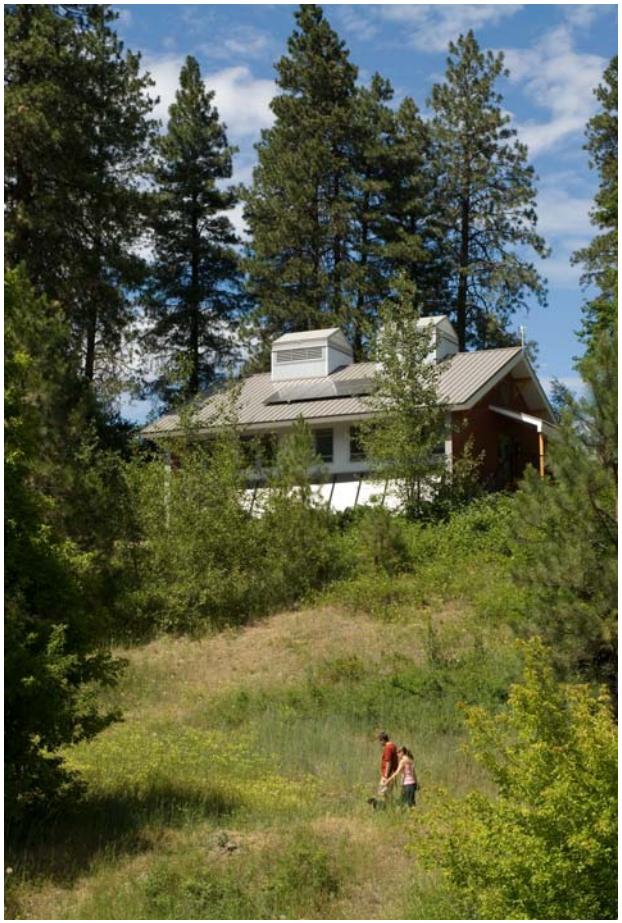


Barn Beach Reserve

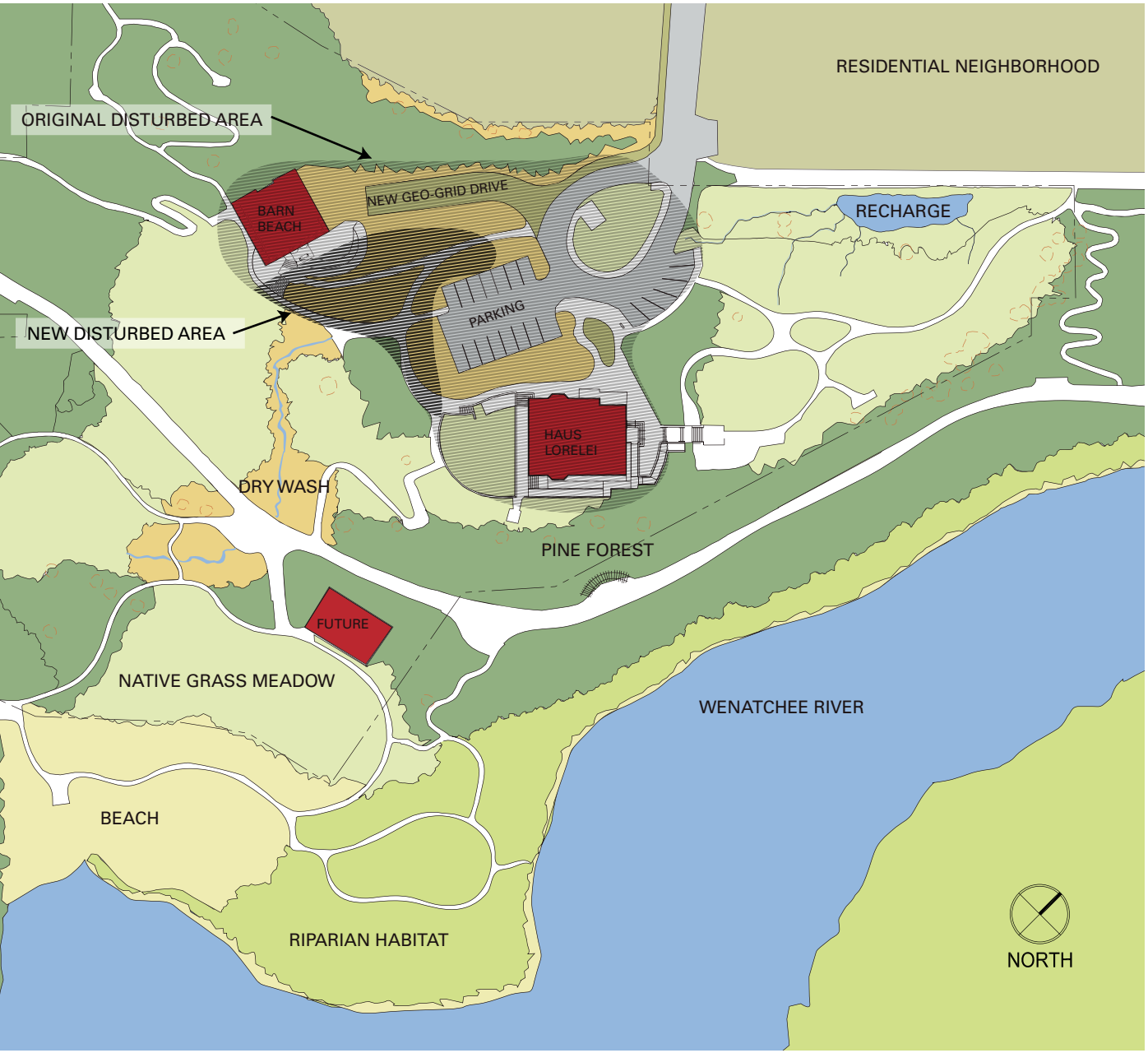
Leavenworth, Washington

Located on a scenic 5.5 acre greenbelt bordering the Wenatchee River, the Barn Beach Reserve's mission is to "celebrate, promote, and conserve the environmental, artistic, and cultural heritage of the greater Wenatchee River Valley through educational programming and stewardship."

A community-based master planning process identified site restoration, interpretation of natural and cultural history, and minimal environmental impact as primary goals. The Master Plan lays out habitat restoration areas and an accessible interpretive path system based on existing trails. New impervious surface is minimized by parking on an existing tennis court and building on the footprint of, or re-using, existing structures.

The Education Building, also known as "The Barn", was constructed on the foundation of a 1960's daylight basement home after a local carpenter salvaged much of the original structure. Envisioned, designed, and constructed as a learning place and a teaching tool, the design team integrated building form and systems into an elegant and legible response to this specific climate, location, and use.

Abundant solar energy is collected in two systems, one to heat the building and another to provide electricity. A simple convection ventilation system operates in mild weather. In extremes, heat recovery ventilation provides high air quality for occupancy that varies from a few people to as many as 100. Permanent signage that identifies and explains sustainable elements is integrated into the Reserve's educational programs.



PLANET

Ecology Based Land Use

Goal & Metric The Reserve intends to use the site as an ecological teaching tool. To achieve this goal, the design team planned to limit disturbance to the 25% of the site already most impacted and restore the remaining 75% of the site to natural habitat.

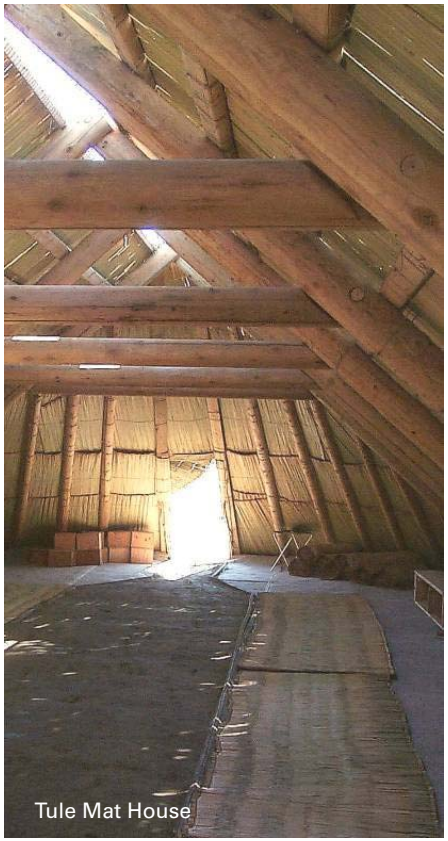
Concept Instead of adding buildings to accommodate the planned programs of the partner agencies, a focused remodel of the existing residence provided needed exhibit and office space. A larger multi-use space was required, so the Education Building was constructed on the foundations of an existing house. An existing asphalt tennis court was overlaid to serve as the parking lot. An existing impervious driveway was replaced with a Grasspave® lane for fire truck access to the Education Building.

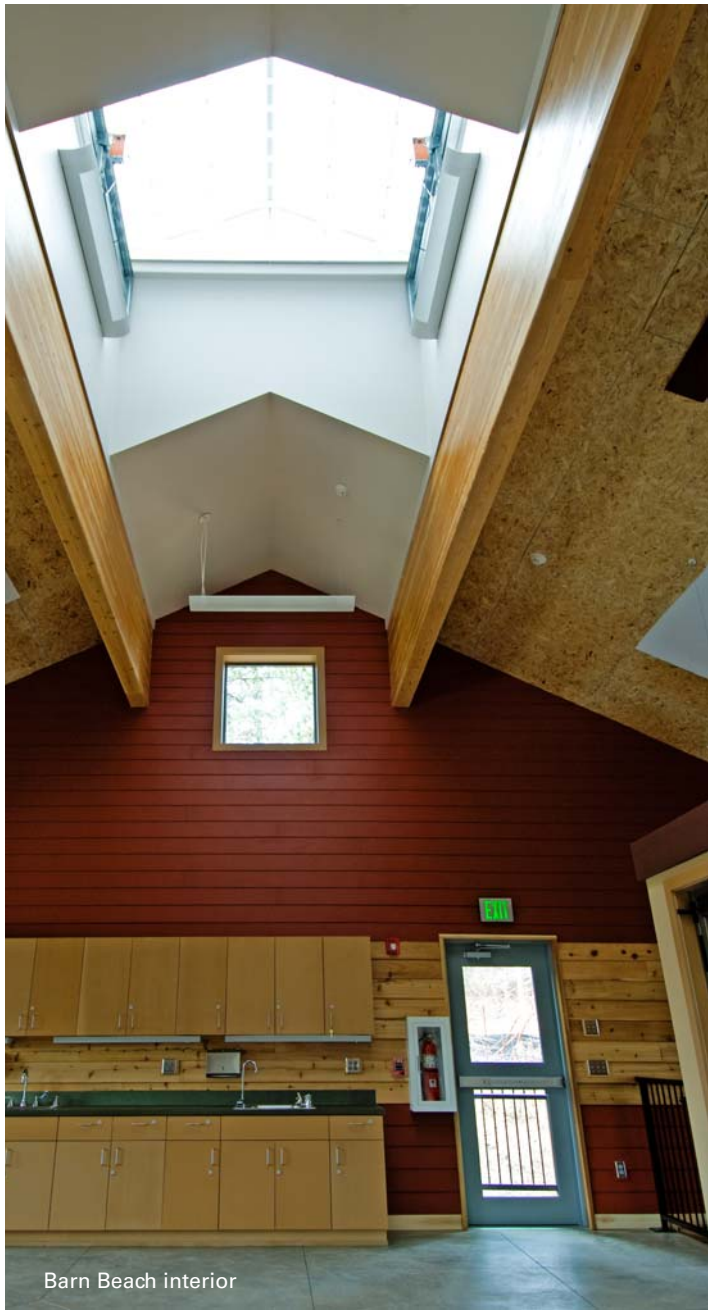
Validation Area take-offs showed that the disturbed area was not increased. A local horticulturist was retained to develop a re-vegetation plan including identification of appropriate native plant species.

Refinement Drive layouts were modified to accommodate fire truck requirements and to enhance traffic flow. The slight increase in asphalt area was more than offset by adding Grasspave® at the fire lane and removing a garage.

Results

- Impacted area at project start: 49,210 SF, 20.5% of site
- Impacted area at project completion: 58,900SF, 24.58% of site
- Impervious area at project start: 40,050SF, 16.7% % of site
- Impervious area at project completion: 39880 SF, 16.65 % of site


Tule Mat House


Barn Beach interior

PEOPLE

Collective Wisdom and Feedback

Goal & Metric The design team consciously decided to learn from historic precedents. Observation and research into indigenous and vernacular forms leads to design evolution, experimentation, and learning. Maintain healthy conditions and comfort by adapting effective indigenous and vernacular principles.

Concept Prior to the age of cheap energy, regional wisdom developed strategies to cope with climate. Indigenous Americans of the region inhabited tule mat lodges, also known as extended teepees. Built to accommodate multiple families and community gatherings, the lodges were constructed with a long open slot between double ridge beams. The slot provided ventilation and daylight. Early settlers built barns, often with picturesque and effective venting cupolas. These strategies informed the Education Building. Large vents in the cupolas are opened to create convection flow of air through open windows to effectively ventilate and cool the building in all but extreme conditions. The cupolas are topped with skylights to enhance daylighting.

Validation The cost of ventilation air flow modeling is high relative to the project value, so ventilation openings were sized based on experience with previous projects.

Refinement The original design-featured a continuous roof monitor with clerestory windows and louvered ventilation openings. To reduce construction cost, the continuous monitor was deleted in favor of the sky lit venting cupolas.

Results Opening the windows and the high vents results in rapid drop in CO_2 levels as noted by observing the CO_2 meter. Airflow through the building is not excessive, so comfort is maintained.

Interior without lights

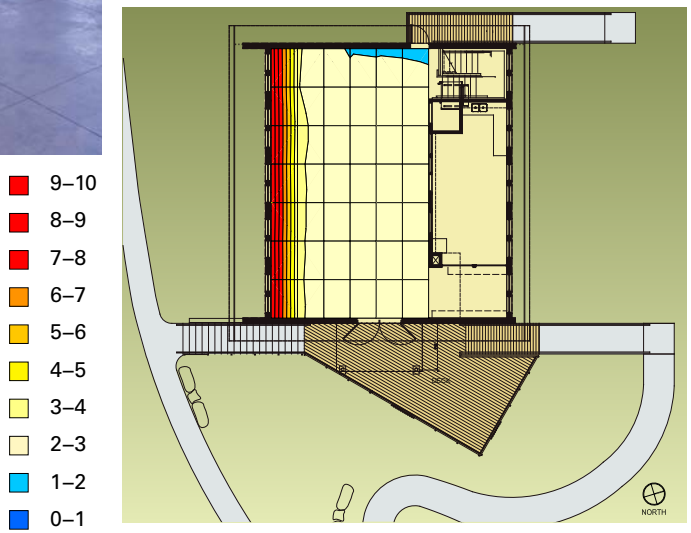
PLANET

Energy Indepence: Efficiency

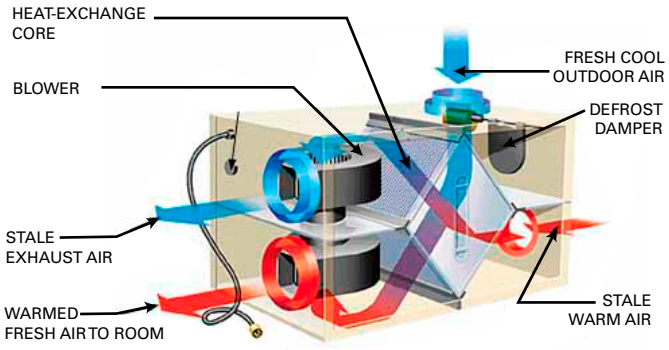
Goal & Metric Minimize energy demand by effective building and system design. Reduce energy demand by 40%.

Concept Use multiple strategies to address all aspects of energy demand:

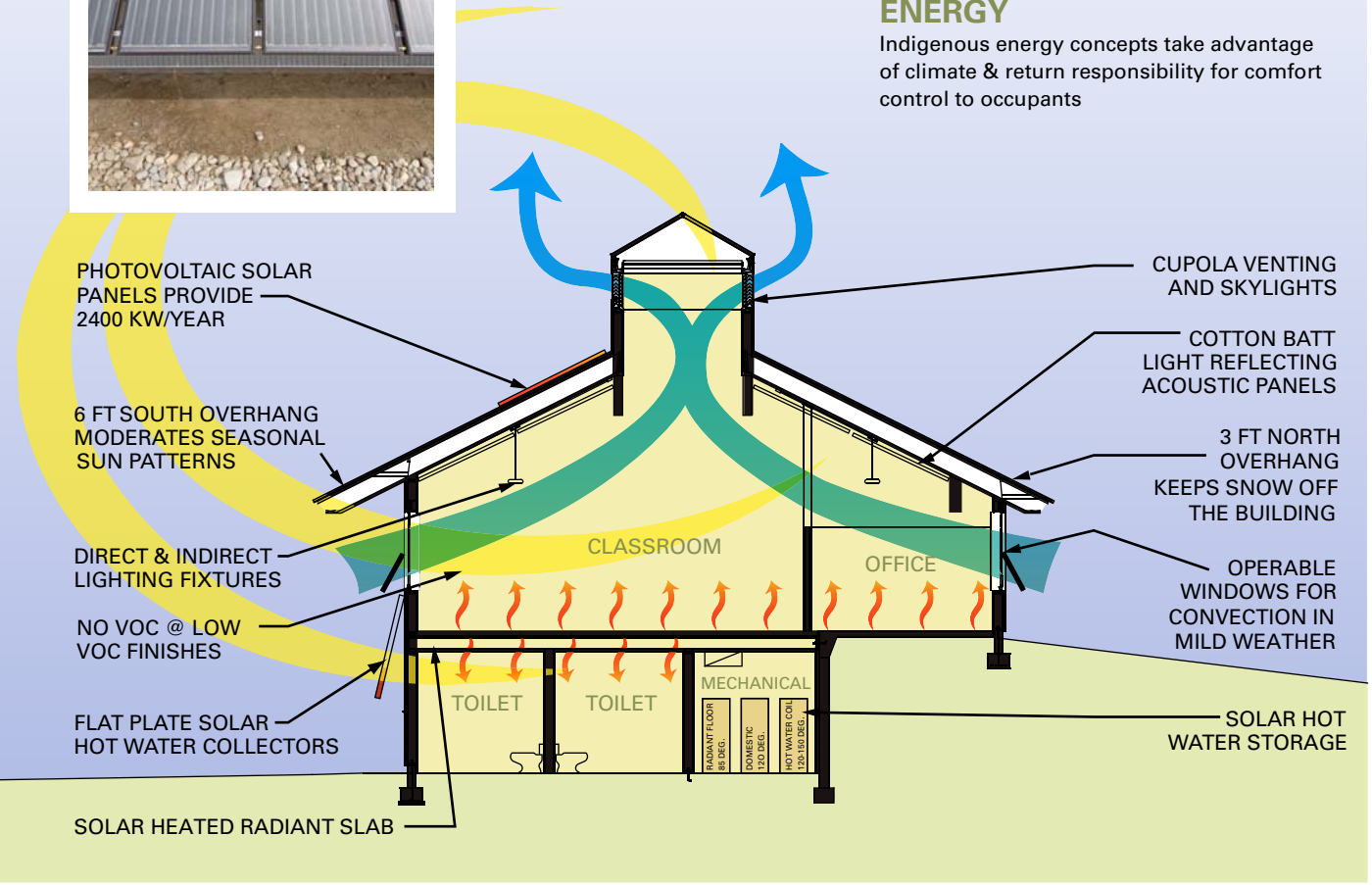
- Daylighting to reduce electric lighting requirements
- Superior insulation—R-26 in the exterior walls, R-49 in the roof—reduces heating and cooling loads.
- Passive solar control—few windows on East & West, 6' overhang on the South, which lets in winter sun, blocks summer sun.
- With the owner's concurrence, the cooling system was deliberately undersized to provide partial cooling while keeping energy use low.
- Heat Recovery Ventilation captures and uses the heat generated by the people when higher numbers of building occupants increases ventilation requirements.



Daylighting Lab diagram: Skylight with brown ceiling



Heat Recovery Ventilation Diagram



PLANET

Energy Indepence: Efficiency continued

Validation Daylighting lab studies indicate greater than 2% daylight factor in critical task areas.

In the energy model, as-designed usage is 13.72 kW/SF/yr compared to Washington State Energy Code (WSEC) base case usage of 21.30 kW/SF/yr, a 36% reduction in demand.

Refinement The original continuous roof monitor design was changed to skylight cupolas. The lighting design lab models showed skylights were more effective than the monitor, so the change was made to meet budget while keeping the benefits of daylighting. At the contractor's request, indirect evaporative cooling was changed to an undersized heat pump which tempers the ventilation air, but doesn't provide true cooling.

Results Electric lights are rarely used in daylight hours. The Reserve staff reports the occupants are pleased with the light quality without electric lighting. A two ton cooling unit was installed instead of the calculated 5 ton unit. Actual energy use appears to validate the model as detailed in the section describing on-site generation. Total net energy use is based on part-year data extrapolated to be 50% of the WSEC baseline, meeting the 2030 Challenge interim goal for 2010.

Solar hot water and PV

PLANET

Energy Indepence: Solar

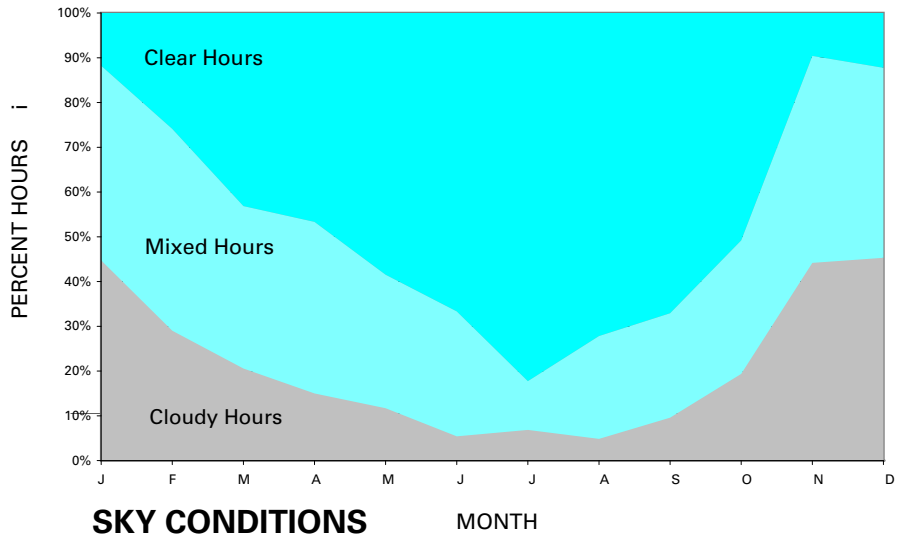
Goal & Metric Minimize energy use and energy cost by taking advantage of the area's abundant sunshine; After reducing energy demand, generate 20% of the buildings remaining energy requirements on site.

Concept On the south wall, angled to the winter sun, solar hot water collectors supply heat for radiant floor, domestic hot water and ventilation air heating. Three 150 gallon insulated tanks store the heated water and three heat exchangers allow the solar energy to be used at the appropriate temperature for each application. A grid-tied 2.4 kW array of photovoltaic collectors on the roof offset a portion of the building's electricity use.

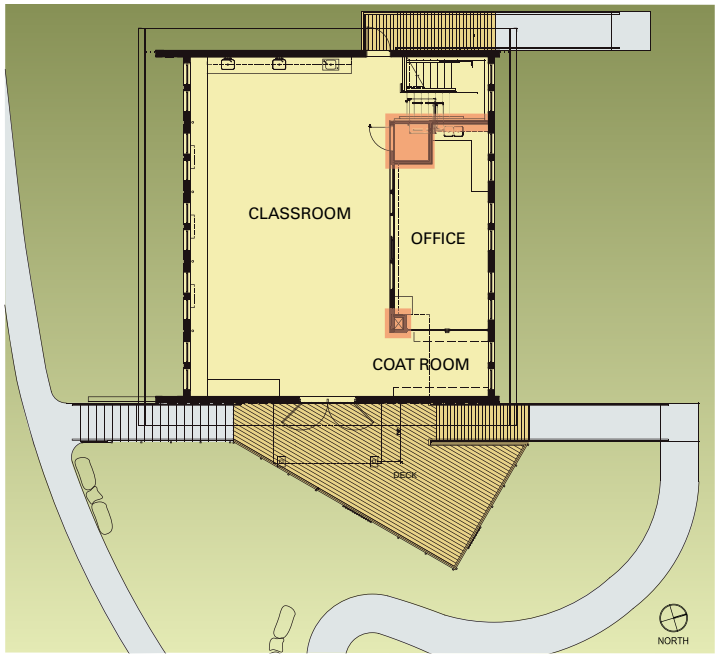
Validation Energy modeling showed that the solar hot water system would provide 2.45 kW/SF/yr, or almost 18% of the building energy demand, reducing energy use to an estimated 11.27 kW/SF/yr. The photovoltaic panels are anticipated to provide an additional 2500 kW, or a little over 5% of the building energy use.

Refinement The photovoltaic panel area was reduced from a proposed 5 kW system for budget reasons and concern over potential snow damage to the panels. The cupolas prevented locating the top of the panels at the ridge, which is ideal in snow areas.

Results Utility bills for the first six months of operation—July through December 2008—show total energy use of 18,995 kW. If we extrapolate to a full year (multiply by 2), energy use would be 11.51 kW/SF/yr. That is about 2% over the predicted value of 11.27 kW/SF/yr. The photovoltaic panels have been generating electricity since September, producing 786 kW in the last 4 months of 2008. Simple extrapolation would result in 2358 kW, or over 6% of the extrapolated energy use. Actual production will likely be higher, since the best sun months are not represented in the data sample.



Interior showing metal siding, OSB ceiling, cement plank siding, and cedar tack strip. The casework is clear finished, formaldehyde-free MDF.



Floor plan showing fixed walls in red

PROSPERITY

Durability and Adaptability

Goal & Metric A small non-profit organization, the Barn Beach Reserve needs to minimize the costs of operations and maintenance so that they can focus on their educational mission. Since the needs of the partner organizations may change over time, the owners will benefit from a building that has adaptable interior configurations.

Concept To reduce ongoing costs, durable, low maintenance exterior materials were incorporated for permanent interior finishes as well as exterior finishes. For adaptability, there are no interior bearing walls or columns. The stair and the lift are fixed points, so plumbing is in these walls or the exterior wall.

Refinement The East and West walls are wrapped in prefinished cement plank siding. The North and South walls have corrugated metal siding inside and out, the floor is sealed concrete, and the ceiling is OSB. Between 3 to 7 feet high, the interior surfaces of the East and West walls were changed to cedar, to accommodate pin attached display.

Results Durable, low maintenance interior finishes at the permanent interior walls.

Control panel

Venting cupola

PEOPLE

Collective Wisdom and Feedback

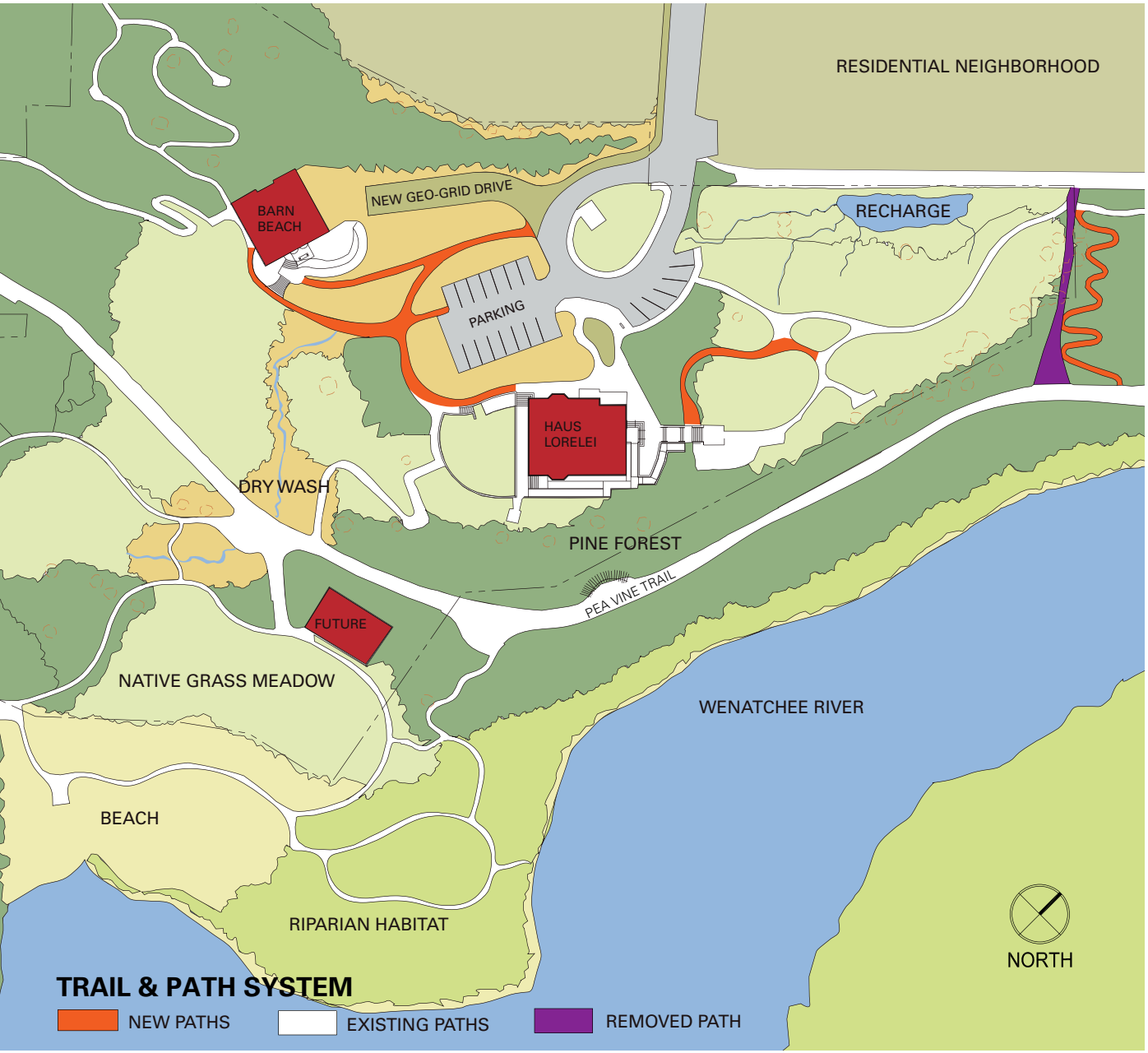
Goal & Metric Incorporate learning onto the building operation. Connect occupants to the environment. Teach that comfort depends on observing the environment, then responding appropriately. Building users actively control the systems.

Concept A collaborative dialogue between the design team and the building users began the educational process for Barn Beach Reserve. We discussed appropriate technology and the concept of "sailing the building" rather than a "set it and forget it" approach. The Reserve staff agreed that an automated building control system was not appropriate for their educational goals or for the size of the building. An accessible, manually operated environmental control system with clear instructions was determined to be the optimum choice.

Validation The engineers on the design team decided that the manual system would work, as long as the radiant heat system was on a thermostat that would be fail-safe to prevent freezing.

Refinement The building environmental controls were grouped together, labeled, and an instruction sign developed. The instructions indicate that when the CO_2 meter flashes or the room feels stuffy, staff either opens the windows and the cupola vents, or if conditions are extreme, they turn on the timed switch for the heat recovery ventilation system. Switchable, multi-speed ceiling fans were included to allow occupants to create a cooling air flow on very warm days.

Results There is a high level of reported occupant satisfaction with building comfort. The staff enthusiastically demonstrates and explains the systems to students and visitors.



PLANET

Ecology Based Land Use / Social Equity

Goal & Metric Universal access to the interpretive programs, including access to the ecologically important site zones is an important part of the Barn Beach programs. That goal appears to be in conflict with the desire to minimize site disturbance. The design team decided to use existing paths, adding pathways only as necessary for access, with a goal of adding path area equal to or less than 2% of the site area.

Concept The design team observed a network of formal and informal paths on the site. These provided access to the major ecological zones of the site: Riparian Edge, Upland Forest, and Native Grass Meadow. The primary path is a former railroad grade, called the Pea Vine, that was used to bring logs from a mill pond on the river up the riverbank to the town's sawmill . The building official agreed to accept small sized crushed rock as an accessible surface. Modification of the path grades and the gravel plus crushed rock surfacing make the Pea Vine an accessible path from the buildings to the riparian and beach zones while maintaining the pervious character of the original path.

Validation Surveyed topographic information was used to determine areas with slopes exceeding accessible grades and to lay out alternate pathways.

Refinement Further review of the grades resulted in additional switchbacks as the path rises through a swale at the northeast corner of the site

Results Universal access is provided to the ecologically important site zones
Area of trail before: 14,420 SF or 6% of site area
Area of trail after: 18,820 SF or 7.85% of site area

Completed design

Original design

PROSPERITY

Value and Wealth Creation

Goal & Metric Construct the building within the budget, maximizing the sustainable features and minimizing ongoing maintenance and operations costs. Complete the building and basic site work for under $300/sf (2007–2008).

Concept The original building design was based on a continuous roof monitor form, structured by four heavy timber trusses, with roof and walls of structural insulated panels (SIP). The local contractors didn't have familiarity with SIP construction, so they estimated the original design at almost 25% over the budget. The building structure was changed to more typical wood frame walls, truss-joist roof framing, and skylight-topped cupolas. The mixed-mode ventilation system, radiant heating based on solar hot water, and daylighting were retained.

Validation The revised cost estimates and construction contract amounts were slightly under budget.

Refinement The walls are constructed of 2x8 studs to allow for extra insulation and the depth of the truss-joist depth provided space to install R-49 insulation at the roof.

Results The project was delivered under budget, allowing the Reserve to purchase a 2.4 kW photovoltaic system to further reduce energy cost.

Barn Beach Reserve

Barn Beach Reserve

Barn Beach Reserve