Sustainable Design and Construction

Sustainable, integrated building practices for school campuses provide healthy, high performing learning environments for children, teachers and staff. There have been many studies done which conclusively verify that green buildings promote higher performance learning and working environments for their occupants. Green schools are tangible demonstrations for students of good stewardship of our communities and environment.

The phased transformation of the Highland Hall campus with the addition of new buildings presents opportunities to implement sustainable design, construction and maintenance practices which will bring rewards in the quality of education, community and the environment that are both measurable and beyond measurement. These projects offer a unique opportunity to create a campus which can truly achieve sustainability; and, that can be an example of green design, resource conservation and program innovation. The campus improvements and new building projects can be a model of sustainable practices which extend beyond physical improvements to creating a broader definition of sustainability as it applies to other dimensions of the school's community. The campus will become more than a facility in which learning takes place. The site and the buildings themselves will become teachers within the Waldorf curriculum.

Implementing sustainable standards throughout the new campus projects will tangibly demonstrate to each student the role which we play in shaping our environment. If our children learn literally how to better care for communities during these formative years, they will develop fundamental analytical skills preparing them to make a real contribution to their futures and that of the communities where they will live and work.

The following narratives describe how, at this schematic design phase, this level of sustainability can be achieved. As the site improvements and new buildings are to be phased over some period of years, these measures should be understood as the projection of what is now currently possible. New technologies will be become known and tools for refining integrated, sustainable design will be developed. Hence, these measures should be understood as a living document, to be revisited and refined over the course of subsequent phases.

Below is an outline of the some of the sustainable, integrated design measures incorporated in the Schematic Design Documents:

Site Planning

Managing stormwater run off by using the site's enhancing the natural topography to direct rainwater into bioswales constructed on the west areas of the site will address the current sheeting, northern rainwater run-off issues and remove oil residues and other impurities. Pervious pavement located below the Sciences Building and at the lower parking lot will act as a filtration media, directing runoff flow to percolate beneath the parking and absorbed within the site boundaries. Pavement in front of the new classroom buildings will be planted with grass allowing stormwater to filter through while still providing the needed fire access. Ambient heat will be reflected rather than absorbed and amplified by exterior surfaces.

- Stormwater Control and Quality Management: Bioswales; Pervious Concrete Parking; Grass Pavement
- Reduce the Heat Island Effect using High Alebdo Paving, High Solar Reflectance Surfaces; and, Cool or Green Roof Installations
- Exterior Lighting which restrain Nighttime Light Pollution

Water Efficiencies

In Southern California water conservation should no longer be an option for any facility. Multiple strategies will maximize the water efficiencies for Highland Hall Campus site improvements and within the new buildings.

- Reduce Potable Water Consumption for Irrigation: use native and draught resistant landscaping; install drip and moisture sensitive irrigation systems
- Cistern retention and grey water irrigation for the Sciences Building Green Roof
- Innovative Waste Water Use: Use of grey water for non-potable uses
- Reduce Sewage Conveyance using Indoor Potable Water: low-flow lavatories, low-flow showers, and occupant sensors can reduce water usage by more than 30% annually.

Energy Efficiencies

The new projects take multiple approaches to advanced energy usage design.

- Building Envelope Design for maximum efficiencies
- Straw Bale Wall Design for the new Gymnasium
- Passive Heating and Cooling Strategies
- Natural Ventilation
- Induced Stack Ventilation
- Displacement Ventilation Designs
- Modular Central Plant System
- Radiant Heating & Radiant Cooling for the Sciences Building
- High Efficiency Lighting Design: using innovative fixtures, occupancy and daylighting controls

Renewable Energy Generation

A substantial portion of the campus energy needs can be provided through multiple renewable energy resources.

- Reducing the Campus Carbon footprint of Greenhouse Gas (GHG) Emissions
- With Geothermal and Wind turbines, the Sciences Building will be self sufficient with no dependence on the supply grid
- Black Box Theater, Classrooms and Gymnasium receive some power needs from Photovoltaic and Aeroturbine installations
- Photovoltaic Installations: at new parking and on the roofs of the classrooms, gymnasium and Black Box theater
- Aeroturbines: on the site at the ridge above of the existing paved circle and on the grass roof of the Sciences Building
- Geothermal: adjacent to or beneath the new Sciences Building

Material and Resource Conservation

The projects will employ the best of practice in waste diversion, recycled and renewable materials content and progressive forest management.

- Construction Waste Diversion from Landfills
- Building Materials with Substantive Recycled and Rapidly Renewable Materials
- Wood Materials harvested from Sustainably Managed Forests

Indoor Environmental Quality

Architectural design will increase the outdoors air ventilation to contribute to healthy indoor air environments. The new projects include CO_2 monitors, pollutant source control, supply air filters and advanced displacement ventilation systems.

- Daylighting Design: daylight harvesting; balanced indirect, direct classroom lighting
- Indoor Air Quality Controls: low emitting materials; pollutant source controls; natural ventilation design
- Acoustic Performance Design: to reduce and control ambient, mechanical and exterior noise in classrooms
- Acoustic Performance Design created for Theater and Eurythmy spaces

Maintenance and Facility Management

High performance buildings can achieve their passive design goals best with the active assistance and guidance of their inhabitants.

- Train Facilities Personnel in operation and care of the high performance systems
- Train Students, Teachers, Staff and Administrators in the correct use of the new systems
- Implement programs to approach zero waste
- Implement Integrated Pest Management practices which do not use toxic chemicals
- Implement Facilities Maintenance and Cleaning practices which use non-toxic and / or Green Seal approved supplies

New Building High Performance Designs for Highland Hall

The following areas will to be analyzed and developed to create high performance solutions which provide for the campus needs and reduce GHG emissions.

- Climate-specific design
- Passive solar heating and cooling
- Natural daylighting
- Energy-efficient construction
- Energy-efficient appliances and lighting
- Radiant Heating and Cooling based on solar thermal and solar electric systems

Our Architectural and Engineering teams will evaluate these measures and take an aggressive lead in designing new buildings that reduce greenhouse gas emissions (GHG). The A/E team as part of the analysis will implement an integrated design team process sometimes referred to as the Whole Building Systems Analysis. Minimizing the building energy use through design is a collaborative process involving all disciplines to investigate energy efficiency measures which the end result is an optimum energy efficient design. Setting your target energy benchmark to meet the 2030 challenge is a starting point and energy modeling analysis should direct the design towards meeting the goal.

<u>Green Roofing</u>
Sciences Building

The Sciences Building is planned to comprise an accessible green roof planted with various sedums and a winding footpath from the east to west side. This exciting feature will serve as a unique teaching tool and provide numerous advantages including ecological, economical, psychological and aesthetic benefits.

Green roofs first date back to the Vikings but didn't appear in modern society until the 1960's in Germany. Green roofs, often called vegetated roofs or living roofs, serve as filter for rainwater and air, removing pollutants, CO_2, and heavy metals while reducing the amount of site stormwater runoff up to 75%. By using vegetation to cover the surface of roofs, heat island effect is greatly reduced and thermal mass is increased. By reducing the heat island effect and increasing the thermal mass, the heat transfer from the roof's surface to the building interior is minimized, therefore reducing the need for a cooling source contributing to the efforts to design these buildings "off the grid".

<u>Living Wall</u>
Theater

The living wall, located on the east side of the Blackbox Theater is a distinctive building feature that will provide superior sound absorption while naturally integrating the built structure into the natural environment. Additionally, the green wall offers many of the benefits of a green roof such as the filtration of volatile organic compounds (VOCs) produced by materials and car exhausts. It aides the reduction and filtration of stormwater runoff. This vegetated structure also provides a habitat for native animal life such as birds and insects.

Similar to the function of vegetated roofs, these walls shade and absorb heat before it enters the building facade to lower the building's heat island impact and energy load requirements. Vegetation used in the living walls will be selected specifically for this site to stabilize within the earth and then grow to maturity succinctly. The absorptive effects of the wall will work with the nearby bioswales as a piece of the new stormwater management measures.

<u>Pervious Concrete Parking</u>
Northern Parking Lot

This material is a low-tech site solution that has been in use since the expansion of the Roman Empire. Pervious concrete is recommended to replace the lower, northern parking area and for construction of the new parking area below the Sciences Building. This material is first known to have been employed by the Romans in the expansion of their empire. Pervious concrete has regained popularity in recent years, due to the advantages of reducing the costs associated with new developments of storm water management infrastructure. It functions as a storm water filtration system, reducing infrastructural costs; and, also has a high albedo which significantly reduces the heat island effect over that created by conventional asphalt paving.

The life expectancy of pervious concrete paving is comparable to that of regular concrete. Due to an inherent ability to adapt to temperature changes, pervious concrete applications which have been in place for over 20 years in temperate climates require less maintenance than conventional concrete paving.

Costs for pervious concrete paving are higher than for conventional asphalt or concrete parking pavements. The additional costs are due both to the increase in the volume of aggregate and cement with a deeper bed set and to the technical knowledge and additional time required for placement on the site.

<u>Straw Bale Wall Construction and Insulation</u>
Gymnasium

Straw has been used for centuries as an efficient, readily available building insulation material. The new Gymnasium siting and program function is ideally suited to utilizing this technology which has been adapted for use with contemporary building codes and seismic requirements. The exemplary insulation properties will allow us to design the building for optimum energy efficiency and passive heating and cooling.

<u>Photovoltaic Installations</u>
New Classrooms, Gymnasium and Black Box Theater

A substantive portion of the new campus energy needs will be met with an array of photovoltaic applications. The Black Box Theater roof will have a combination cool roofing membrane with integral photovoltaic panels. The new Classrooms and Eurythmy buildings will have a standing seam metal roof with integral photovoltaic panels. The new Gymnasium will have rooftop panels and additional vertical installations on the southern facade. There will be two freestanding arrays in the new parking areas—one across the northern side of the lower parking area and another across the northern side of the new parking below the new Sciences Building.

There are state and utility incentives available to offset the costs of purchase and installation of photovoltaic. Specific programs will be evaluated for use by Highland Hall during the design development phases.

<u>Aeroturbines</u>
Sciences Building & Site Installations

Aeroturbines are an excellent source of renewable energy for the Highland Hall campus. The turbines are more efficient that traditional windmill technology in capturing the energy created by wind and converting it to more useful forms. The purpose of the turbines for Highland Hall is to support the electrical needs for the Sciences Building. The turbines will be located on the green roof of the building and on highest elevation ride point adjacent to the playing field and at the terminus of the existing entry drive. The aeroturbines unique design consists of a helical rotor and airfoils housed within a 5' x 10' steel cage. These vertical aeroturbines do not require the presence of a predominant wind and work well with wind in any direction.

<u>Geothermal</u>
Sciences Building

Geothermal heating and cooling has been used since Roman times as a way of maintaining a constant, comfortable temperature in buildings by drilling into the earth's surface. These systems operate on a very simple premise; the ground, below the frost line, stays at approximately 50 °F (10 °C) year round and a water-source heat pump uses that available heat in the winter and puts heat back into the ground in the summer.

A common system consisting of polyethylene tubing, pumps, and fans connected to the wells utilizes water to heat and cool the building, which has no boiler, furnace, or even a gas meter. Water never leaves the tubes in the closed loop system, which transfers heat to and from the earth as needed to meet the building's cooling or heating needs. The heating, ventilating, and air conditioning systems contain no CFC-based refrigerants, HCFC's, or Halons.

Siting & Climate Responsive Design

All strategies incorporating natural daylight, wind, sun, etc. will be analyzed to create climate responsive designs during the design development phase. A climate response design uses the positive effects of the climate in lowering the energy use of a building. Passive strategies are beneficial to aggressively reduce energy use associated with air conditioning and artificial electrical lighting. Building materials will be selected to take advantage of a climate responsive design with the use of thermal mass to store thermal energy. This used in conjunction with passive strategies will provide further comfort conditions in the new buildings.

There are opportunities within the schematic designs for optimal daylight and solar utilization while minimizing unwanted solar heat gain to the interiors. Daylight harvesting will be analyzed for maximum results, using energy modeling and daylight modeling simulation tools. For example, south exposed clerestory and light monitor windows on the new gymnasium shall be designed with shade control to limit radiation in the warmer months while allowing passive heating in the winter months.

Building design will be modeled early in the design development process. Whole systems building energy modeling will be used to optimize the siting and massing. From this we will focus our design to incorporate passive heating and cooling, along with natural lighting.

Besides the economical benefits of energy efficient buildings, they contribute to increased student performance; teacher's morale and effectiveness; and, administrative staff productivity levels. Students will have the added benefit of studying in an environment for which they can learn tangible knowledge of energy conservation and can understand their personal role as contributors to the solution of over consumption.

Light

Natural light is free and studies have found that use of the appropriate amount of natural light in the classroom can make students happier, healthier and more productive. The use of natural light also reduces air conditioning loads by minimizing heat produced by artificial lighting, thereby providing energy savings. Daylighting occupancy sensors should be incorporated so that artificial lights calibrate only to compensate for the daylight available at any given time.

Shading & Overhangs

Reducing glare, shading windows, and minimizing the amount of direct sunlight and heat that reaches spaces will alleviate summer heat load on the heating, ventilation and air conditioning (HVAC) system.