872	4,872	
	Connect S2	1	EA	4,850	4,850	5,626	5,626	
	Connect S3	1	EA	3,060	3,060	3,550	3,550	
	Connect ERU 1-6	6	EA	1,380	8,280	1,601	9,605	
	Connect S5	1	EA	3,750	3,750	4,350	4,350	
	Connect S6	1	EA	3,750	3,750	4,350	4,350	
	Connect S12	1	EA	3,750	3,750	4,350	4,350	
	Connect S13	1	EA	1,050	1,050	1,218	1,218	
	Connect S14	1	EA	2,885	2,885	3,347	3,347	
	Connect ERU7	1	EA	1,380	1,380	1,601	1,601	
	Connect AC1	1	EA	1,050	1,050	1,218	1,218	
	Connect elevators	14	EA	4,962	69,462	5,755	80,576	
	Connect operable louvers	351	EA	574.83	201,766	666.80	234,048	
	Connections to medical equipment	524,710	GFA	1.24	648,477	1.43	752,233	
	Raceways, equipment connections in Procedure rooms	4	EA	53,404	213,617	61,949	247,796	
	Connections to OR equipment	10	EA	9,833	98,329	11,406	114,062	
	FIRE ALARM							
	Complete system	524,710	GFA	2.50	1,311,775	2.90	1,521,659	
	NURSE CALL							
	Complete system	524,710	GFA	3.75	1,967,663	4.35	2,282,489	
	ACCESS CONTROL							
	Complete system	524,710	GFA	1.00	524,710	1.16	608,664	
	CCTV							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	TELEPHONE/DATA							
	Boxes, empty conduits	524,710	GFA	1.00	524,710	1.16	608,664	
	Faceplates, cabling, terminations,	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	CABLE TRAY	524,710	GFA	1.00	524,710	1.16	608,664	
	OVERHEAD PAGING							
	Complete system	524,710	GFA	0.80	419,768	0.93	486,931	

HIGH PERFORMANCE HOSPITAL | **Estimate:** **Program Study**
SEATTLE, WASHINGTON **524,710** **SF** | **Floor Area:** **524,710** **SF**
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY | **Date:** **April 8, 2010**
GEC/SS/AH/TV/OF | **By:** **GEC/SS/AH/TV/OF**

Ref.	Section	System Quantity	Unit	Seattle $/Unit	Total Cost	Inc. Markups $/Unit	Total Cost	Percent of Total
	DEPARTMENTAL INTERCOM							
	Complete system	524,710	GFA	0.50	262,355	0.58	304,332	
	CLOCKS							
	Master clock, remote clocks, ET clocks, reset switches etc.	524,710	GFA	0.25	131,178	0.29	152,166	
	PATIENT ENTRAINMENT							
	Complete system	524,710	GFA	0.25	131,178	0.29	152,166	
	AUDIO/VISUAL SYSTEMS							
	Boxes, empty conduits only	524,710	GFA	0.25	131,178	0.29	152,166	
	INFORMATION TECHNOLOGY							
	Two way radio	524,710	GFA	0.30	157,413	0.35	182,599	
	Distributed antenna system	524,710	GFA	3.00	1,574,130	3.48	1,825,991	
	Wireless telemetry	524,710	GFA	0.75	393,533	0.87	456,498	
	Time and Attendance	524,710	GFA	0.10	52,471	0.12	60,866	
	Digital signage and Way finding	524,710	GFA	0.50	262,355	0.58	304,332	
	Central Dictation	524,710	GFA	0.15	78,707	0.17	91,300	
	Teleconferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Medical Alert	524,710	GFA	0.25	131,178	0.29	152,166	
	Telemedicine technology	524,710	GFA	0.25	131,178	0.29	152,166	
	Radio paging	524,710	GFA	0.15	78,707	0.17	91,300	
	Video conferencing	524,710	GFA	0.15	78,707	0.17	91,300	
	Patient controlled video visitation	524,710	GFA	0.40	209,884	0.46	243,465	
	OR room status cameras	524,710	GFA	0.10	52,471	0.12	60,866	
	Radiation detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Chemical Bio Detection	524,710	GFA	0.10	52,471	0.12	60,866	
	Asset tracking system	524,710	GFA	0.20	104,942	0.23	121,733	
	Patient wandering/tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Personnel tracking	524,710	GFA	0.20	104,942	0.23	121,733	
	Infant protection	524,710	GFA	0.20	104,942	0.23	121,733	
	MISC ELECTRICAL							
	Testing, commissioning	1	LS	210,102	210,102	243,718	243,718	
	Coordination, documentation	1	LS	504,061	504,061	584,710	584,710	
	Start-up	1	LS	386,109	386,109	447,886	447,886	
	ELECTRICAL				33,689,478		39,079,795	16.63%
E10	**EQUIPMENT**							
	EQUIPMENT							
	Allowance for equipment	524,710	GFA	2.75	1,442,953	3.19	1,673,825	
	EQUIPMENT				1,442,953		1,673,825	0.71%

SCHEME B3

HIGH PERFORMANCE HOSPITAL						**Estimate:**	**Program Study**	
SEATTLE, WASHINGTON				**524,710**	**SF**	**Floor Area:**	**524,710**	**SF**
SCHEME B3 - PERFORATED GEOMETRY, TARGET 100 ENERGY						**Date:**	**April 8, 2010**	
				GEC/SS/AH/TV/OF		**By:**	**GEC/SS/AH/TV/OF**	
Ref.	**Section**	**System Quantity**	**Unit**	**Seattle $/Unit**	**Total Cost**	**Inc. Markups $/Unit**	**Total Cost**	**Percent of Total**
E20	**FURNISHINGS**							
	FIXED FURNISHINGS							
	Allowance for casework inc. nurse stations, reception desks & patient rooms.	524,710	GFA	5.00	2,623,550	5.00	2,623,550	
	Mechoshades (North side only)	15,998	SF			8.00	127,984	
	MOVABLE FURNISHINGS							
	Excluded							
	FURNISHINGS				2,623,550		2,751,534	1.30%
F10	**SPECIAL CONSTRUCTION**							
	SPECIAL STRUCTURES							
	Not required							
	OTHER SPECIAL							
	Not required							
	RECORDING INSTRUMENTATION							
	Not required							
	BUILDING AUTOMATION							
	Not required							
	OTHER SPECIAL CONTROLS							
	Not required							
	SPECIAL CONSTRUCTION							
F20	**SELECTIVE BUILDING**							
	BUILDING DEMOLITION							
	Not required							
	HAZARDOUS COMPONENTS							
	Not required							
	SELECTIVE BUILDING							
G	**BUILDING SITE WORK**							
	Not included							
	BUILDING SITE WORK							
	TOTAL DIRECT COSTS w/GC				202,582,564		234,703,991	100.00%