Green Projects Entry

Ben Franklin Elementary School (o)

Section 1 - Project Overview Information Part 1

Project name:	Ben Franklin Elementary School (o)
Project owner:	Lake Washington School District
Project address:	12434 Northeast 60th Street Kirkland, WA 98033

Section 2 - Project Overview Information Part 2

Project completion date:	8/2005 *(m/y) format*
Project Site:	Previously Developed
Project type:	K-12 education
Project site context/setting:	Suburban
Other Building description:	New (100% new)
Lot size:	9.70 acres
Building gross floor area:	56792 ft2
BOMA floor area method used?:	no
Number of permanent occupants:	483
Number of visitors:	200
Occupants (hours/week/occupant):	38
Visitors (hours/week/visitor):	20
Total project cost:	$9,857,000

Section 3 - Project Overview General Description

General description: Learning is about creating connections. That's one reason why the new 56,000-square-foot Ben Franklin Elementary School was designed to connect students directly with the environment in which they live.

The new public school replaces an existing facility on a narrow 10-acre site that is oriented north-south. The surrounding residential neighborhood is interlaced with equestrian trails, horse paddocks and forested lands, including a mature stand of douglas fir that covers the northern third of the property. This rich natural setting and a requirement to maintain operation of the existing school during construction led to new facility's location at the center of the site, embracing the woods. Inside, the school's 450 students in grades K-6 are distributed within small learning communities formed by clusters of four naturally ventilated and daylit classrooms around a multi-purpose activity area. Stacked within two-story wings that extend towards the woods, these communities are integrally linked with views and access to nature beyond.

A proactive initiative by the school district that anticipated forthcoming legislation to mandate sustainable practices at the state's publicly funded schools, this high performance facility provides the district with an exemplary model for future development. As such, the new school expands learning beyond the classroom by connecting the district's educational pedagogy with environmental sustainability at every level.

Section 4 - Top Ten Measures

Top Ten Measure 1: Sustainable Design Intent & Innovation

Key environmental aspects: Ben Franklin is a fully integrated design. The sustainable concepts which distinguish this project are: environmental learning through site connections and 100% natural ventilation and daylighting for all learning spaces.

Environmental Connections: The school is designed to preserve and harness the environment as learning opportunity. The large wooded area along the north end of school's site is recognized as a valued community asset. Creating connections with this rich natural environment became a primary goal in the design process. Two-story classroom wings reach like fingers toward the woods and visually connect students with nature. Between, courtyards landscaped with native plants and enhanced with integrated art work, serve as outdoor classrooms and feature an intermittent stream fed by roof runoff. Gathering areas for outdoor classes have been located within the landscaping.

Natural ventilation and Daylighting: Understanding the profound impact of daylight and indoor air quality on student performance, the design maximizes building performance in these areas. Through rigorous daylight and thermal modeling, the goal of 100% natural ventilation and daylight in all teaching spaces met expectations and in doing achieved exemplary energy performance by using only 16,405 BTU/sf.yr. Baseline data from the old school will provide valuable data in a structured POE planned over the next year aimed to validate performance results.

Top Ten Measure 2: Regional/Community Design & Connectivity

Regional/Community Design: Community workshops were used to identify the needs and desires of the District, City, students, parents, and neighbors. The forested area at the northern portion of the site was identified as a community asset. As a result, the design of the school focuses on integrating and highlighting the building's relationship to the forest for both learning and recreation. Connections from both the classrooms and play areas to this naturalized environment are consistently maintained. The school building is shifted to the east to allow both visual and physical connections from the public street to the forest beyond, inviting the neighborhood to utilize all outdoor amenities of the site.

In addition, the site design balances the academic needs of the school with the recreational needs of the neighborhood. Partnering with City Parks Department created passive recreational improvements within the forested area and a multi-sport play field for shared community use.

The parking area is configured to accommodate only daily users (staff and volunteers). Twice daily parent pick-up and drop-off is accommodated by double one-way drive lanes within the parking lot. Large school events utilize the bus loop and paved play areas as overflow parking eliminating the need for oversized parking lots found at many schools.

Metrics: Percent of building population using transit options other than the single occupancy vehicle: 85% Number of parking spaces per person: 0.13

Use other transport options:	85%
Parking spaces per person:	0.13

Top Ten Measure 3: Land Use & Site Ecology

Site ecology:

Realizing that each student has the potential to share their environmental ethic with the community at large, the educational program of this site not only celebrates current sustainable building practices, but also focuses on inspiring and educating generations of student toward more sustainable patterns.

The two central courtyards provide structured outdoor learning environments, exposing students to elements of our region's unique hydrologic process and direct connections to the site's native forested ecosystem. The functional ecosystem of the southern courtyard makes natural processes visible on a day-to-day basis. This outdoor environment provides educators with a 3-dimensional, 'hands-in-the-dirt' laboratory fostering understanding through observation. Highlighting subtle environmental variations in sun, wind, rain and shadows, the integration of building, courtyard and sculptural focal point provides a lens through which visitors of all ages can view the intricate workings of the environment in which they live.

The continued use of the previously developed site and the multi-story design of the new facility have resulted in no net increase in the impervious surface area. Joint use of site, combining the resources of the City Parks Department and the School District to incorporate shared community amenities has reduced impacts to other undisturbed sites in the region. The new building was constructed atop an area previously occupied by playfields. New site amenities such as playfields, playgrounds, parking, and bus circulation were located on the former building pad and/or paved portions of the site.

Top Ten Measure 4: Bioclimatic Design

Bioclimatic design:

Providing balanced daylight and implementing natural ventilation strategies resulted in an articulated building footprint and roof form allowing all spaces to benefit from exposure to light and air. In addition, the buildings two courtyards intimately connect the students and teachers with the local ecosystems by drawing in the surrounding environment.

Daylighting during the winter season is relatively easy with the predominantly overcast sky. Direct sun exists primarily in the summer months when it is high in the sky and easy to control. Major glazing and roof slopes are oriented either to north or south to maximize and control natural daylight and views. To reduce the effects of solar heat gain, significant overhangs and sunshades on the south elevations have been incorporated. The result minimizes glare while increasing diffuse light into the learning areas.

With maximum temperatures ranging from 45 to 75 °F and 36+" of rainfall a year, the Pacific Northwest climate allows for a relatively permeable and articulated structure. Outdoor temperature and humidity levels from late spring through early fall are generally within the acceptable limits of indoor comfort conditions as prescribed by ASHRAE, creating an ideal opportunity to provide natural ventilation and passive cooling. (see Light and Air)

Top Ten Measure 5: Light & Air

Light & Air:

Air: All learning areas will be naturally ventilated without the use of air handling equipment or supplemental fans. Classrooms contain operable windows and ventilation chimneys to generate a natural stack effect resulting in ten air changes an hour, providing an exemplary indoor air quality without energy consumption. All rooms have

been modeled for thermal performance using computer simulation. USGBC LEED Boundary Comfort Parameters set the benchmark for acceptable comfort levels. Operable windows located throughout allow for individual control of the environment. In 80% of the building, required minimum ventilation will be achieved through a system of perimeter louvers located behind the heating units. CO2 sensors and occupancy sensors automatically adjust louvers to control ventilation and conserve energy. Natural convection will draw outside air through the lower louvers and exhaust through the thermal chimneys. At the limited spaces with forced air ventilation (i.e. gym and commons) no duct liners have been used in the supply ducts.

Light: Extensive glazing continually connects the users with the outdoors. The spaces are oriented east/west with glazing facing north/south to control and maximize the natural daylight within the building. Daylight modeling confirmed the appropriate configuration of windows and the extent of shading devices to control glare and maintain diffuse balanced daylight into all learning areas while providing carefully planned lower view windows.

Percent of building area that is daylit:	67%
Percent of building that can be ventilated or cooled with operable windows :	79%

Top Ten Measure 6: Water Cycle

Water Cycle:

Low impact development (L.I.D.), "rain-garden", strategies were used to collect stormwater on-site rather than piping it away. This is the first project within the City to utilize this innovative approach. Rainwater is collected and visibly sheets off the butterfly roofs and collects in point-source bio-retention cells. The planted stormwater collection/management system maximizes groundwater recharge, water quality filtration, evapo-transpiration and minimizes discharge rates.

Two landscaped courtyards serve as outdoor classrooms and highlight Puget Sound's unique hydrologic cycle through the use of sculptural art pieces and an intermittent stream that are fueled by runoff.

Site specific, native, and drought tolerant plantings are used throughout and require no permanent irrigation. The playfield is operated and maintained by the Parks Department. Tightly specified controller scheduling conserves more than 1.6 million gallons per year compared to conventional operational procedures. Irrigation water use is included in the metrics analysis.

Plumbing fixtures are low-flow and low-flush, to conserve the use of treated potable water. The use of waterfree urinals throughout the building is a critical component of the water conservation strategy, saving an estimated 60,000 gallons of potable water per year.

Precipitation managed on site:	34%
Total water used indoors:	280000 gal/yr
Total water used outdoors:	910000 gal/yr
Percent of total water from reclaimed sources:	0%
Percent wastewater reused on-site:	0%

Calculated annual potable water use: 21 gal/sf/yr

Top Ten Measure 7: Energy Flows & Energy Future

Energy description:

The primary and fundamental goal of the Ben Franklin Elementary School design team was to identify and create synergies between consultants, ensuring that all elements of the building work together to respond to seasonal climate changes and occupancies. Implementing the concept of year-round natural ventilation combined with natural daylighting, and the elimination of mechanical comfort cooling required close coordination of all disciplines and users. Thermal chimneys create a stack effect in the building, drawing fresh air through low-level perimeter windows and louvers, and then venting at high level, using the concept of thermal buoyancy and pressure differentials. Extensive computational analysis was performed to perfect the geometry of openings through each classroom. Whole-building natural ventilation design techniques, including building orientation, windows, shading, construction materials, daylighting, and ventilation openings were employed to allow for passive cooling throughout the building during occupied seasons. In heating mode, the air passes over fin-tube hot water heating elements located at the perimeter louvers, before being introduced into the classroom spaces.

Occupancy sensors and automatic dimming controls are installed on lighting fixtures in all classrooms. Daylighting models of the classrooms, activity areas, library, gym and commons were analyzed to ensure that the spaces met optimal design criteria and could achieve the 2% of outside illumination baseline. Automatic dimming controls adjust light levels in the classrooms to maximize the energy efficiency benefit of the natural light. Daylight harvesting is expected to reduce lighting energy usage by 25% in these areas.

The building systems were designed to reduce reliance on any energy source, including fossil fuels, through improvements beyond code requirements for insulation and lighting levels, deletion of mechanical comfort cooling, daylighting, year-round natural ventilation, lighting controls, and the use of high efficiency equipment such as condensing boilers that serve perimeter hydronic convection heating units. The building skin provides a high performance-building envelope. Twenty percent greater insulation value, R-38, is used on the roof. Glazing performance equals U=0.29 SHGC=0.38 The building, which has all regularly occupied spaces on the perimeter, would continue to be functional during regular school hours, even in the case of a blackout.

Performance Rating

EPA	93
HERS	
Percent total energy savings	25

	Base Case	Design Case
Total energy (Btu/sf/yr)	21724	16405
Electricity (Btu/sf/yr)	13771	10082
Natural gas (Btu/sf/yr)	7953	6323
Other: (Btu/sf/yr)		
Heating (Btu/sf/yr)	8271	5228
Cooling (Btu/sf/yr)	1352	694
Cooling capacity (sf/ton)	464	18931
Lighting load connected (W/sf)	1.35	1.3
Lighting load after controls (W/sf)		1
Plug load (W/sf)		0.4
Peak electricity demand (W/sf)	4	1.1
Percent on-site renewable energy (%)		0

Percent grid-supplied renewable energy (%)	0

Supplemental Narrative

Modeling methodology: Trace 700 was used to perform the energy simulation. In all, five different cases were modeled in detail, comparing a variety of HVAC, lighting and envelope parameters. ASHRAE 90.1 was used as the basis for the comparative analysis; however, modifications were made to ensure that all cases were compliant with the Washington State Energy Code, as well as the requirements for Washington State General Administration's Guidelines for Energy Life-Cycle Cost Analysis (ELCCA). All state-funded projects are mandated by law to submit an ELCCA comparing different building systems prior to applying for permit. The baseline building systems use GA-mandated prescriptive values, which are already better than code minimum. Our simulations demonstrated 25% savings beyond the prescriptive values, and it is expected that when compared to minimum code values for equipment efficiencies, insulation, lighting power densities and lighting controls, an additional 10% savings would be observed.

Top Ten Measure 8: Materials & Construction

Materials description:

The primary selection criteria for any public school project are durability and maintainability, while the impact of the materials on the indoor environmental quality for children is becoming ever more significant part of the selection criteria. Durable, non-toxic, low-impact materials have been implemented throughout the project including low VOC paint, rubber resilient flooring; wool tackable wall coverings; retro-plated concrete floors; ground-face concrete block; cement board siding; and recycled glass cullet. In many cases the materials utilized were able to meet all three criteria. For example, the retro-plated concrete floor finish provides the school with an extremely durable finish (3x harder than normal concrete); a surface that requires only hot-mopping for cleaning (eliminating the need for chemical or high pH detergents); and improves indoor air quality by completely doing away with applied adhesives and surfaces for dust and mold to collect. The wool wall covering, 100% renewable material, offers a warm, abuse resistant material that serves the need of both tackable surface and acoustic surface, critical in the indoor environmental quality of any school. Where possible, the use of interior finish materials has been limited to the essential. Materials were chosen that could contribute to multiple factors like acoustic absorption, light reflectance, durability, and comfort. Applied materials that did not directly benefit the performance of the building were eliminated.

Construction waste was sorted and followed the advantageous practice of recycling encouraged and well supported in this region.

Top Ten Measure 9: Long Life, Loose Fit

Long life, loose fit:

The school building life cycle is planned for a minimum of 40 years based on State funding requirements. Through community partnerships and outreach the facility and site is available and being used well after the school hours, on the weekends and during summer months. The planning process identified the library, gym, and commons as spaces heavily used by the public. These spaces are located near the entry for easy after-hours use.

New school planning often is faced with the need to address ever changing educational delivery models. Franklin implements shared learning areas as flexible, alternative teaching areas. The cluster arrangement provides opportunities for a variety of grade configurations and teaching models while grouping teachers and students in small learning communities.

To reduce the risk of over-building, the District requires the planning for four portable buildings on each site. This policy contributes to overall flexibility by allowing the District to accommodate fluctuation in student enrollment. Too often school buildings are demolished or under utilized because of changes in demographics.

Mechanical systems were designed to avoid unnecessary redundancy. Instead of 'doubling up' on equipment to ensure complete backups, or relying on large safety factors, the ASHRAE design criteria were used for the heating systems. Each condensing boiler was sized for 60% of the total capacity, rather than 100%.

Top Ten Measure 10: Collective Wisdom & Feedback Loops

Collective Wisdom & Feedback Loops: School Districts are charged with wise spending of their constituents' resources. The balance must be struck between what the District's know is the responsible action and the public perception. Progressive thought is often tempered by the status quo. Recognizing that each building, client, and site has particular requirements was the first step to achieving the right balance of high performance features. Schools in particular have many needs that are unique to the building type. High performance strategies were established and agreed to by all individuals involved in the design and future maintenance and operations of the building. Ultimately this integrated process resulted in systems that work together and are fundamental to the building performance. In addition, support from other public entities was essential to the success of the project. Local and State agencies were receptive to the new approaches and rewarded the progressive goals of the district.

The School District is committed Post Occupancy Evaluations to understand the effects of high performance buildings on student test results, staff retention, absenteeism, energy savings and true total cost of ownership. A comparison with several other "conventionally" built schools following similar programmatic guidelines recently constructed in the same School District will yield important data to help guide the future school construction for this District and others in the State and region.

Section 5 - Project Economics

Finance: The project received funding of $1.20/sf, $61,000 total, from Puget Sound Energy upon presentation of energy modeling results that demonstrated more than 25% savings. Partnership with the City Parks and Recreation Department provided $175,000 of funding to improve community used site features such as the playfield and restoration of the forested area.

Cost and payback analysis: The building was designed to come in on the same budget as that of a conventional building. Cost trade-offs were made by investing in the structure, building form and architecture, while reducing the size and amount of mechanical equipment. The school is state-funded, and therefore, the design team was required to perform a detailed comparative analysis of several building system options, in the form of an Energy Life-Cycle Cost Analysis (ELCCA). The ELCCA undertook a review of HVAC options with varying system components and first costs to evaluate the best option over a 30-year life span. The selected integrated building design demonstrated lower annual energy consumption than the other options, which included electric heat pumps, VAV with hydronic heating and an air-cooled chiller, and natural/displacement ventilation with minimum comfort cooling. The capital costs of the four HVAC systems varied within a range of approximately $300,000, with the selected system at the mid-range of first costs, lower than the mechanically cooled systems in terms of replacement costs within the 30-year time frame, lower or equivalent for maintenance and repairs, and significantly lower in energy costs. After trade-offs between HVAC and envelope systems were taken into account, the 30-year life cycle cost of the selected design was demonstrated to be the most cost-effective option.

Section 6 - Process and Results

PreDesign:	•Anticipating local, regional and eventually national mandates for more sustainable buildings, the School District proactively pursued "green" design to better understand the effects on school buildings and district wide policies. •Recognizing the benefits to learning by providing access to natural light, views, and fresh air became a focus for the whole team and helped solidify the goals of the project. •Specific sustainable goals were determined in an Eco-Charrette at the beginning of design. All individuals involved in the design and future maintenance and operations of the building participated in and contributed to this initial exercise. The results guided the design team and help reinforce decisions with the client group during the entire process.
Design:	•Early and continued dialogue with the jurisdiction allowed the design team to articulate and clarify progressive storm water management methods for the site, thereby alleviating concerns and facilitating approval of the low impact development strategies proposed. •Natural ventilation computer modeling gave the design team clear, precise data to support the design approach and detailed data to help the School District understand the expected performance of the building. •Large-scale daylighting models were tested to refine natural daylighting strategies in the Classrooms, Commons, Gymnasium, and Library. •Close collaboration with a local artist has created a sculptural art piece for one of the courtyards expressing the importance of rain in our area. The multi-faceted basaltic sculpture demonstrates the effects of rain in a variety of ways, including use of a roof scupper, a polished dew-collecting surface, and three fountains that are activated by rain leaders.
Construction Process:	•As a publicly bid project education was a large part of both the specification and bidding process. Sustainable strategies needed to be clearly explained. Uncertainty with systems and procurement risk leading to higher costs and hidden contingencies. Discussions of sustainable features and systems were presented during a pre-bid conference to ensure foreknowledge and reduce surprises.
Operations/maintenance:	
Commissioning:	
Measurement & verification/ post-occupancy evaluation:	•The School District is keenly aware of the value of Post Occupancy Evaluation and established a 'Control' project for detailed analysis. Comparison with other schools recently designed and built following conventional practices will allow the district to gather empirical and anecdotal evidence on sustainable design.
Rating System Name:	See below under credits
Version:	
Rating Date:	
Score or rating level:	
Credits:	Washington Sustainable Schools Protocol Program: Using the preliminary scoring system the

project would have achieved a minimum score of 50 points, exceeding the minimum threshold of 35 points.

Sections 7: Visuals

Exhibit A

01.Exterior_650.jpg

Image has been scaled down. Click it to view actual size...

Description: West Elevation of Classroom Cluster

Exhibit B

02.Site-Context-Plan_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Site/Context Plan

Exhibit C

03.Floor-Plan_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Floor Plan

Exhibit D

04.Activity-Classroom_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Classroom and Activity Area connection to woods

Exhibit E

05.Classroom-Section_650.jpg

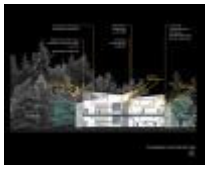

Image has been scaled down. Click it to view actual size...

Description: Section of Classroom Cluster

Exhibit F

06.Exterior_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Classroom Clusters

Exhibit G

07.Gymnaisum_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Gym and Commons

Exhibit H

08.Comm-Gym-Lib-Section_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Section of Commons, Gym, Library

Exhibit I

09.Library_650.jpg

Image has been scaled down. Click it to view actual size...

Description: Library

Exhibit J

10.Exterior_650.jpg

Image has been scaled down. Click it to view actual size...

Description: South Outdoor Learning Courtyard