MONTESSORI SCHOOL OF MAUI
GUIDELINES OF SUSTAINABILITY

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Provided to the
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Contains the Final Draft of the following:

MONTESSORI SCHOOL OF MAUI

GUIDELINES OF SUSTAINABILITY

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I. BACKGROUND

Montessori of Maui Inc. (MOMI), a not-for-profit school, has been educating children on Maui since 1978. The school has been operating at its current location since 1992. It serves approximately 194 children from 18 months to 14 years old. The school is located on the island of Maui and at an elevation of roughly 1500 ft on the northern slope of Haleakala. Situated about five miles from the North Shore, the nine-acre campus is also near the town center of Makawao.

The school is committed to integrating the built and natural environments with the curriculum. Therefore, we believe that it is necessary for our campus expansion to incorporate the conservation and preservation of natural resources and to move into a position of balance within the community. The school's expansion plan includes a multi-purpose facility, a middle school complex, additional classrooms, auxiliary buildings, and required parking. This expansion will enable the school to serve up to 270 students and to be available to the community as a meeting and event venue.

In the spring of 1996, a handful of people associated with MOMI met to discuss developing an outdoor learning environment on the school's campus. After several meetings, we decided to pursue the concept of a Living Classroom. A grant provided the seed money for the project. The committee, which was composed of board members, administrative staff and faculty, formulated the mission and purpose of the proposed project. The Earth Education Program and the Community Garden were developed as a result of those initial meetings.

In July of 2003, Professor Stephen Meder, of the University of Hawaii's School of Architecture, facilitated a Design Charette composed of MOMI staff and community volunteers. The purpose of the charette was to develop a set of Sustainable Design and Operational Guidelines to define the parameters of our sustainable campus expansion. The school received a grant from the Hawaii State Department of Business, Economy and Tourism to develop the guidelines and Rebuild America provided additional support.

The guidelines are meant to serve as a design template for MOMI, as well as for other schools that seek to integrate educational philosophy and sustainable design principles. We made the guidelines available during the preparation of MOMI's Proposed Site Plan and they are meant to guide the comprehensive Campus Design and Construction Plan. To the extent possible, all components and features of the campus will be working elements within the school's curriculum, providing the students with opportunities to learn about and experience the natural world and its systems. Ultimately, we believe that the students will respect and appreciate their environment in the same way that they respect and appreciate themselves and each other.

Our model is one of many and it has grown and changed with the community's interests and needs. Although our primary intent was to create an outdoor classroom that reflected the Montessori principle of Cosmic Education, the curriculum has expanded and the concept has outgrown our original vision. The MOMI community has discovered that extending the classroom into the outdoors gives new depth and meaning to student learning by expanding and enriching it through interaction with the natural environment. It is changing the way we relate to our campus, how we envision our campus expansion, and how we view our community as a whole.

II. PURPOSE OF THE SUSTAINABLE DESIGN and OPERATIONAL GUIDELINES

Montessori School of Maui (MOMI) is embarking on a campus expansion that will be largely defined by sustainable building guidelines. These guidelines will support the school's mission and curriculum, as well as provide a guiding template for the architects and engineers in the development of the MOMI campus. The purpose of the guidelines goes beyond the integration of the Montessori educational philosophy and the creation of a beautiful, high quality, and functional environment. We also plan to create a model campus in terms of sustainable design, materials and practices. These guidelines include specific qualitative and quantitative sustainability principles, as well as actionable design methods.

Our intent is to maximize the use of existing topography and trees to create a village of low-maintenance, non-toxic buildings and special-use areas, interconnected by paths and covered walkways. Buildings and outdoor areas will be situated to maximize benefits of existing contours and trees. The entire campus will be seen as a sustainable living classroom that integrates all areas of the curriculum.

Water catchment, storage, filtration, and re-usage will constitute a conspicuous feature in the form of cisterns, ponds, streams and water features. Landscaping will be indigenous, edible, fragrant, and functional. Extensive application of photovoltaics and solar water heating should result in net positive energy consumption.

Non-toxic, low-maintenance materials will be used as a rule. Buildings will be designed to maximize natural lighting and ventilation. Indoor-outdoor spaces will maximize the students' relationships to the natural environment. In addition to providing exposure to indigenous plants, this will increase the students' awareness of Hawaiian culture and history as it relates to this particular place.

To the extent possible, all components and features of the campus will be functional elements of the school's curriculum, providing students with opportunities to learn about and experience first hand their environment and their impact upon it. Ultimately, we hope that children will learn to respect and appreciate their environment in the same way they have learned to respect and appreciate themselves and each other.

III. DESIGN and OPERATIONAL GUIDELINES

The purpose of the Design and Operational Guidelines is to supply a platform of sustainable principles as a foundation and direction for future development on the MOMI campus. We also intend the guidelines to provide an operational template for the daily activities on the campus and, most importantly, to establish a working model through which the purpose and performance of the built environment can be positively integrated with the Montessori curriculum and its educational environment.

There are natural overlaps among the various Design and Operational Guideline topics. A reference note is placed at the beginning of related topics. For example, the topic heading:

Landscape and Exterior Design

REF. 2.1, 3.3

indicates that topic 1.5 Landscape and Exterior Design, is also related in strategy and application to 2.1 Overall Building Quality and Performance and 3.3 Water Conserving Landscaping.

Each topic in the guidelines makes specific design and operational recommendations, as well as considers the intent and impacts of each of the recommendations through the lenses of the following three scales:

MACRO

This is the perspective that measures the impacts and influences of each strategy at a scale well beyond the site. This would include ramifications at an island, state, regional and/or global level.

MESO

Meso typically means intermediate or middle. In ecological terms, it connotes the inclusion of mountains. In Hawaii, we can consider it to mean "from the ridge to the reef," or the *ahupua'a*. The meso perspective estimates the influences and impacts upstream and downstream of the site. For example, this scale includes the contiguity of ecosystems, and examines the influence of each strategy on neighboring communities.

MICRO

This is a more site-specific scale. It accounts for the ramifications of the various strategy applications within the boundaries of the site. This could include everything from site- specific rainfall, wind patterns and solar exposure, to the implementation of the school's recycling program and its influence on a child.

III. DESIGN and OPERATIONAL GUIDELINES

1.0 Site / Ecosystems

1.1 Erosion Control
1.2 Alternative Transportation
1.3 Reduced Site Disturbance
1.4 Storm Water Management
1.5 Landscape and Exterior Design
1.6 Light Pollution Reduction

The purpose of this section is to provide a guideline for design, the near-term construction, and the long-term preservation and improvement of the MOMI site. We expect that the points herein will assist MOMI to preserve open space, preserve and restore ecosystems on and around the site, stand as a best practice model for other schools and the community, incorporate the principles of sustainability in tangible ways into the curriculum and create an overall improved quality of life for the students, faculty, families and all who visit the Montessori School of Maui.

In support of these objectives, the architects and engineers working on the MOMI site will provide a comprehensive campus master plan and documentation that will:

- Document and identify existing topography, drainage patterns, soil conditions, ecosystems, trees and vegetation.
- Identify the available and potential views, the sun, wind and precipitation patterns, and the locations and functions of existing buildings.
- Map and describe any potential natural disasters.
- Include a plan depicting all new development and a description of that planned development's impacts on the existing natural and built environments, as well as a plan to control and mitigate all potential negative, natural, and/or development impacts.

These issues shall be documented, in both text and graphic formats, and provided to the MOMI administration.

In addition to the campus master plan, the architects/engineers will provide documentation that indicates adherence to the recommendations found in the Montessori School of Maui Guidelines of Sustainability.

We recommend that the strategic plan be completed before the campus plan is established. The strategic plan should precisely identify the existing and projected programmatic and spatial needs of the campus. This will require a consensus among the MOMI decision makers. The need for, purpose of, size and potential location of any new facilities, the spaces between new and existing buildings, and the overall nature of the campus should be clearly identified and recorded by MOMI. With these decisions made and clearly communicated, the architects/engineers developing the campus plan will be able to more effectively bring the long-term MOMI vision into reality.

1.1 Erosion Control

REF. 2.2 Site Selection, 3.3 Water Conserving Landscaping

Sustainable Guideline Goals:

- Control negative impacts to site and surrounding areas from wind-blown losses, soil erosion and sedimentation during construction. Retain and stabilize as much existing soil as is possible.[1]

  ACTIONS:

  - Architects and engineers develop a plan that conforms to or exceeds the best practices of the State of Hawaii, Maui County and/or the EPA's Storm Water Management for Construction Activities Doc # EPA 832-R-92-005, Chapter 3.[2] Design to avoid and minimize disruption of sensitive areas such as steep slopes and mature ecological areas.[3]
  - Stage construction process sequentially to maximize efficiency and minimize erosion potential and negative impacts on and around the site, including adverse impacts to ongoing educational programs.[4]
  - Consider the use of the following methods and/or similarly effective measures:
  - Use level spreaders to make storm water sheet off landscape instead of channeling
  - Use broad flat ditches to lower flow velocity in center
  - Use check dams, quick-rooting vegetation (even non-invasive temporary species), and erosion control fabrics in sensitive areas
  - Design landscape to reduce runoff velocity and protect unstable zones

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Demonstrates best practice implementation

MESO
- Improves air and water quality around site by controlling erosion and sedimentation during construction
- Reduces harmful off-site sediment flow
- Reduces off-site erosion
- Reduces reef damage from runoff
- Demonstrates best practice implementation

MICRO
- Could have higher initial costs
- Improves air and water quality on site
- Reduces erosion on site
- Saves valuable topsoil
- Increases usable land area
- Reduces long-term storm water management costs and storm water impacts
- Reduces possible costly foundation maintenance

CURRICULUM
- Introduce impacts of development
- Reinforce *ahupua'a* concept
- Off-site impacts are acknowledged
- Make externalized costs of construction visible
- Primary: Land and water forms
- Elementary and Middle School: Historical erosion, studies & field visits, comparisons and contrasts, local visitations of erosion sites, ocean & erosion, rain, reports, presentations, solutions to erosions: seawalls, planting

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[1] *Guide to Resource Efficient Building in Hawaii, 2000 (GTREBIH)*
[2] *Leadership in Energy and Environment Design 2.0 (LEED)*
[3] *Sustainable Building Technical Manual. (SBTM)*
[4] *SBTM*

1.2 Alternative Transportation

The MOMI Campus is not close to a public transportation system. Any method to reduce emissions and vehicle trips by encouraging low-emission vehicles, buses, or car pooling is an improvement.

REF. 3.3 Water Conserving Landscaping, 3.1 Overall Water Reduction

Sustainable Guideline Goals:

- Reduce number of vehicles on road and vehicle trips

  ACTIONS:

  - Encourage and facilitate car pooling for daily needs and off-site visits
  - Encourage and facilitate the use of vans/school buses when viable
  - Provide preferred parking and other incentives for car pool vehicles
  - Meet minimum county parking requirements to minimize over-developing site as a response to increased vehicle use
  - Investigate off-site parking accommodations for special MOMI events

- Reduce harmful CO_2 emissions from vehicles

  ACTIONS:

  - Encourage the use of, and disseminate information on, alternative fuel and low emission vehicles to the MOMI community
  - Advocate for and select, for school use, alternative fuel and low-emission vehicles
  - Provide preferred parking for alternative fuel and low-emission vehicles
  - Provide covered bicycle racks and shower rooms to encourage bicycling
  - Provide learning modules on personal transportation decisions, traffic density and global warming
  - Consider alternative vehicle recharging station for MOMI community

SCALES AND CURRICULUM—Intent and Impacts

MACRO

- Educates MOMI students and community on far-reaching impacts of personal transportation decisions
- Demonstrates best practice implementation for rural school transportation
- Reduces CO_2 emissions
- Reduces heat islanding

MESO

- Reduces local traffic density
- Elevates awareness in local community
- Reduces local land development due to increased automobile site use
- Reduces local pollution from traffic

MICRO

- Reduces on-site development for parking
- Allows more green space/less paved area and greater ground water recharge
- Highlights MOMI as a model and a leader in community
- Elevates awareness of MOMI community on transportation issues
- Recognizes health benefits of bicycling

CURRICULUM

- Integrated environmental awareness
- Student appreciation that they are part of something larger – their personal decisions do matter
- Student appreciation that they can contribute and lead
- Provides safer, comfortable learning environment
- Primary: ID human needs, forms of transportation, benefits/effects of transportation
- Elem & MS: Comparison of benefits of different modes of transportation

1.3 Reduced Site Disturbance

REF. 1.5 Landscape and Exterior Design, 2.2 Site Selection, 3.3 Water Conserving Landscaping

Sustainable Guideline Goals:

- Conserve and restore natural areas to promote and preserve open space and biodiversity
- Reduce potential for overbuilding

  ACTIONS:

  - Utilize viable existing buildings wherever possible
  - Minimize need for new building wherever possible, minimize building areas and footprints, maximize use of exterior spaces and semi-enclosed spaces
  - Construct on areas of existing development; minimize need to develop open areas
  - Minimize vehicular, pedestrian and service vehicle damage onto site, as well as between and around buildings

- Reduce negative impacts to ecosystems, site, and surrounding buildings during and after construction

  ACTIONS:

  - Limit earthwork and vegetation clearing to 30 feet beyond building perimeter
  - Minimize earthwork and vegetation clearing around roadways, pedestrian paths and utility access areas
  - Plant as much as possible in the remaining open areas. Use native and/or site-appropriate species to restore areas, include curriculum-based planting, as well as opportunities to plant oxygen-producing plants. Such plants will offset the CO_2 emissions associated with the embodied energy of the building materials as well as the operational impacts of the campus facilities, including transportation.
  - Architects to provide campus master plan documents as described in the introduction to the Site / Ecosystems section
  - Architects to provide highlighted site drawings and narrative describing adherence to above points
  - Provide incentives for contractors to minimize disturbance. [5]
  - Align buildings, parking and other developed areas with existing terrain contours.[6]
  - Use half basements and floor-level changes to minimize earthmoving.[7]
  - Use existing road and path networks if possible.[8]
  - Restore existing degraded areas with low-maintenance plantings
  - Minimize job site waste and clearly define construction areas.[9]

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[5] *Energy Design Guidelines for High Performance Schools, 2000 (HPS)*
[6] *SBTM*
[7] *Ibid.*
[8] *Ibid.*
[9] *GTREBIH*

1.3 Reduced Site Disturbance *Continued*

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Reduces heat islanding
- Demonstrates best practice implementation for maintaining open space and preserving ecosystems
- Increases landscape, increases oxygen, and decreases CO_2

MESO
- Reduces harmful off-site erosion and sediment flow
- Improves contiguity of ecosystems
- Demonstrates best implementation practice

MICRO
- Preserves and creates more campus open space
- Reduces on-site erosion
- Saves valuable topsoil
- Increases usable land area and interior/exterior opportunities
- Protects and preserves ecologically important areas

CURRICULUM
- Healthy effects of ecological planting and open space
- Introduce impacts of development
- Reinforce *ahupua'a* concept
- Mapping at all levels
- Journaling of construction process: photo and written
- Children work with engineers in learning/charting process and progress

1.4 Storm Water Management

REF. 2.2 Site Selection, 3.1 Overall Water Reduction, 3.3 Water Conserving Landscaping

Sustainable Guideline Goals:

- Reduce off-site storm water impacts on the MOMI site

  ACTIONS:

  - Gutter along road edge
  - Group pavement uses.[10]
  - Drains at low point of driveway to collect and redirect to on-site collection
  - Evaluate filtering needs for collection of road runoff for on-site use, including vegetated swales and detention ponds
  - Minimize total paved area[11], maximize pervious surfaces in parking, pedestrian and other developed areas, and use permeable paving options—especially in low-traffic areas (porous concrete, open cell).[12]

- Eliminate storm water runoff from MOMI site to other sites

  ACTIONS:

  - Identify existing areas of storm water runoff to adjacent sites and redirect to appropriate on-site locations
  - Consider the use of infiltration basins, sod/roof gardens, detention ponds, and cistern storage

- Collect on-site storm water for ground water recharge and/or on-site irrigation

  ACTIONS:

  - Direct storm water away from buildings
  - Architects and engineers to generate storm water management plan
  - Increase pervious surfaces, including parking areas
  - Increase roof catchment areas
  - Locate and install cisterns
  - Eliminate harmful chemicals on site (lawns, gardens)
  - Revisit drainage on NW side of site
  - Assign sufficient area in site plan for storm/wastewater mitigation.[13]

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10 *SBTM*
11 *SBTM*
12 *SBTM*
13 *SBTM*

1.4 Storm Water Management *Continued*

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Demonstrates best practice implementation

MESO
- Reduces harmful off-site sediment flow
- Reduces off-site erosion
- Reduces impacts on surrounding ecosystems, including nearby wetlands
- Reduces reef damage from runoff
- Improves overall water quality, recharges fresh water aquifer
- Control of off-site storm water may positively affect unsatisfactory “upstream” practices
- Demonstrates best practice implementation

MICRO
- Could have higher initial costs
- Reduces erosion on site
- Saves valuable topsoil
- Increases usable land area
- Storm water can be used for irrigation, toilets
- Water bill savings
- Minimizes sedimentation, toxics, and nutrient runoff on site (i.e. hydrocarbons from parking lots)

CURRICULUM
- Introduce water catchment systems, water conservation, water runoff, water reclamation, and the aquifer
- Hydrological cycle lessons
- Introduce impacts of development
- Reinforce *ahupua‘a* concept

1.5 Landscape and Exterior Design

REF. 1.3 Reduced Site Disturbance, 2.2 Site Selection, 3.1 Overall Water Reduction, 4.1.A Baseline Energy Performance, 5.2 Construction and Demolition Waste Management

Sustainable Guideline Goals:

- Encourage and restore ecosystems

  ACTIONS:

  - Identify existing and desired ecosystems on, near and contiguous to site
  - Develop open space on site to promote the restoration of appropriate ecosystems
  - Landscape with regionally-appropriate species
  - Use landscaping to offset environmental impacts of campus built environment
  - Provide ecosystem restoration model on campus
  - Landscape with native or site-appropriate adaptive vegetation
  - Require integrated pest management plan (eliminate harmful agricultural chemicals on site and utilize physical barriers for termite and other pest control).[14]

- Promote campus open spaces

  ACTIONS:

  - Do not overbuild
  - Create integrated indoor/outdoor spaces
  - Provide educational purpose to exterior spaces and landscape

- Reduce Heat Islanding

  ACTIONS:

  - Use sod/roof gardens
  - Use Energy Star Roofing products
  - Provide at least 50% shading on non-pervious services, and shade HVAC equipment.[15]

- Design for efficient, low-energy maintenance

  ACTIONS:

  - Use site-appropriate, drought-tolerant and perennial plant species if possible
    – Minimize necessary maintenance by providing easy access for equipment.[16]
    – If irrigation is necessary, use a drip system or gray water recycling system.[17]
    – Collect campus green waste for soil enrichment on campus

[14] *Hawaii Advanced Building Technologies Program.*
[15] *HPS*
[16] Federal Sustainable Design Guidelines.
[17] *Ibid.*

1.5 Landscape and Exterior Design *Continued*

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Restores island ecosystem
- Reduces large-scale heat islanding
- Landscapes to offset/sequester CO_2
- Demonstrates best practice implementation

MESO
- Encourages continuity of biodiversity and ecosystems
- Connects environmental stewardship with local economic development
- Demonstrates best practice implementation

MICRO
- Thoroughly integrates interior/exterior spaces
- Creates an attractive, comfortable campus
- Provides possible edible/saleable products
- Energy bill savings

CURRICULUM
- Natural learning environment
- Introduce the built/natural/human environment
- Reinforce *ahupua'a* concept
- Introduce permaculture, xeriscape, natural & endemic studies, micro ecosystems, sod roof gardens
- Landscape as a lesson: the science of outdoor design and pattern language
- Landscape as part of the curriculum by growing usable plants, i.e.; food for the farmers market and school lunches, plants for weaving and lei making, etc.

1.6 Light Pollution Reduction

REF. 2.1 Overall Building Quality and Performance, 4.1.A Baseline Energy Performance, 4.7 Renewable Energy

Sustainable Guideline Goals:

- Eliminate light trespass and light pollution
- Minimize energy use
- Reduce impacts from MOMI campus on surrounding nocturnal environments

ACTIONS:

- Design to light only where lighting is needed
- Eliminate any direct-beam illumination from leaving the site by using cut-offs, shading, or light focusing.[18]
- Comply with Maui County night lighting regulations or the IESNA (Illuminating Engineering Society of North America) exterior footcandle level requirements as found in “Recommended Practice Manual: Lighting for Exterior Environments”
- Provide lighting plan and narrative describing adherence to above recommendations
- Provide lighting plan and narrative that describes how the exterior lighting provides for safety in an energy-efficient manner
- Light area as minimally as possible and for minimum time
- Use motion sensors for security lighting, and timers or photocells for seasonal lighting.[19]

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Improves night sky viewing
- Energy-efficient lighting reduces energy demand and pollution
- Demonstrates best exterior lighting implementation

MESO
- Protects nocturnal ecosystems
- Improves nocturnal conditions for neighbors
- Reduces local impacts of development

MICRO
- Energy cost savings
- Improves nocturnal conditions on site
- Creates opportunities for interesting campus night time activities
- Elevates awareness of night sky issues for MOMI community

CURRICULUM
- Introduce lighting design
- Introduce night sky lessons
- Introduce light as energy

[18] *SBTM*
[19] *SBTM*

2.0 Buildings

2.1 Overall Building Quality and Performance
2.2 Site Selection

Building design, as an essential part of the Montessori educational method, is not new. Maria Montessori emphasized the importance of the built environment as a conducive element in the child's educational experience. The Montessori School of Maui began to formalize its interest in merging the built, natural and learning environments in 1996. At that time, a group of MOMI faculty and parents gathered and conceived the Learning Classroom. This concept combined the real aspects of Earth Literacy with the more traditional topics of literacy that are expected in a K-12 experience. The difference is a more comprehensive educational approach that allows the children to see themselves as part of a larger living system; this natural system is one in which they play an active part, through their daily decisions and actions.

The development of the campus and the design of new buildings present a unique opportunity to teach by demonstration. The buildings, the spaces in and around them, the overall building performance and the campus operations, as well as the tangible integration of the principles of sustainability, are all important components of the MOMI Earth Education Program.

With these holistic educational values in place, it is imperative that the MOMI campus, and the buildings on it, embody these principles in a real and exemplary way. The overall design and operation of the campus must not simply reduce resource and energy use for the sake of decreasing costs. The design of this facility must also align with the school's mission and find purpose in its ability to elevate the educational experience of every child.

The overall site design will integrate fully with its location. It will preserve resources and open space, as well as strive to restore the ecosystems of the *ahupua'a.* The buildings will consider orientation and appropriate climactic interaction to create interior and exterior classrooms. Enclosed spaces will be naturally lit and ventilated. These educational environments will be designed with comfort and high performance in mind. The buildings will be designed to conserve energy, water and material, and they will fully support the pedagogical experience for both the students and the teachers. Finally, the buildings will provide healthy indoor environments that capture every opportunity to incorporate ecological awareness, and all other sustainable design principles, as tangible, interactive teaching tools for the students, visitors and the larger community.

2.1 Overall Building Quality and Performance

REF. 2.2 Site Selection, 3.1 Overall Water Reduction

Sustainable Guideline Goals:

- Create resource and energy-efficient buildings that utilize renewable energy and natural ventilation, that connect the exterior with the interior, that are healthy, attractive learning/working environments, and that stand as models to the students, other schools and the larger community

ACTIONS:

- Buildings to be designed for flexible, adaptive use over their lifetime
- Incorporate solar hot water for all hot water needs
- Orient building to minimize solar gains from East and West, maximize natural ventilation
- Incorporate daylighting to meet required classroom and office lighting needs
- Use energy-efficient lighting that is integrated with the daylighting system
- Utilize building and operational materials that are resource efficient, do not off-gas and have a low embodied energy
- All buildings to utilize water catchment systems
- All buildings to minimize water use and incorporate gray water and water recycling processes where safe and reasonable
- Buildings are to minimize material in construction and operation
- Building design is to maximize use of recycled content materials
- Architects/contractors are to establish a construction and demolition waste management plan
- Buildings to be designed and built to be disassembled, in whole or in part, for adaptive reuse of the building, its sections and/or its various components and materials
- Orient building to maximize solar energy generation potential
- Incorporate renewable energy technologies to meet at least 20% of the aggregate campus energy demand
- Utilize certified forestry products where reasonable
- Utilize locally-grown, and/or locally-produced building products whenever possible
- Establish recycling process in the operation of the building
- Eliminate the use of harmful chemicals and other materials in the operation of the campus
- Compost all green waste

2.1 Overall Building Quality and Performance *Continued*

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Demonstrates best building design and operation practice implementation
- Supports local materials suppliers
- Keeps money in the state economy
- Reduces demolition and construction waste in landfill
- Reduces green waste and operational waste in landfill

MESO
- Demonstrates climactically-appropriate architecture for locale
- Increases green/open spaces

MICRO
- Reduces energy bill
- Water bill savings
- Creates environments conducive to learning and working
- Assists in establishing operational recycling programs
- Assists in reducing harmful campus chemical use

CURRICULUM
- Introduction to ecological design
- Introduction to renewable resources
- Introduction to energy-efficient building design

2.2 Site Selection

REF. 2.1 Overall Building Quality and Performance, 3.1 Overall Water Reduction

Sustainable Guideline Goals:

- Redirect storm water away from buildings

  ACTIONS:

  - Mitigate incursion of off-site storm water onto MOMI site
  - Redirect surface runoff away form interior and exterior teaching areas
  - Capture or retain storm water for use or ground water recharge

- Minimize building footprints and maximize campus open space

  ACTIONS:

  - Build only what needs to be built
  - Consider exterior and interstitial spaces useable pieces of a whole- not left-over
  - Consider multiple uses of buildings rather than simply more buildings-stagger use schedules for a single building
  - Work with topography; minimize excavations and earth moving

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Demonstrates best practice implementation

MESO
- Reduces harmful off-site sediment flow
- Reduces off- site erosion
- Reduces reef damage from runoff
- Demonstrates best practice implementation

MICRO
- Could have higher initial costs
- Reduces erosion on site
- Saves valuable topsoil
- Increases usable land area
- Storm water can be used for irrigation, toilets
- Water bill savings

CURRICULUM
- Introduction to the concept of a building footprint
- Introduce impacts of development
- Reinforce *ahupua'a* concept

3.0 Resources: Water

3.1 Overall Water Reduction
3.2 Reduced Wastewater
3.3 Water Conserving Landscaping

Water is a vital resource that is dwindling in both quantity and quality around the world. Hawaii is not an exception. On Oahu, the sustainable yield of the aquifers is stable only until 2011.[20] This means that at this date water withdraws will be greater than replenishment. Similar conditions exist on the island of Maui.

Development exacerbates the shortages of water supply. Ground water is recharged when rainwater seeps through pervious ground surfaces. When this area is covered with roads, parking lots, walkways and buildings, their impervious surfaces resist water penetration and cause storm water to flow into discharge channels for disposal in the sea. This condition is problematic not only because it diverts valuable rainfall away from recharging aquifers but storm water runoff also causes flooding, erodes valuable topsoil, carries toxins and pathogens, and fouls the marine habitat.

Water consumption in buildings accounts for 20-25% of overall water use. When this precious resource is used inefficiently, it is wasted. Wasted water wastes money and hastens the depletion of this limited resource. Toilets are a large water-consuming fixture. They use large quantities of high-quality water. An effective water conservation method is to utilize an appropriate grade of water for the appropriate use. This opens opportunities for water recovery and recycling.

This section addresses methods by which MOMI can reduce water use and recharge aquifers through effective design measures. This section will also assist the MOMI administration and staff in developing operational strategies to responsibly use, reuse and recharge water on the MOMI campus and to employ these methods as effective educational tools to demonstrate water conservation principles for the MOMI students, their families, and the community beyond the campus.

This section also recommends strategies to reduce water use in buildings and in irrigation practices, as well as methods to extend the resource through water reuse, recycling, water catchment, and ground water recharge. We expect that this campus will save 20-30% more water than a typical, similar facility once design and operational guidelines related to water use are met.

The architects/engineers are to work with the MOMI administration to develop educational signage for all water-conserving methods on the campus.

[20] *Oahu Water Management Plan, 1992.*

3.1 Overall Water Reduction

REF. 2.2 Site Selection, 3.2 Reduced Wastewater

Sustainable Guideline Goals:

• Maximize on-site water collection, reuse, and groundwater recharge

• Reduce load on county water supply and waste water system

• Extend the sustainable yield of the island's aquifers

ACTIONS:

• Reduce aggregate potable water use on all fixtures by at least 20% below the U.S. Energy Policy Act 1992 levels

• Architects/engineers to provide narrative with manufacturer's product information to quantify reduction as meeting or exceeding the 20% reduction noted above

• Install low-flow fixtures and sensors with flow restrictors

• Install and maximize use of water catchment system

• Provide gray water system

• Use recycled/gray water for irrigation, wastewater and other viable processes

• Maximize on-site ground water recharging opportunities

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Reduced water use requires less energy for pumping, thereby reducing island energy demand and emissions
- Demonstrates best water conservation practice implementation

MESO
- Assists in ecosystem restoration
- Provides a water conservation model for community

MICRO
- Water bill savings
- May have higher first cost
- Requires regular maintenance and monitoring for pathogens in recycled/gray water systems

CURRICULUM
- Introduce water conservation
- Introduction to the aquifer

3.2 Reduced Wastewater

REF. 2.2 Site Selection, 3.1 Overall Water Reduction

Sustainable Guideline Goals:

- Reduce water required for waste water processes
- Reduce amount of potable water used for waste water processes

ACTIONS:

- Use rainwater catchment supply for waste water processes
- Use recycled gray water for wastewater processes
- Assess viability of on-site waste water treatment to tertiary level
- Refit existing toilets exceeding the U.S. Energy Policy Act of 1992 level of 1.6 gal/flush to 1.6 gallons or less
- Design and install all new water closet fixtures with flows of at least 20% below the 1.6 GPF standard
- Utilize waterless urinals were possible
- Utilize composting toilets were possible

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Reduced water use requires less energy for pumping, thereby reducing island energy demand and emissions
- Demonstrates best waste water treatment practice implementation

MESO
- Assists in ecosystem restoration

MICRO
- Water bill savings
- May have higher first cost
- Requires regular maintenance and monitoring for pathogen problems in wastewater process
- Creates valuable topsoil

CURRICULUM
- Introduction of waste = food concept

3.3 Water Conserving Landscaping

REF. 2.2 Site Selection, 3.1 Overall Water Reduction, 3.2 Reduced Wastewater

Sustainable Guideline Goals:

- Reduce water required for irrigation
- Reduce amount of potable water used for irrigation

ACTIONS:

- Use site-appropriate, low-water-intensity planting
- Use rainwater catchment supply for irrigation
- Use recycled/gray water for irrigation
- Establish water quality testing methods, especially for irrigated areas where water may contact children
- Utilize efficient irrigation schedule
- Utilize efficient irrigation methods
  - Avoid systems that cause evaporation
  - Utilize subterranean and drip systems
- Architects/engineers to supply drawings and narrative describing and quantifying water conserving landscape and irrigation plan

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Lengthens sustainable yield from island aquifers
- Demonstrates best practice implementation

MESO
- Reduces harmful off-site sedimentation
- Reduces harmful off-site erosion
- Appropriate planting restores *ahupuaʻa* ecosystems

MICRO
- Reduces harmful on-site sedimentation
- Reduces harmful on-site erosion
- Saves valuable topsoil
- Water bill savings

CURRICULUM
- Introduce water conservation, irrigation and landscape design
- Introduce native plants
- Reinforce *ahupuaʻa* concept

4.0 Resources: Energy

4.1 Overall Energy Utilization
4.2 Commissioning
4.3 Daylighting
4.4 Electric Lighting
4.5 Building Envelope
4.6 Ventilation
4.7 Renewable Energy

Maui has one of the highest electricity costs in the country—and these costs are increasing. Hawaii, as a state, has a greater reliance on burning fossil fuels than any other state and approximately 65% of all oil burned for energy in Hawaii is delivered from foreign sources. Additionally, fossil fuel power plants are a leading contributor to greenhouse gases and global warming. Hawaii's citizens pay premium prices for a source of energy that is environmentally destructive and potentially hazardous to the state economy.

Furthermore, the primary existing energy resources, fossil fuels, are not infinite. Current estimates project approximately thirty more years of supply from known oil reserves in the world. These facts demonstrate that changing our energy resources and consumption will soon become a necessity rather than an option.

A first line of defense against the negative environmental and economic impacts is energy conservation. Reducing energy use will save money, reduce pollution and diminish the state's demand to import fossil fuel. This is the "do less damage" path. In addition, utilizing renewable energy will not only eliminate harmful emissions and reduce reliance on foreign fuel imports but will also create jobs, improve the state economy and, after a period of time, provide the user with financial rewards. As Hawaii leads the country in its dependence on fossil fuel it also, according to a 1997 U.S. Department of Energy study[21], leads the U.S. as the state with the greatest solar energy generation potential. Photovoltaic energy generation is a viable approach to energy generation on the MOMI campus. Combining energy conservation, energy efficiency and renewable energy technologies, MOMI can become a near-zero net energy consumer and a model of energy sustainability to the students and the larger community.

The primary approach to energy conservation on the MOMI campus is passive design. This is a non-mechanical approach that involves occupant control of temperature, humidity, airflow and light. These strategies must be considered as a whole and not as design methods in isolation. For example, ample light for the classroom can be delivered by daylighting techniques. But if applied improperly, direct light delivered to the interior of a building can also transmit undesired glare and heat. Therefore, successful daylighting also considers the building's orientation, the ability of the walls, the roof and the windows to mitigate heat gain, the natural ventilation patterns, the specific function within the day-lit space, the integration with electric lighting, and the overall aesthetic appeal of the building's exterior and interior design.

The passive, environmentally-integrated design approach will reduce energy use, set the stage for renewable energy applications and, if done well, provide an excellent learning environment. Such a design will promote overall wellness on the campus and stand as a model to be emulated beyond the MOMI campus.

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[21] *Renewable Technologies*

4.1 Overall Energy Utilization

The primary approach to energy conservation on the MOMI campus is passive design. This is a non-mechanical approach that involves occupant control of temperature, humidity, airflow and light. These strategies must be considered as a whole and not as design methods in isolation. For example, ample light for the classroom can be delivered by daylighting techniques. But if applied improperly, direct light delivered to the interior of a building can also transmit undesired glare and heat. Therefore, successful daylighting also considers the building's orientation, the ability of the walls, the roof and the windows to mitigate heat gain, the natural ventilation patterns, the specific function within the day-lit space, the integration with electric lighting, and the overall aesthetic appeal of the building's exterior and interior design.

This whole-systems, passive design approach will reduce operating costs and power plant emissions. It will support the Montessori Earth-based curriculum and will create a design and educational program model for the larger community.

REF. 2.2 Site Selection, 2.1 Overall Building Quality and Performance, 4.3 Daylighting , 4.5 Building Envelope, 4.6 Ventilation

4.1 Overall Energy Utilization

4.1.A Baseline Energy Performance

A building energy baseline sets a standard of energy use per building system, per square foot, according to the function(s) within the building. For example, lighting in an office space is not to exceed 1.5 watts/sq. ft., whereas other areas with different functional needs may require more or less illumination—and more or less energy to supply it. The minimum standard is set by code. If the MOMI campus is to seek LEED certification, it is prerequisite that a baseline energy performance level be set. It is the intention of the school that the implemented energy-efficiency methods will exceed the code requirements. In doing so, MOMI will substantially reduce energy use on the campus.

School buildings fall under the ASHRAE/IESNA 90.1-1999 code or the Maui County code, whichever is stricter. At this writing, Maui County is undergoing a code revision. ASHRAE/IESNA 90.1-1999 is a commercial code. ASHRAE/IESNA 90.2-1999, which is written for low-rise residential buildings, and the Maui County adaptation of ASHRAE 90.2 will actually be more applicable to the scale of buildings on the MOMI campus.

This guideline will recommend that the actual performance of the MOMI buildings exceed code requirements. This can be done by exceeding the prescription of the code and by providing a performance-based analysis of the design. The optimized energy strategies will be further addressed in this section.

This standard will also apply to existing MOMI buildings.

REF. 2.2 Site Selection, 2.1 Overall Building Quality and Performance, 4.1.B Optimized Energy Performance,
4.3 Daylighting, 4.5 Building Envelope, 4.6 Ventilation

Sustainable Guideline Goals:

- Establish minimum energy use level for all buildings and their systems. The baseline will address all energy-consuming building systems, as well as the envelope components.

  ACTIONS:

  - Architects/engineers to provide documentation of code adherence by identifying all specific energy demands and stating whether compliance conforms to Maui County codes or ASHRAE/IESNA 90.1-1999
    Part 6.1.3 of ASHRAE/IESNA 90.1-1999 describes cooling information for small buildings.
  - MOMI Facilities head to provide energy consumption data for all existing campus buildings

SCALES AND CURRICULUM- Intent and Impacts

MACRO
- Provides metrics for identifying energy savings and best practice model
- Reduces consumption of finite fossil fuel resources

MESO
- Demonstrates the practice of best energy benchmarking in utility district
- Reduces reliance on foreign fossil fuels

MICRO
- Reduces electric bill
- Higher first cost
- Establishes baseline against which savings can be marked
- Clarifies operational energy usage

CURRICULUM
- Introduction to the laws of thermodynamics
- Introduction to baseline energy measurement
- Introduction to energy use and energy monitoring

4.1 Overall Energy Utilization

4.1.B Optimized Energy Performance

This section will use the energy baseline that was established in section 4.1.A to measure additional energy reductions.

REF. 2.2 Site Selection, 2.1 Overall Building Quality and Performance, 4.1.A Baseline Energy Performance, 4.3 Daylighting, 4.5 Building Envelope, 4.6 Ventilation, 4.7 Renewable Energy

Sustainable Guideline Goals:

- Achieve optimal energy savings on the MOMI campus and have the MOMI building designs and campus operations serve as a pollution-prevention model. Savings to be marked in kWh and at least a 40% energy savings will be achieved, as compared to the standards set in ASHRAE/IESNA 90.1-1999, or in the State of Hawaii Department of Education regulations.

  ACTIONS:
  - Buildings are to be passively designed
  - Solar hot water is to meet all hot water needs on campus
  - Existing buildings will, on aggregate, reduce their energy consumption by 20% as reflected by baseline
  - New buildings will consume 40% less energy, as measured against standards listed above. Architects / engineers to provide metrics and narrative describing methods and amounts of energy savings
  - MOMI Facilities head to provide Optimized Energy Performance Plan for existing buildings

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Provides an energy conservation/energy efficiency model for small rural schools
- Prevents harmful emissions

MESO
- Demonstrates best-energy-optimizing for new and existing buildings in utility district

MICRO
- Reduces electric bill
- Higher first cost
- Provides a more efficient, humane educational environment
- Clarifies operational energy usage

CURRICULUM
- Introduction to energy use and energy monitoring
- Introduction to energy efficiency, energy conservation, and renewable energy
- Introduction to data collection and analysis

4.2 Commissioning

Commissioning is typically conducted by a commissioning authority. This is a consultant who is hired directly by the building owner and acts as a representative of the owner to fulfill the goals that are outlined below. Fundamental commissioning is prerequisite for LEED certification. Additional commissioning is important to verify that the energy-conserving building design has been constructed and is operating as intended. It is expected that, since the campus is located in a mild non-heating climate and will be following a passive design approach, that the additional commissioning will not be extensive and will be worth the investment if the LEED branding is desired.

Sustainable Guideline Goals:

- Ensure that the building systems, and especially the sustainable principles articulated by the owner, are incorporated into the design and construction. Verify that all the components and systems are operating as intended after occupancy.

  ACTIONS:

  - MOMI to hire commissioning agent
  - MOMI to clearly state goals and objectives for development of campus to commissioning agent
  - Agent is to develop a commissioning plan and perform all required duties to ensure that the school's requirements and basis of design are implemented
  - If LEED certification is desired, it should be incorporated into the commissioning plan in the design process

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Conserves energy and resources, and reduces pollution
- Demonstrates best water and energy conservation practice implementation
- Promotes and advances the role and value of commissioning authorities in Hawaii projects

MESO
- Ensures that the sustainable principles that affect the immediate locale are incorporated and implemented

MICRO
- Reduces water bill
- Reduces electric bill
- Higher first cost
- Ensures better training for staff
- Assures that the buildings will perform as intended

CURRICULUM
- Introduction to commissioning
- Commissioning documents can be used in curriculum documents

4.3 Daylighting

Daylighting conserves energy and can help to create very pleasing well-lit spaces. Studies have shown that children perform substantially better in daylight classrooms. [22]

REF. 2.2 Site Selection, 4.5 Building Envelope, 4.6 Ventilation

Sustainable Guideline Goals:

• Reduce electric lighting, cooling load, and overall energy demand through effective daylighting design

ACTIONS:-

- Orient buildings to maximize daylighting opportunities (East-West Axis is typically the best orientation that allows optimal solar control with overhangs on the South and North sides). It should be noted that, at the Maui latitude, summer solar angles are to the north of the zenith. There is a NE exposure in the mornings from mid-spring to mid-fall and a NW exposure in the later afternoons during the same seasonal period. •
- Control direct solar radiation. Hawaii is subjected to more direct solar radiation than most temperate climate locations. This reduces the effectiveness of daylighting standards such as the Daylight Factor (DF) calculations. Since diffused overcast skies are not the norm, direct beam radiation must be carefully controlled to bring useable, high-quality diffused light into the building, while leaving the heat out.
- Low emissivity glazing may be used. It should have high Visible Light Transmissivity (VT) (70% or greater) and have a low Solar Heat Gain Coefficient (SHGC) (40% or below). Low e glazing should be chosen for southern latitudes. This level of spectral selection will allow the long-wave radiation to escape through the glazing, thereby preventing undesired interior heating from occurring.
- Interior reflectances should be high (approx. 80%) on ceilings and strategic wall locations. Reflective surfaces should also be used on exterior surfaces that are not in the viewing plane in order to reflect and diffuse the daylight into the interior.
- Indirect top-lighting may provide more useable light on important vertical classrooms surfaces. Undesired brightness contrasts and glare can easily be created on those surfaces from side-lighting. Carefully consider illumination levels and glare on classroom desk surfaces when using top- lighting.
- Top-lighting, such as roof monitors, can also be utilized for ventilation purposes
- Employ shading devices and light shelves to enhance daylighting opportunities
- Utilize lighting controls to coordinate daylighting with electric lighting

[22] *Daylighting in Schools,* report for Pacific Gas and Electric Company, 1999.

4.3 Daylighting *Continued*

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Conserves energy and reduces pollution
- Demonstrates best daylighting and energy conservation practice implementation

MESO
- Reduces electricity demand in local utility district
- Reduces emissions
- Provides a good daylighting demonstration for Maui community

MICRO
- Enhances educational environment
- Reduces electricity bill
- Provides an improved indoor/outdoor environmental connection
- Reduces cooling demand

CURRICULUM
- Introduction to daylighting
- Introduction to relationship of natural light and learning
- Reinforce data collection and analysis

4.4 Electric Lighting

Lighting can be responsible for 25%-40% of a school's energy costs. Ineffective lighting can add to the building's cooling load, create glare, and provide inadequate illumination for the various educational tasks.

REF. 2.2 Site Selection, 4.1 Overall Energy Utilization, 4.1.B Optimized Energy Performance, 4.3 Daylighting

Sustainable Guideline Goals:

• Reduce electric lighting energy demand, while providing appropriate lighting levels for all of the classrooms tasks

ACTIONS:-

- Designers should strive for 1.0 watt/sq. ft. or less for lighting in classrooms by utilizing an effective combination of daylighting and electric lighting
- Coordinate electric lighting with daylighting through effective automated photo-sensor controls that create a seamless day-lit/electrically-lit space
- Use indirect lighting patterns to coordinate with daylight and reduce glare
- Zone light switching patterns to run parallel with windows
- Develop room geometries and room reflectances to enhance appropriate illumination
- Consider the importance of vertical surfaces such as chalk boards, book shelves and computer display screens
- Select the most efficacious (lumen per watt) lamps and energy-efficient ballast, lens, fixture and control systems
- Use occupant, motion, time clocks and other automated controls to maximize energy conservation
- Use LED or higher efficacy exit lamps
- Electronic ballasts are preferred over magnetic ballasts
- Use low-mercury fluorescent tubes

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Conserves energy and reduces pollution
- Demonstrates best classroom lighting design practice

MESO
- Reduces electricity demand in local utility district
- Reduces emissions
- Provides a good daylight/electric classroom lighting model for Maui community

MICRO
- Reduces electricity bill
- Reduces cooling demand
- Enhances educational environment
- Reduces maintenance required for lighting
- Increases awareness of good lighting

CURRICULUM
- Integrate energy use and lighting with curriculum
- Introduction of the ecological aspects of ballast and lamp disposal
- Introduction of electrical energy production and conservation

4.5 Building Envelope

REF. 2.2 Site Selection, 2.1 Overall Building Quality and Performance, 4.1.A Baseline Energy Performance, 4.3 Daylighting, 4.6 Ventilation 4.7 Renewable Energy

Sustainable Guideline Goals:

- Increase energy conservation, such as reduced electric lighting, cooling load and overall energy demand, through effective building envelope design

  ACTIONS:

  - Utilize Energy Star reflective roofing and light-colored exterior surfaces to minimize heat gain
  - Incorporate radiant barrier into the roof and into South, East and West walls
  - Insulated wall and roof cavities can be used to mitigate heat gain even if no mechanical cooling system is used
  - When employing insulation, consider ecologically supportive and health-friendly types such as blow in cellulose made from recycled paper and boric acid
  - Coordinate building envelope form with orientation to maximize solar hot water and photovoltaic generation, to maximize ventilation and desired views, and to minimize thermal gains
  - Arrange building configuration to be easily inspected for termite infiltration
  - Shade windows from direct solar radiation
  - Utilize Low-e for tropical climates to reduce heat gain
  - Develop landscaping to augment the shading, ventilation, and heat- mitigating influences of the building envelope
  - Reduce overall material use and embodied energy in the building envelope

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Advances framing and other methods of reducing material use in envelope
- Decreases the depletion of resources, decreases energy use, and decreases emissions

MESO
- Incorporates locally-grown materials, thereby supporting local economy
- Reduces landfill waste from construction
- Provides a best practice natural light, ventilation, and thermal mitigation model for Maui

MICRO
- Enhances indoor/outdoor experience
- Reduces electricity bill
- Provides higher indoor environmental quality
- Reduces cooling demand
- Provides pleasant interior spaces

CURRICULUM
- Reinforce building form as teaching tool
- Introduction to the concept of a building envelope
- Introduction to embodied energy in construction (materials and method) and building orientation
- Curriculum connections to material supplies, use and disposal

4.6 Ventilation

REF. 2.2 Site Selection, 2.1 Overall Building Quality and Performance, 4.1.A Baseline Energy Performance, 4.3 Daylighting

Sustainable Guideline Goals:

- Develop a comfortable classroom environment without the use of a mechanical cooling system
- Improve the indoor environmental quality with natural ventilation
- Save energy, save dollars and reduce emissions through use of natural ventilation

ACTIONS:

- Orient buildings to maximize natural ventilation opportunities
- Coordinate strategies for ventilation, daylighting, and thermal mitigation with building orientation and form
- Provide adequate spacing between and around buildings to encourage air flow
- Use landscaping elements to improve flow around and through buildings
- Minimize exterior or interior barriers that would adversely disrupt or redistribute air flow
- Locate window and vent openings to ensure air flow at the occupant level (every grade level)
- For spaces with openings on opposite walls rotate room 30-45 degrees from wind direction to enhance air movement within room
- For rooms with windows on adjacent walls or on the same wall only, move windows as far apart as possible to enhance circulation
- Do not place “barrier spaces,” such as closets or functions giving off heat or odors, on the windward side of an occupied space
- Choose the right window, with an appropriate operable opening area, for the right locations
- Outlet openings that are 1.25 times larger than the inlet opening will increase air velocity through the space
- Ventilate roof and attic spaces. Ridge vents should incorporate baffled lips to increase negative air pressure—even on the windward side.

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Reduces energy use and emissions

MESO
- Reduces demand on local utility
- Provides a best practice natural ventilation, daylighting, and thermal mitigation model for Maui

MICRO
- Enhances indoor/outdoor experience
- Reduces electricity bill
- Provides higher indoor environmental quality
- Reduces cooling demand
- May require a higher level of maintenance

CURRICULUM
- Introduction to ventilation
- Introduction to habitat (abiotic factors)
- Introduction to macro/micro climates
- Reinforce building form as teaching tool

4.7 Renewable Energy

REF. 4.1.A Baseline Energy Performance, 4.1.B Optimized Energy Performance

Sustainable Guideline Goals:

- Encourage the use of renewable technologies such as solar, wind, water and geothermal-generated electricity
- Decrease our reliance on fossil fuels

ACTIONS:

- Use a renewable energy source for a portion or all of the MOMI campus buildings' needs

SCALES AND CURRICULUM—Intent and Impacts

MACRO
- Increases awareness of renewable energies
- Decreases dependence on fossil fuels

MESO
- Promotes local power production through sustainable means

MICRO
- Possible reduction of electric bill
- Higher initial cost

CURRICULUM
- Introduction to renewable energy production

5.0 Resources: Materials

5.1 Material Selection
5.2 Construction and Demolition Waste Management
5.3 Design for Recycling

Building material choices have substantial impacts on the building's occupants and the health of our environment. Materials can be derived from precious, even endangered, sources and locations. Materials may also be collected and composed from regenerative sources or may simply be reused in their fabricated form. A building component's raw material extraction, manufacturing, packaging, shipping, installation, use and final disposal may have a very high energy cost associated with it. The energy demand, required in each stage of the material's development and life, is quantifiable and known as the material's embodied energy. Building products with recycled content typically have a much lower embodied energy than a similar product manufactured from virgin material. The product with the lower embodied energy is an energy efficient product. It is also important to utilize building and operational materials that are resource efficient. These products conserve water and other materials in their extraction, processing and use.

Beyond the considerations of energy and resource efficiency, the materials must be durable, non-toxic, aesthetically appropriate and purchased locally whenever possible. The wrong material can be harmful to workers in the manufacturing process and on the construction site once installed. It can be unhealthy for students, teachers and staff as well as destructive to the environment at any point from primary extraction, through processing to final disposal. It is MOMI's goal that all building material choices be socially and environmentally supportive, be non-toxic, energy and resource efficient, have the lowest embodied energy possible, be locally derived and support the local economy when ever possible, and most importantly, support safe, healthful learning environments for the children. The MOMI board of directors, administration, and faculty promote this principle as a building design goal and commit to carrying balanced material choices into the classroom and into the campus operations.

The Rule of the 4 Rs applies very appropriately to the area of Material Resources: Reduce, Reuse, Recycle and Restore. The first measure is always to Reduce the amount of material required. Reduce waste, design to standard industry sizes- get the least amount of material to do the most work. Secondly, Reuse what is already available. Reusing concrete formwork or reapplying it as siding or decking, salvaging building components to be used in a new facility, rehabbing buildings and designing a rehabbed flexibility into future possibilities for the campus buildings are all methods of Reuse. Recycling requires more energy to transform the material than does Reuse but it can still save significant amounts of energy and resources over comparable products that use only virgin material. The recyclability of the product, after its useful life as a building component, is also a valuable design consideration, especially in Hawaii where diverting material from limited landfill space is always desirable. The first 3Rs lead to the last, Restoration. The more we can restore, reuse and recycle the more we are able to restore the health of the global, regional and local environments as well as improve the well being of the people who live within them.

Sustainable building material options are fewer in Hawaii than in many other regions of the country due to lengthy geographic distances, lack of supporting industries and limited existing building stock. It will be a challenge for the architects to realize the full range of LEED credits in this area. But it will be important to demonstrate commitment to sustainable material decisions and support for the local environmentally supportive material market at every reasonable opportunity.

5.1 Material Selection

The MOMI campus is a residential-scale complex and the expansion of the school is intended to retain that sensibility. The sustainable design strategies, such as passive design approaches to achieve thermal comfort within the classrooms, is achievable on this site with this scale of building. Residential buildings have their challenges when addressing material choices. A typical US home requires about one acre of forest, generates approximately 4 pounds of waste for every square foot of floor area and the 55 yards of foundation concrete creates about 20,000 pounds of CO_2. [1]

It is the recommendation of this guideline that the architects follow the LEED criteria and it is strongly recommended that the architects use the GreenSpec Directory: Product Directory with Guideline Specifications as a tool to achieve the LEED material credits. This directory will give specific information on the building materials in the CSI (Construction Specification Institute) format. It supplies design and construction recommendations and a list of products that have been evaluated by the *Environmental Building News* research staff. It is also recommended that, for further information and evaluation, the *Environmental Resource Guide, 1998* (or a more recent edition by the American Institute of Architects, Wiley and Sons publishers), be utilized. This guide will give a more thorough background and evaluation for the various material options. Each of the documents provides a glossary for defining the various types of recycled content and methods for evaluating them. These two documents will be indispensable for making the preliminary sustainable material choices.

These standards will also apply to changes and improvements in the existing MOMI buildings.

REF. 2.1 Overall Building Quality and Performance, 4.1 Overall Energy Utilization, 4.5 Building Envelope, 4.6 Ventilation

Sustainable Guideline Goals:

- Reduce the embodied energy and resource intensity of the building materials

  ACTIONS:

  - MOMI administration and architects to establish reduced embodied energy and resource intensity as a design and construction goal throughout project
  - Architects to evaluate and balance selection of materials with other performance criteria such as durability, thermal properties, aesthetics, cost (initial and long-term), warranties, local service and other environmental issues
  - Purchase local materials whenever possible to reduce transportation energy and support local economy
    - Target 20% of all materials (by cost) to be harvested, manufactured, and/or assembled within the State of Hawaii

- Select products that support the natural environment

  ACTIONS:

  - Select materials that have high durability and low maintenance requirements. These products are ultimately environmentally supportive and very resource and energy efficient in that they need to be replaced infrequently and take little energy or resources to maintain.
  - Certified wood products- Select FSC (Forest Stewardship Council) products or equivalent, especially from Hawaii sources (contact Hawaii Forest Industry Association)
    - Target- 50% of all wood products (by cost) including but not limited to framing, flooring, decking, siding, finish material, furnishings and non-rented temporary construction material such as bracing, concrete formwork, and barriers have a certification from the Forest Stewardship Council or Hawaii equivalent.
  - Select rapidly renewable products whenever applicable
    - Target—5% of all materials (by cost) are from rapidly renewable sources

[1] *GreenSpec Directory: Product Directory with Guideline Specifications, Third Edition* 2002

5.1 Material Selection *Continued*

- Eliminate toxicity in the processing, construction, operation and disposal of building materials

  ACTIONS:

  - Evaluate materials for toxic off-gassing and by-products, and for effects on workers and building inhabitants
  - Select Low VOC materials
  - Select benign materials, including all finishes, adhesives, sealants, wood treatment
  - Subterranean termite treatment to be effective against termites but innocuous to humans. Avoid CCA (copper chromium arsenic compound) and ACZA (ammoniacal copper zinc arsenate) for their toxicity. Use ACQ (alkaline copper quaternary) when not in contact with water (copper is toxic to marine organisms). Use boric acid (borate) treatment where moisture is not directly present. Physical barriers such as basalt termite barrier (BTB), stainless steel mesh systems (termi-mesh) and dry mix concrete (no cracks) are preferred over chemical ground treatments that can infiltrate ground water and be rendered ineffective in sunlight and in certain wet conditions.

SCALES AND CURRICLUM—Intent and Impacts

MACRO
- Reduces energy use and environmental and social/cultural disruption for primary material excavation, mining and/or harvesting
- Reduces consumption of finite fossil fuel resources
- Reduces emissions from combustible fuels
- Choosing benign materials and pest control avoids hazardous working conditions

MESO
- Supports local green building suppliers
- Reduces landfill waste
- Reduces local energy consumption and green house gas emissions
- Demonstrates best practice implementation
- Reduces reliance on fossil fuels
- Physical ground termite barriers and chemical treatments such as borate based solutions will protect ground water supply
- Choosing benign materials and pest control avoids hazardous local conditions

MICRO
- Creates healthier indoor environmental quality (potential)
- Higher first cost (potential)
- Reduces operational energy usage
- Benign pest control methods do not endanger the safety of the children

CURRICULUM
- Introduction to manufacturing of local products and materials
- Introduction to “think globally act locally” philosophy and short and long term environmental impacts
- Introduction to rapidly renewable resources
- Introduction to VOC (volatile organic compounds)
- Introduction to sustainable forest management and planting practices
- Introduction to the concept of certified wood
- Introduction to species and life-cycle of termites
- Introduction to the techniques and science of termite barriers

5.2 Construction and Demolition Waste Management

36% of Honolulu's municipal solid waste (MSW) is generated from the construction and demolition of buildings. The percentage of Construction and demolition (C&D) waste in the other counties around the state is similar. Waste reduction and recycling should begin in the design phase of the project. In the late 1990s the State of Hawaii created a C&D waste management system. There are mandatory job site separation and transfer stations that were established for the specific purpose of handling C&D material in several of the counties. Since that time, thousands of tons of concrete, metals and other reusable and recyclable materials have been diverted from the straining landfills. This is a shining example of environmental solutions with social and economic benefits since the C&D Waste Management program has also created several new companies and many new jobs.

REF. 1.3 Reduced Site Disturbance, 4.5 Building Envelope, 5.1 Material Selection

Sustainable Guideline Goals:

• Reduction and diversion of construction and demolition waste from the landfill

• Reuse or recycle C&D waste. Recycling can include returning material to soil or production process.

ACTIONS:

- Architects establish C&D waste management as a sustainable goal
- Contractor creates and implements a C&D waste management plan that quantifies amounts of C&D and site clearing generated and the percentage that is properly managed (see A Contractor's Waste Management Guide, DBEDT 1999)
  - Target- 75% of C&D and site clearing (by weight) is reused, recycled or composted

SCALES AND CURRICLUM—Intent and Impacts

MACRO
- Best practice demonstration of C&D Management

MESO
- Reduces landfill waste
- Supports local salvage and recycling industry
- Best practice demonstration of C&D Management in county

MICRO
- Potential of reusing buildings and materials
- Lighter site impact

CURRICULUM
- Introduction to the concept of the lifecycle of materials
- Introduction to the product manufacturing process and the resulting environmental, social and economic impacts
- Reinforce the 4Rs
- Introduction to landfills

5.3 Design for Recycling

Material reduction, reuse and recycling begin in the design phase. Designing to standard industry dimensions reduces construction waste. Reusing building parts or designing to disassemble and reassemble building components and creating spatial flexibility within the plan are methods to reduce waste through better design. These strategies along with recycled content in the building materials are design goals to be incorporated into the campus plans. The other side of designing for recycling is the facilitation of the collection, storage and transportation of materials to be recycled on the campus. These operational materials to be recycled include everything from green waste to paper, glass, plastic, furnishings and the various building components and materials discarded in the typical routines of facilities repair and maintenance. This section will address the goals of both the building design and operational needs of designing for recycling.

REF. 1.3 Reduced Site Disturbance, 4.5 Building Envelope, 5.1 Material Selection, 5.2 Construction and Demolition Waste Management

Sustainable Guideline Goals:

- Conserve energy and resources, reduce waste, decrease environmental impacts and extend the useful life of buildings and their components

  ACTIONS:

  - Reuse buildings that are to be demolished.
    - Target- maintain 75% of building shell for reuse for LEED credit
  - Reuse existing building materials, building components and building assemblies as much as possible
    - Target- 5% (by cost) of material in new building is reused /refurbished salvage
  - Design to minimize resource use and waste
    - Design to standard industry dimensions, do not over build, reuse concrete forms, use engineered lumber rather than sawn, full dimension stock (especially if engineered material has formaldehyde free binders and a FSC certification), choose high durability products, etc.
  - Design new buildings to be spatially flexible
    - Maintain freedom in interior spaces to accommodate changing programmatic needs in the future
    - Interior spaces have year round option to open to exterior for changing program
  - Design buildings for ease of disassembly and reuse of components

- Maximize energy and resource efficiency and minimize emissions and environmental impacts by the use of recycled, and recycled content, building materials

  ACTIONS:

  - Select building materials that contain recycled content – balance recycled content choices with other factors such as off-gassing, costs, overall performance, durability, installation ease, environmental impacts, recyclability and disposal requirements
    - Target: Select a minimum of building materials that in aggregate contain a minimum weighted average of 20% post-consumer recycled content or a minimum weighted average of 40% post-industrial recycled content (LEED credit compliance)

5.3 Design for Recycling *Continued*

- Reduce landfill waste by supporting the facilitation of campus recycling

  ACTIONS:

  - Design an area in each new building for the collection and short-term storage of recycling material. Give additional consideration for safety when locating this area in the classrooms.
  - Design an area on campus for the collection and storage of the aggregate material to be recycled
  - Allow ample access, for carts or vehicles, for the removal and transportation of the material from both the individual buildings and from the larger campus storage area
  - Allow ample area for the collection, processing and vehicular access to a green waste location

SCALES AND CURRICLUM—Intent and Impacts

MACRO
- Reduces energy and resource use and harmful emissions
- Supports sustainable forest management practices
- Supports recycling industries and green building product industry
- Best practice demonstration of building reuse and recycled content material choices
- Regenerative materials offset green house gas debt of new buildings

MESO
- Reduces land fill waste
- Supports local salvage and recycling industry
- Supports Hawaii recycling industries and green building product industry
- Best practice demonstration of building reuse and recycled content material choices

MICRO
- Reduces campus building footprints and promotes open space
- Supports healthy campus environmental quality—interior and exterior
- Promotes campus recycling and recycling information outreach to MOMI community
- Creates attractive highly functional, flexible spaces
- Regenerative materials could be grown on campus

CURRICULUM
- Introduce “closing the loop” processes
- Reinforce “waste equals food” concept
- Science and practice of recycling
- Reinforce concept of a “building footprint”
- Create visible Campus Recycling Center

6.0 Indoor Environmental Quality

6.1 Material Selection
6.2 Environmental Quality Management in the Construction Process
6.3 Ventilation
6.4 Lighting, Acoustical and Thermal Quality

If a classroom is to be a conducive learning environment it must first be a safe and healthy environment. Studies in the 1990s revealed that more than 20% of US schools suffer from unsatisfactory indoor air quality. Children are especially susceptible to health risks due to poor indoor air quality, their higher metabolic and breathing rates relative to their size and the extensive time they spend in the classrooms. Additionally, their innocent lack of caution may increase their contact with potentially harmful agents. The environmental quality within the classroom, around the buildings and on the campus in general is critical to the health and performance of the students, as well as to the health and well being of the teachers and staff. MOMI is committed to providing the safest and healthiest environments to its students, teachers and staff within the classrooms, the offices and on the entire campus.

6.1 Material Selection

REF. 2.1 Overall Building Quality and Performance, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection

In the previous section the topic of material selection had resource efficiency and long-range environmental impacts as its primary concerns. In this section, the selection of materials is principally focused on the quality of the immediate environment in which the chosen materials are placed. Various materials may have unhealthy effects, such as noxious off-gassing and the proliferation of pernicious conditions such as mold, particulate migration and the transfer of harmful chemicals or biological contamination. When specifying materials it is important to balance the long-term and immediate environmental considers with the durability, performance, installation serviceability and costs of the materials to be selected.

Sustainable Guideline Goals:

- Eliminate toxic emissions from building materials, furnishings and operational supplies and materials, within MOMI classroom, offices and on the campus

  ACTIONS:

  - Specify and confirm that installed materials are non- or very low emitters of VOCs (volatile organic compounds) and other indoor air contaminants (includes structural, framing and finish materials, carpets, furnishings, adhesives, sealants, paint, classrooms/office supplies, cleaning supplies and process emissions from office equipment and/or any equipment or displays operating in the classrooms)

SCALES AND CURRICLUM- Intent and Impacts

MACRO
- Best practice demonstration of material choices to support improved indoor environmental quality
- Supports distant and long-term environmental quality improvements
- Supports green building product industry

MESO
- Reduces harmful material use and waste
- Best practice demonstration
- Supports local green building products industry and supplies

MICRO
- Creates healthy campus environment for students teachers and staff
- Demonstration and educational outreach to immediate MOMI community

CURRICULUM
- Reinforce understanding of material processes and product selection impacts
- Reinforce understanding of environmental conditions and impacts on human health and safety

6.2 Environmental Quality Management in the Construction Process

REF. 1.3 Reduced Site Disturbance, 5.1 Material Selection, 6.1 Material Selection

Many materials such as treated wood, adhesives, sealants, finishes, fabrics, furnishings and other products will continue to emit volatile organic compounds and other toxins for a period after construction. The preferred course of action is to eliminate the source of the problem by choosing benign materials. Another method to resolve the emissions issue is to flush the building.

Sustainable Guideline Goals:

- Eliminate indoor air quality problems and exterior environmental problems caused by construction processes, installation of materials, and renovation processes

  ACTIONS:

  - Provide dust barriers around construction
  - Isolate all on-site absorptive materials from moisture, chemical and biological contaminant exposure
  - Provide flush out of the building for a minimum of two weeks following the completion of construction and before the occupancy of the building
  - Eliminate the moisture build up in or around the buildings

SCALES AND CURRICLUM—Intent and Impacts

MACRO
- Best practice demonstration of maintaining healthy exterior and indoor environmental quality during and after construction process

MESO
- Reduces harmful off-site impacts from construction
- Best practice demonstration on local level

MICRO
- Creates healthy campus environment for students teachers and staff

CURRICULUM
- Reinforce understanding of environmental conditions and impacts on human health and safety
- Reinforce understanding of Construction Waste Management
- Reinforce “waste equals food” concept

6.3 Ventilation

Flushing fresh air through the building is important after construction and before occupancy; it is also critically valuable to supply ample amounts of fresh air through the building during the occupied periods. Clean outside air moving though the building, flushes off-gassing, provides oxygen and improves occupant comfort.

REF. 1.3 Reduced Site Disturbance, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection, 6.1 Material Selection, 6.2 Environmental Quality Management in the Construction Process, 6.4 Lighting, Acoustical and Thermal Quality

Sustainable Guideline Goals:

- Deliver adequate volumes of outside air, at appropriate velocities, to sustain the health and comfort of the occupants

  ACTIONS:

  - Match or exceed the ventilation requirements set in ASHRAE Standard 62-1999
  - Ventilate to evaporate any accumulated moisture in the buildings
  - Follow LEED criteria for effective ventilation

SCALES AND CURRICLUM- Intent and Impacts

MACRO
- Best practice demonstration of natural ventilation in classrooms

MESO
- Best practice demonstration on local level

MICRO
- Creates healthy classroom environment for students teachers and staff

CURRICULUM
- Reinforce understanding of environmental conditions and how they affect human health and safety
- Introduce ventilation and air quality

6.4 Lighting, Acoustical and Thermal Indoor Quality

Natural and electric lighting, acoustical conditions and the temperature and humidity levels of the classrooms should be controlled to enhance rather than inhibit learning. Daylight and lighting fixtures should be useful and should not produce glare or fatigue. The classroom shape and design of the surrounding surfaces, fixtures and furnishes should support acoustical quality appropriate for all classroom activities. Air flow, humidity and classroom temperatures should be maintained at comfortable levels.

REF. 2.1 Overall Building Quality and Performance, 4.3 Daylighting, 4.4 Electric Lighting, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection

Sustainable Guideline Goals:

- Provide lighting levels using both daylight and electric lighting that is optimal for classroom activities
- Eliminate undesired noise and design classrooms to optimize acoustic performance

ACTIONS:

- Provide daylighting strategies that allow usable light in and keep unwanted heat and noise out
- Provide openings that maintain connection to the exterior with out causing distractions
- Use electronic controls to maintain proper light levels between electric and daylighting systems
- Utilize building orientation, shading devices, light shelves, reflective interior surfaces and/or spectrally selective glazing to eliminate direct solar gain and glare and provide high quality indirect lighting
- Arrange classrooms, absorptive and reflective surfaces to optimize acoustical quality within the classrooms and other buildings
- Balance natural ventilation with lighting and thermal strategies
- Use building orientation, envelope design and mechanical assistance of fans, when necessary, to maintain comfortable conditions within classrooms and other facilities

SCALES AND CURRICLUM- Intent and Impacts

MACRO
- Best practice demonstration of maintaining healthy indoor environmental quality

MESO
- Best practice demonstration on local level

MICRO
- Creates healthy, pleasant, supportive learning environments and healthy pleasant office spaces

CURRICULUM
- Introduction to building design and how it affects on learning, human health and safety
- Introduction to acoustics
- Introduction to noise pollution

7.0 Integrated Curriculum

7.1 Site/Ecosystems
7.2 Buildings
7.3 Resources: Water
7.4 Resources: Energy
7.5 Resources: Materials

Purpose

"To go out of the classroom in order to enter the outside world which includes everything is obviously to open an immense door to instruction."
—Maria Montessori

The purpose of the Sustainability Design and Operational Guidelines is to provide a guiding template for architects and engineers as they work to manifest the principles of MOMI's Earth Education Program in our campus expansion. Similarly, we've developed this Integrated Curriculum as an extension of our Earth Education Program and with the purpose of integrating lessons on sustainability for students aged three to fifteen years with real, on-campus sustainable development.

Inherent in the Montessori approach to education is the "prepared environment" as an essential tool to promote the auto-education of the student. Also inherent within the Montessori philosophy is the idea that children should develop a "global vision" and an understanding that all things are connected and interrelated. Because of these tenets, we believe that our sustainability guidelines and integrated curriculum should direct new campus construction in such a way that students and teachers can utilize the facilities and grounds as learning tools within an *expanded* prepared environment. The campus and the buildings must provide and maximize opportunities for students to fall in love with the natural world, learn about Earth's natural cycles, and gain an understanding of humanity's relationship with Earth's systems and species.

Maria Montessori defined the goal of education as "the development of a complete human being, oriented to the environment, and adapted to his or her time, place, and culture." Our hope is that this curriculum, integrated with our Sustainability Design and Operational Guidelines, is used by educators both within and outside our school community. We envision its core components to be creatively utilized by students and their mentors in *any* educational setting—including MOMI *after* our campus expansion is complete.

Indeed, we feel that sustainability is a salient topic today for people everywhere, and that it is a topic that will be vitally important for decades to come. The concept of sustainability has been around for a long time, and became more widely discussed in the 1980s. The word *sustainable* suddenly began to appear everywhere and its meaning seemed to be rather slippery and ever-changing. Gradually, people came to agree that for an action or product to be truly sustainable, it needed to be environmentally sound, socially responsible, *and* economically viable. In 1987, after thousands of interviews with people worldwide, the World Commission on the Environment and Development broadly defined sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Our goal is that this curriculum may assist generations of young people to *learn about*, *contemplate*, *assess*, *question*, *further define*, and *live* sustainability—one of the most important topics of this era.

Rationale

"Once the emotions have been aroused—a sense of the beautiful, the excitement of the new and unknown, a feeling of sympathy, pity, admiration, or love—then we wish for knowledge about the object of our emotional response."
—Rachel Carson

Our Philosophy

To present lessons on sustainability to children ages three to fifteen years is to help them to understand *balance* in the universe. For children to comprehend the value of humans living in a "sustainable" way, they must first grasp the exquisite delicacies, niches, nuances, cycles, strategies, systems, and secrets of the natural world of which they are a part. As they are spurred to use all of their senses, their minds, their imaginations, their bodies, and their innate curiosity to investigate their immediate environment, their questions will flow. These questions will demand more answers and lead to more—and even better—questions.

Such inquiry can lead to deep exploration, understanding, celebration, and enjoyment in nature. For younger children, **empathy** with other living organisms in the natural world comes naturally. For older children, it may take longer to revisit this sense of empathy, or sense of true connection, to plants and animals. But this feeling of connectedness, of humans being a part of the web of life—and not outside it—is essential

It is vital that students understand that almost all living creatures require the same things to survive: shelter, food, oxygen, and water. In this way, a human is not that different from an earthworm, a eucalyptus seedling, a ladybug, or a gecko. When students begin to comprehend this kinship between themselves and other creatures, they are poised to fall in love with the natural world. Children will only fully embrace, and understand, sustainability when they are inspired to *ask* how it's possible for humans to live in balance with nature. Younger children will have the curiosity to **explore** and observe nature for clues as to how other creatures meet their own needs, with minimal waste and with minimal damage to their environment. Older children will have the desire to **take action** and investigate what humans can do to live in a more sustainable fashion, and in greater harmony with nature.

Core Components

A great many individuals, and their thoughts, writings, and experiences, have influenced this curriculum. Of course, our philosophy about how best to introduce children to the concept of sustainability largely mirrors the Montessori philosophy of education. We also found inspiration and ideas from naturalists, storytellers, and educators such as Rachel Carson, Louise Chawla, David Caduto, John Muir, Joseph Cornell, Rona Levinthal, Amory Lovins, Gary Paul Nabhan, Stephen Trimble, Brian Swimme, and David Sobel (to name a few).

We feel that for young people to understand what sustainability truly is, this concept should *gradually* become part of their reality over the cycle of years. Moreover, we think that a "sustainability curriculum" should not only unfold slowly, but it should also recognize the stages through which each child's relationship with the natural world progresses. Finally, we feel that the best sustainability curriculum—and, really, the best curriculum of any kind—is one that is *experience-based* and *internally-driven* [by the students], as opposed to externally-driven [by a teacher].

Because of our beliefs about how best to introduce sustainability to children, this curriculum comprises three core components: a different approach in each of the three **developmental stages** through which children progress as their relationship with the natural world changes, the use of **stories**, and emergent **questions** (student-based inquiry).

Bonding with the Earth: Honoring Developmental Stages

"What's important is that children have an opportunity to bond with the natural world, to learn to love it and feel comfortable in it, before being asked to heal its wounds."
—David Sobel

The Montessori philosophy of education closely parallels the writings and theories of David Sobel and of other educators who've observed that children aged three to fifteen experience distinct stages of development. In Sobel's words, these "formative years of bonding with the earth… include three stages of development that should be of primary concern to parents and teachers: early childhood from ages four to seven, the elementary years from eight to eleven, and early adolescence from twelve to fifteen." Sobel also notes that while these age frames should be considered flexibly he feels that "environmental education should have a different tenor and style during each of these stages." When we ask children (especially those under twelve) to deal with environmental problems we are expecting them to think too abstractly of weighty, scary subjects before they have a chance to fall in love with, explore, find comfort in, and begin to understand the natural world of their backyard, neighborhood streets, and school campus. We at MOMI agree.

Empathy: Finding Animal Allies. Children aged three to seven spend most of their time playing within sight or earshot of home. They have a natural tendency to empathize with the natural world and activities should enhance this developmental tendency and foster a sense of wonder. Ideal lessons include songs, moving like animals, celebrating seasons, and informal meandering walks.

Exploration: Teaching the Landscape. Children aged eight to eleven rapidly expand their geographical range. When asked to draw maps of their "significant world," elementary students tend to draw their home very small and the majority of the map becomes the "explorable landscape." Activities for elementary students should focus on exploration. They want to create imaginary worlds, build forts, search for treasure, take care of animals, and garden.

Social Action: Saving the Neighborhood. As children enter adolescence, at ages twelve to fifteen, social gathering spots (like the mall, downtown stores, the city, park, etc.) become their favorite places to spend time. As they begin to discover the "self" and to think about their place in society, they lean toward wanting to make a difference and "wanting to save the world." Sobel suggests that social action take precedence at this stage and recommends such activities as "managing school recycling programs, passing town ordinances, testifying at hearings [and] planning and going on school expeditions…."

The Sustainability Design and Operational Guidelines and the Integrated Curriculum take into consideration these developmental stages. The scales of the intents and impacts of each guideline, or sustainable development strategy, are organized into Micro, Meso, and Macro. They are similar to the three developmental stages in which a child's world expands to include, at first, just the home, school, and neighborhood, and ultimately encompasses all of society-at-large and the globe. In our Sustainability Guidelines, we consider Micro to be a site-specific scale, or the ramifications of a particular strategy within the bounds of the campus. Meso is an intermediate scale, or the consequences of a particular strategy for the landscape, or region, surrounding the campus. In Hawaii, such a region is the *ahupua'a*, or watershed, that extends from the mountains to the sea. Finally, Macro is the most expansive scale, and represents the results of a certain strategy at a multi-regional, state, country, or even global level. The fact that the Micro, Meso, and Macro scales of the Sustainability Guidelines' intents and impacts mirrors the student developmental tendencies toward Empathy, Exploration, and Social Action ensures that the integration between the curriculum and the Sustainability Guidelines is even tighter.

Why Tell Stories

"When you tell stories, the world changes."
—A girl in Crozet, VA, after attending a storytelling event at her library

We believe that the power of telling a story in order to introduce a topic addresses a fundamental concept that's inherent to an integrated, intrinsic approach to education. A story provides a larger context from which the children's interest can be sparked and from which their imaginations can make connections. Stories can be original or adaptations of other works, and they can be presented from a cultural, historical, scientific, geographic, or interdisciplinary perspective. The importance of stories is that they create contextual references to universal life principles.

The stories we tell in sustainability lessons should, in the words of master storyteller Michael Caduto, "…grow from the very earth upon which they were first told. That is where they take root." Stories that are told from generation to generation hold wisdom harvested from those who lived closely with the natural world and they demonstrate how human needs have been met and how natural life laws have been understood by different cultures in different time periods. Stories of the connections and interactions between humans and the natural world also acquaint students with universal life principles that can, in turn, lead to specific lessons in sustainability through the introduction of compelling science-based questions.

Tell a story that contains a question. The story allows you to plant the seeds, fire the imagination, and frame questions from which the students will begin to form their own questions.

Why Ask Questions

"When you try to pick out anything by itself you find it hitched to everything else in the universe."
—John Muir

I wonder just how the leaves on the very top of that starfruit tree receive water from the soil?
Isn't it curious that there are so many puddles and mud in the parking lot after it rains and there no large puddles or mud around the koa and kou trees, I wonder why?

A cornerstone of our sustainability curriculum is the use of well-chosen stories and compelling questions to initiate student-based inquiry. These core components shift this curriculum from an externally-driven curriculum to an emergent, experience-based curriculum.

Compelling science-based questions are meant to spark student interest in a specific topic and to motivate students to formulate their own questions. It is important for the teacher to be flexible, encouraging students' intrinsic motivation. The instructor, on a lesson-by-lesson basis, must decide just how to balance student questions, motivation, and excitement with the lesson's intended topic and special circumstances. In finding this balance, perhaps it's good to remember Maria Montessori's words: "Our aim …is not merely to make the children understand…but so to touch their imagination as to enthuse them to their inmost core."

Following are examples of how to frame open-ended, leading questions that encourage students to contemplate and question: "I am curious as to why…"; "Do you ever wonder if…"; "I noticed that…"; "What might be the reason…." Such introductions to questions leave much more fodder for young minds than inquiries that begin with words like: "What are…"; "Do you like…"; "How much…"; "Name all of the…". Questions that engage students invite them to be present in the learning process. Well-crafted, open-ended, and compelling questions can also guide children on a *journey* of problem-solving and more questioning. On such a journey, students begin to lead their own studies and the curriculum emerges from their intrinsic interests. Because of this, the specific examples of compelling questions listed in this curriculum extend to become a transferable framework that can be applied to any school's culture and campus where students are invited to lead their own learning.

Layout

"... all factors of culture may be introduced to [children] ... not in a syllabus to be imposed upon them, nor with exactitude of detail, but in the broadcasting of the maximum seeds of interest."
—Maria Montessori

We refer to this curriculum as the Integrated Curriculum because we wish to integrate our outline for introducing sustainability to children with our Sustainability Design and Operational Guidelines. Thus, we've organized this curriculum piece in a fashion similar to the organization of our Sustainability Guidelines. For each of the six guideline sections (Site/Ecosystems; Buildings; Resources: Water; Resources: Energy; Resources: Materials; Indoor Environmental Quality), we first discuss the important themes that we'd like to see students begin to experience, learn about, and question. We've written two categories of important themes, "Themes for Younger Students" and "Themes for Older Students." We leave it up to individual teachers to decide just what themes seem most appropriate for the developmental level of their students. Similarly, we've also included two lists of stories in each guideline section, one list for younger students and one list for older students. We selected these stories from around the world based on how well we felt they highlighted or touched on aspects of the important themes. These lists of stories aren't exhaustive; we will always be looking for more stories to assist us in presenting sustainability lessons.

Finally, for every sustainability guideline listed within each guideline section, we have created a table of "Scales and Curriculum: Emergent Questions and Lessons." This table looks very similar to the table of "Scales: Intents and Impacts" included after each individual guideline in the list of Sustainability Design and Operational Guidelines. In fact, to clearly draw a parallel between the two sets of similar tables, the Scales and Curriculum table is divided into three sections, Empathy, Exploration, and Social Action. Written next to these titles are Micro, Meso, and Macro, respectively.

Within each section in the Scales and Curriculum table, we have included example questions and activities that involve issues related to the particular sustainability guideline AND that are appropriate for the developmental and age levels of the students. Like our lists of possible stories, our lists of questions and lessons are not meant to be exhaustive. They simply represent possible ways in which student interest in the overall themes in a sustainability guideline section may be fostered in students. We've titled the example questions listed in the table "emergent questions"; however, questions like these may be used by teachers to assist students in learning about an aspect of sustainability or they may be questions that literally emerge from the students themselves. Either way, we have listed example questions that touch on important aspects of sustainable development.

Every learning environment is unique and it's therefore difficult to provide a specific study outline that will fit every campus. With this sustainability curriculum, we intend to provide a *template* of ideas from which teachers can develop their own specific plans that are best-suited to their own campus and goals. However, this sustainability curriculum does assume that teachers will make every effort to conduct lessons where it's most appropriate. For example, we feel it's unacceptable to discuss a concept like erosion *inside* the classroom, when the effects of erosion are visible everywhere *outside*. We agree with Gary Paul Nabhan who writes, "We need to return to learning about the land by being *on* the land, or better, by being *in* the thick of it."

REFERENCES

The following books and websites are sources that we found to be the most informative and inspiring as we developed this sustainability curriculum. These books and websites are listed in no particular order.

The Sense of Wonder (Rachel Carson)

Geography of Childhood: Why Children Need Wild Places (Gary Paul Nabhan and Stephen Trimble)

Place-Based Education: Connecting Classrooms & Communities (David Sobel)

Beyond Ecophobia: Reclaiming the Heart of Nature Education (David Sobel)

Natural Learning: The Life History of an Environmental Schoolyard (Robin C. Moore and Herbert H. Wong)

To Educate the Human Potential (Maria Montessori)

The Ecology of Imagination in Childhood (Edith Cobb)

Traces of an Omnivore (Paul Shephard)

Nature Design (David W. Orr)

Ecological Literacy (David W. Orr)

The Spiritual Life of Children (Robert Coles)

Natural Capitalism (Paul Hawken, Amory Lovins, and L. Hunter Lovins)

Montessori Today (Paula Polk Lillard)

Bringing the World Alive: A Bibliography of Nature Stories for Children (The Orion Society)

Stories in the Land: A Place-Based Environmental Education Anthology (The Orion Society)

First Country of Places: Nature, Poetry and Childhood Memory (Louise Chawla)

The Universe is a Green Dragon (Brian Swimme)

Poetry for Young Scientists (compiled by Leland B. Jacobs and Sally Nohelty)

Storytelling with Children (Nancy Mellon)

Storytelling and the Art of Imagination (Nancy Mellon)

Communities by Choice: Advancing the Practice of Sustainable Development www.communitiesbychoice.org

Sustainability Is...: www.sustainablemeasures.com

Rocky Mountain Institute: www.rmi.org

Bergey Windpower Company: www.bergey.com

RECOMMENDED NATURE ACTIVITIES

The following are some excellent sources of activities to do with kids in nature. Most activities are tailored for kids aged six to nine years, but several activities can be modified for both younger and older children. The books listed here are ones from which we drew some of our suggested lessons and questions listed in this sustainability curriculum. These activity guides are listed in no particular order.

Education Goes Outdoors (Frank A. Johns, Kurt Allen Liske, and Amy L. Evans)

Moving the Earth: Teaching Earth Science through Movement (Helen Landalf)

The Kids Nature Book (Susan Milford)

Play Lightly with the Earth (Jacqueline Horsfall)

Sharing Nature with Children I & II (Joseph Cornell)

Nature Activities for Early Childhood (Janet Nickelsburg)

Ecological Education in Action: On Weaving Education, Culture, and the Environment (Gregory A. Smith and Dilafruz R. Williams)

Spinning Tales, Weaving Hope (Rona Levinthal and Katie Green)

Green Thumbs (Laurie Carlson)

A Sense of Place: *Teaching Children about the Environment with Picture Books* (Daniel Kriesberg)

Roots, Shoots, Buckets, and Boots: *Gardening Together with Children* (Sharon Lovejoy)

Mapmaking with Children (David Sobel)

Kids Gardening: A Kids' Guide to Messing Around in the Dirt (Kevin Raftery and Kim Gilbert Raftery)

*Sunship Earth (*Steve Van Matre)

Acorn Naturalists (an educational catalog that specializes in "resources for the trail and classroom"): www.acornnaturalists.com

A Hawaiian Treasure Hunt (Wren)

Life in Early Hawaii: The Ahupua'a (Kamehameha Schools Press)

From the Mountains to the Sea: Early Hawaiian Life (Julie Stewart Williams)

The National Gardening Association Guide to Kids' Gardening (Lynn Ocone with Eve Pranis)

Teaching Kids to Love the Earth (Marina Lachecki Herman, Joseph F. Passineau, Ann L. Schimpf and Paul Trever)

Teaching Children about Life and Earth Sciences (Elaine Levenson)

Grow Lab: Activities for Growing Minds (Eve Pranis and Joy Cohen)

Scientific Crafts for Kids (Gwen Diehn and Terry Krautwurst)

7.1 Site / Ecosystems

1.1 Erosion Control
1.2 Alternative Transportation
1.3 Reduced Site Disturbance
1.4 Storm Water Management
1.5 Landscape and Exterior Design
1.6 Light Pollution Reduction

"Thou canst not stir a flower without troubling of a star."
—Francis Thompson

Themes for Younger Students:

A story that can meaningfully introduce topics in this section is one that highlights the connections and relationships between all living and non-living things. The best story is one that emphasizes that no living thing on the planet lives in isolation; the lives of all living things affect the lives of others. Tread lightly. Give others space. Be kind to your neighbor. Think of every consequence of every action. Additionally, another good story is one about how a place changes over time and plays host to a variety of living creatures alive at different times in history. In this way, the **place** is what connects different communities of living things that do not inhabit the place at the same time. The place holds wondrous secrets, tales, and wisdom—uncovered only by those who really observe and listen. Some of these secrets may still be told by elders who remember "old days" and "old ways." Ultimately, the best story is one that inspires the students to appreciate, and begin to understand, the wonder, complexity, connections, inhabitants, history, and future of what they envision as their "world," or their "place."

Story Recommendations:

Mother Earth (Nancy Luenn)

The Fruit, the Tree, and the Flower (Richard & Ruth Matsuura)

Ki'i and Li'i: A Story from the Stones (Jeremiah Ho'oku'u Gruenberg)

All the Places to Love (Patricia McLachlan)

Archie, Follow Me (Lynne Cherry)

We're Going on a Bear Hunt (Michael Rosen & Helen Oxenbury)

The Armadillo from Amarillo (Lynne Cherry)

Me on the Map (Joan Sweeney)

Nature Spy (Shelly Rotner and Ken Kreisler)

The Big Tree (Bruce Hiscock)

The Backyard (John Collier)

Once there was a Tree (Natalia Romanova)

7.1 Site / Ecosystems *Continued*

Themes for Older Students:

Important themes for older students to grasp about the Site/Ecosystems section of the Sustainability Guidelines are similar to those listed under Themes for Younger Students. Children's **sense of place**, and their awareness and appreciation of the complex, interwoven ecosystems therein, is the foundation upon which their feelings about culture and the environment rests. Indeed, we feel that children's sense of place is intrinsic to their sense of self and their overall view of the world. Throughout their learning in the Site/Ecosystems section *all* students should strengthen their sense of place. Older students, as compared to younger children, will be able to better comprehend the complexities of the components of their place (e.g., invasive species, species adaptations to particular niches, etc.) than will younger children. Moreover, the "significant world" for older children is larger and vaster than the world of younger children; thus, the recommended stories listed below reflect the more expansive view of older students.

Story Recommendations:

The Mapmaker's Daughter (Mary-Claire Helldorfer)

Miss Rumphius (Barbara Cooney)

The Church Mouse (Graham Oakley)

Julie of the Wolves (Julie Craighead George)

*The Man who Planted Trees (*Jean Giono)

My Place (Nadia Wheatley & Donna Rawlins)

The Wind in the Willows (Kenneth Grahame)

Story about sea turtle hatchlings, and how they must follow the light of the moon to make their way from their nests on the beach to the ocean (lights from cars, condos, streets, etc. can confuse them).

If You're Not from the Prairie… (David Bouchard)

A New England Scrapbook: A Journey through Poetry, Prose, and Pictures (Loretta Krupinski)

Heron Street (Anne Turner)

Walden (Henry David Thoreau)

Rachel Carson (William Accorsi)

John Muir: Man of the Wild Places (Carol Greene)

Keepers of the Earth (David Caduto and Joseph Bruchac)

The Lorax (Dr. Seuss)

Just So Stories (Rudyard Kipling)

The Call of the Wild and *White Fang* (Jack London)

The Lord of the Flies (William Golding)

The Big Wave (Pearl S. Buck)

The Secret Garden (Frances Hodgson Burnett)

7.1 Site / Ecosystems

1.1 Erosion Control

REF. 2.2 Site Selection, 3.3 Water Conserving Landscaping

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I am curious if there are examples of soil erosion on campus? *Have you heard of contour lines? I wonder what effect slope has on erosion?* *I wonder if you have seen any water catchments on campus?* *Isn't it curious how in some places the water soaks into the ground faster than in other places?* **Suggested Lessons** Build a terraced garden on a slope (including trees). Plant an entire hillside with a ground cover. Propagate the ground cover yourself beforehand. Do a downstream effects study. Follow the runoff from the next storm on foot, once the rain stops. Where does it go? Is there erosion? Measure how much soil is carried in a given amount of runoff by catching, settling and then measuring soil.	*I'm curious why, after a really hard rain, there's more mud on the hill behind the parking lot than there is on the hill under the monkey pod tree?* *Now I'm really curious as to why we see a lot of mud in some places at school and not very much in other locations?* *Besides the flow of water, what are some other ways that valuable soil is lost?* *I wonder why the color of the ocean next to the beach is a brown color when it's been raining for several hours?* **Suggested Lessons** Explore campus and look for signs of erosion and sedimentation; determine why soil loss is worse in areas. Soil "dissection" and write a "recipe" for the very best soil. Experiments to show how plants trap and "drink" H20. Introduce native versus introduced plants. Introduce watershed concept. Discuss old Hawaiian water-shed mgmt.: ahupua'a.	*Can you think of the recipe for the very best soil ever (the kind of soil that grows the healthiest and strongest plants)?* *Do you ever wonder if it's possible for a plant to get too much soil, air, sun, or water?* *I wonder what caused those big ruts in the soil?* *When it's raining really hard, and there's muddy water flowing down Baldwin Avenue, where do you think this water goes?* **Suggested Lessons** Explore campus and look for signs of water on soil, soil loss, and mud; explore campus and find those areas where there's little mud and few ruts.... Experiments to show how plants hold water in their roots, suck up water in vascular tissue, and trap water with their leaves (e.g., celery "drinking" food coloring). Introduce Hawaiian versus non-Hawaiian plants. Work with maps of Maui and discuss "where H_20 goes."

1.2 Alternative Transportation

REF. 3.1 Water Use Reduction, 3.3 Water Conserving Landscaping

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I was just thinking what our island would be like if everyone rode bicycles? *What are your thoughts about buses, cars etc.?* *Do you know if there are any buses we can catch on Maui?* *Are there alternative fuels available in our community? Are they sustainable? Can your car run on alternative fuels?* *Does anyone carpool?* **Suggested Lessons** Make a map showing the morning commute route for each parent in the class. How many of those routes overlap? Can they be encouraged to carpool? Attend a county council meeting of the transportation committee. Do you have an opinion on the traffic situation on island? Is there anything you can do? Organize and implement a carpooling program at school. How do you make it attractive to drivers?	*Think of all the ways a person can move. Please walk. Please skip. Please hop with two feet. Please hop on one foot. Please run. Pretend that you're riding a bicycle, then a skateboard, then a surfboard, then a snowboard, and then a horse. Next, pretend you're driving a car, then a truck, then a motorcycle, and, finally, a plane.* *Can you think of another animal that can move in so many different ways?* *I'm curious as to how, exactly, a car moves?* *Is there another kind of fuel besides gasoline that some people use to power their cars?* **Suggested Lessons** Identify animal/human needs. Animal role-playing. Design "alternative" transportation vehicles for people. Research different kinds of fuel and introduce fuel as "chemical energy." Introduce different forms and the transfer of energy.	*Please show me how a toad moves. Now please show me how an earthworm moves. How about a Jackson's chameleon, a myna bird, a crab, a butterfly, a fish…? Why do almost all animals move?* *Now think of all the ways a person can move. Please walk. Please skip. Please hop with two feet. Please hop on one foot. Please run. Pretend that you're riding a bicycle, then a skateboard, then a surfboard, then a snowboard, and then a horse. Next, pretend you're driving a car, then a truck, then a motorcycle, and, finally, a plane. Why do you think humans move in so many different ways?* *Can you smell a bicycle when you're riding it? How about butterflies and earthworms—can you smell them when they're moving?* **Suggested Lessons** Identify animal/human needs. Animal role-playing. Brainstorm, draw, and act out forms of transportation. Design "imaginary" or "alternative" transportation vehicles for people and animals. Observe types of animal locomotion [by looking up at animals on glass].

1.3 Reduced Site Disturbance

REF. 1.5 Landscape and Exterior Design, 2.2 Site Selection, 3.3 Water Conserving Landscaping

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious if we can build a new structure without displacing a single plant, animal or insect? *I wonder if our school buildings could be built on stilts? Would this result in fewer disturbances of the land and animals?* *I wonder if it is possible for humans and animals to inhabit the same piece of land? Why do we spend so much time and energy keeping animals and insects out of our structures?* *I wonder if we can find an example of a culture which places an emphasis on living with, rather than apart from, animals and plants.* **Suggested Lessons** Observe the erosive effects of a hard rain on bare ground around existing structures or on bare slope immediately after a storm. Plant low-maintenance ground covers and then observe the effects. Level a three-square-meter of dirt and clear and it as if you were to build on it. Cover the site, wait a month, then make a plant and animal count. Compare with the plants and animals on a nearby undisturbed parcel. Attend a county planning meeting to learn about the public approval process for a school or school-like commercial building. Would you approve the project?	*I'm curious as to how many different animals and plants live on our campus. How many do you think we can list? Can you think of an animal that only lives here in the winter?* *Let's walk around the campus and try to find as many animal shelters, or homes, that we can. What did the animals build their shelters out of?* *Did you notice if any of the animals made a mess or hurt a living thing while they built their home?* *How do you think we could find out what the campus looked like before we built our school here?* **Suggested Lessons** Keep a journal for thoughts, "data," maps, and drawings about nature. Treasure/scavenger hunts. Mapping projects. Games to explain symbiosis. Scientific "expeditions" around the school campus. Meet with architects and engineers, share student lists of animals and animal needs. Interview a local historian about what the school campus used to look like. Activities related to habitat, migration, and *ahupua'a.*	*Can you help me think of the four most important things almost every animal needs in order to live?* *Let's walk around the garden and see if any animals have built a shelter there. I wonder what animals might like to have a shelter in the garden?* *If you were a spider/bird/toad/lizard/earthworm that lived at school, where would you like to build your home? Why? What things would you use to build your home?* *What are your special places at school that you don't want to see ever destroyed? Why are these places so special to you?* **Suggested Lessons** Make a special Nature Book. Treasure/scavenger hunts. Mapping projects. Create poems and drawings of special places at school [for students and animals]. Animal role-playing. Games introducing symbiosis. Visit a place on campus that is not mowed, mulched, or developed in any way and record how it changes over the school year. Talk with *kupuna* about what campus used to looked like. Introduce *ahupua'a* concept (ancient Hawaiian beliefs). Perform "Leaf Relays." Pass fragile leaves without damaging them.

1.4 Storm Water Management

REF. 2.2 Site Selection, 3.1 Overall Water Reduction, 3.3 Water Conserving Landscaping

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious; does the rain fall in different amounts on different parts of the campus? Is there a rain gauge on campus? *I wonder how long rainfall records have been kept where you live? Do you think it is important to keep records?* *Do you ever wonder how we might catch storm water and hold it for use in landscape irrigation?* *I wonder if anyone has an idea on how we can minimize runoff during construction? How about after new buildings are in place?* **Suggested Lessons** Follow local stream bed on path to sea, collect data on pollution, erosion, farming inputs, and human impacts. Repeated field trips to coastal areas, assess watershed health.	*Where on the school campus do we have the biggest puddles after a hard rain? Why do you think this is the case?* *Have you ever noticed the color of the ocean next to the beach when it's been raining for several hours? Do you think plants and animals in the ocean notice this change in color?* *How do you think we can prevent erosion during big storms?* *How can we collect muddy water ("storm water") before it floods our school campus, and then flows down to the ocean?* **Suggested Lessons** Discuss watersheds and the Hawaiian *ahupua'a;* Identify own *ahupua'a* on topographic maps of Maui and discuss conservation ethic of Hawaiians. Color-in own *ahupua'a* on map. Build a miniature watershed, with detailed regions: *uka* (mountains), *kula* (garden), *kai* (sea). Collect rainwater from selected sites around campus; compare/contrast amount of water. Plant native Hawaiian plants in areas of highest erosion. Plant vegetables in jars of water, examine root growth(taproot vs. fibrous root).	*I've noticed that, when it rains really hard, there are big puddles in the parking lot at school. But there aren't huge puddles under the monkeypod trees. Why do you think the biggest puddles are always in the parking lot?* *When it's raining really hard, and there's muddy water flowing down Baldwin Avenue, where do you think this water goes?* *Have you ever noticed certain plants that collect water with their leaves? What plants have leaves that are like umbrellas?* *Do you think you could design a way to catch rain before it flows down the hill and takes soil away?* **Suggested Lessons** Discuss the concept of a watershed, including the ancient Hawaiian *ahupua'a,* and have students build a mini watershed with paper, cardboard, and trees, etc. drawn with water-soluble markers; pour water, trace its path. Examine topography maps to understand the flow of water from mountains to sea. Identify own *ahupua'a* on map. Plant vegetables in jars of water, examine root growth (taproot vs. fibrous root).

1.5 Landscape and Exterior Design

REF. 1.3 Reduced Site Disturbance, 2.2 Site Selection, 3.1 Overall Water Reduction, 4.1.A Baseline Energy Performance, 5.2 Construction and Demolition Waste Management

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Imagine you are already attending school on the new campus...will you be spending more time indoors or out-doors? Why? *Why do you think we build school structures? Are they absolutely necessary for learn-ing? For playing?* *Do you ever wonder if we are the only animals that work indoors more than outdoors?* *I wonder if the plants and trees we already have on campus could be used for landscaping the new campus? Do we have to bring in plants and trees from elsewhere? Why?* **Suggested Lessons** Find out what plants would live best in your microclimate without needing to be irrigated. Try to plant as many edible plants as possible. Choose plants which are also low-maintenance and drought-tol-erant. Try and go a whole day at school eating only from the garden. Are there many plants which are edible that are not regularly grown for human consumption? Could you eat them in order to survive?	*I'm curious to know just how many animals we can think of that live on our school campus? Where do all of these animals like to spend their time and build their homes?* *I've noticed that we see a special bird on the school campus only in the winter. Why do you think this bird comes to our school only in the winter?* *I wonder if there are other animals that migrate to Hawaii? Why do you think it's important that they travel so far to get here?* *What are your special places at school? Why?* *If you could wish for anything, what is your dream for your school? What kinds of things would you want at your dream school?* **Suggested Lessons** Keep a journal for nature ideas, dreams, and drawings. Scientific "expeditions" around campus (i.d. plants/animals). Meet with architects, share ani-mal/plant lists. Create an "ABC book" of school animals and their habitats. Introduce biomimicry. Focus on migratory animals. Build bird nest/bird feeder/ bird-bath. See if birds visit. Build "sun traps" to introduce heat islanding.	*I'm curious to know just how many animals we can think of that live on our school campus?* *What kinds of places do geckos like? How about Jackson's chameleons, toads, Japanese white-eye birds, skinks, nematode worms, earthworms, cockroaches, and monarch butterflies?* *What are your special places at school? Why?* *If you could wish for anything, what is your dream for your school? What kinds of things would you want at your dream school?* **Suggested Lessons** Make a special Nature Book. Embark on scientific "expeditions" around the campus and identify animal homes. Pretend you are a special animal and you must build a new home; where will you build and with what? Why? Create poems and drawings of special places at school [for stu-dents and animals]. Discuss migratory animals as "temporary residents." Design "wee homes" in nature for action figures, or figures you make.

1.6 Light Pollution Reduction

REF. 2.1 Overall Building Quality and Performance, 4.1.A Baseline Energy Performance, 4.7 Renewable Energy

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder why some animals do not like artificial light? What advantages does darkness give certain animals? Are any of those animals on campus? *I wonder if it is possible to light areas of our campus at night without disturbing the natural ecosystem?* *Why do you think it is called light "pollution" if it is only composed of light rays and not chemicals, dirt or debris?* *I wonder if we might want to build a campus that allows plenty of areas to remain dark at night? How will this benefit our campus?* **Suggested Lessons** Find out just how much light emanates from your campus at night. Take a light meter and make measurements of the ambient light in different positions and distances from buildings. Is there an easy way to reduce the light pollution? Find out if your local government has statutes regarding light pollution. Is there any way to control this form of environmental degradation while still allowing commercial and residential development to continue?	*I'm curious as to whether you can think of all the nocturnal animals on the school campus that travel, find food, and spend time together at night?* *I wonder if there are other nocturnal animals that don't live on our campus, but live somewhere else on or near Maui?* *How do you think these animals walk around, find food, and find each other when it's very dark?* *What are some of the dangers that nocturnal animals face?* *Have you ever noticed what a gecko on the wall does when you suddenly turn a light on in a dark room?* **Suggested Lessons** Night sky lessons, compare visibility in rural/urban areas. Research projects on animals affected by light pollution. (e.g., sea turtles), field trip. Play "Turtle Hurdles," dodge dangers facing hatchlings. Intro. to bioluminescence. Examine satellite photos of Earth, note areas of light. Intro. to diurnal, nocturnal, and crepuscular activities in animals.	*Pretend you are a scientist who wants to study a special group of animals on the school campus. Try to think of all of the animals at school that are more active at night than they are during the day.* *How do you think these animals walk around, find food, and find each other when it's very dark?* *Why do you think some animals are only active at night—and sleep during the day?* *Pretend that you are a nocturnal animal who lives on the school campus. Where do you build your home? What do you eat? How do you find this food? What are the dangers that scare you?* **Suggested Lessons** Nocturnal animal role-playing (e.g., a gecko, a hoary bat). "Trust walks" where a blindfolded student is led around a course by a seeing person. Brainstorm how we can help the animals that need to "make a living" at night. Guess what items are in a "Mystery Box" by only using the senses of touch or smell (not sight). Intro. to bioluminescence, how animals produce light.

7.2 Buildings

2.1 Overall Building Quality and Performance
2.2 Site Selection

"When we see land as a community to which we belong, we may begin to use it with love and respect."
—Aldo Leopold

Themes for Younger Students:
A story that can meaningfully introduce the topics in this section is one that discusses one of the basic needs of all living creatures: **shelter**. This story may describe the dens, nests, burrows, condos, apartments, caves, tents, and holes that human and non-human animals build. This story might also compare and contrast different kinds of shelters constructed by different groups of humans living in different parts of the world. And, as a final example, this story might describe the different building materials between which species may choose when constructing their shelters.

Story Recommendations:

The Three Little Pigs (Margot Zemach)
With Love, to Earth's Endangered Peoples (Virginia Kroll)
Our Big Home: An Earth Poem (Linda Glaser)
People (Peter Spier)
The Salamander Room (Anne Mazer)
The Mousehole Cat (Antonia Barber)
Winnie the Pooh (A.A. Milne)
I Took a Walk (Henry Cole)
Under Your Feet (Joanne Ryder)
Hawk, I'm Your Brother (Byrd Baylor)
What We Find When We Look Under Rocks (Frances L. Behnke)
This House is Made of Mud (Ken Buchanan)
The Little House (Virginia Lee Burton)

Themes for Older Students:
A meaningful story is one that introduces students to the concept of **habitat**. The best story is one that inspires students to attempt to describe their ideal habitats, both at school and at home, and to debate whether these habitats can be improved to better meet their needs. Additionally, the best story spurs students to wonder just why certain animals and plants prefer to live on the MOMI campus. Finally, just the right story will inspire children to determine how new buildings can be constructed so as to best meet their needs in their ideal school habitat, while negatively affecting the habitats of other living creatures as little as possible.

Story Recommendations:

Crinkleroot's Guide to Knowing Animal Habitats (Jim Arnosky)
Explore the Wild: A Nature Search-and-Find Book (Beverly Duncan)
The Mountain that Loved a Bird (Alice McLerran)
A Spark in the Stone (Peter Goodchild)
Sod Houses of the Great Plains (Glen Rounds)
The Empty Lot (Dale H. Fife)
Worm's Eye View: Make Your Own Wildlife Refuge (Kipchak Johnson)
The Summer Sands (Sherry Garland)

7.2 Buildings

2.1 Overall Building Quality and Performance

REF. 2.2 Site Selection, 3.1 Overall Water Reduction

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if we could live without buildings? *I'm curious about what materials are used in building construction?* *If you were building your own home, what kind of materials would you use?* *I wonder if we should set goals for how long our school buildings will be useful?* **Suggested Lessons** Research school buildings across the globe. Do other cultures place the same emphasis on classroom quality that we do? What do other cultures do when growing student populations necessitate new school sites? Study science of embodied energy and estimate relative environmental costs of using wood, glass, stone and metal construction methods. Visit local construction sites. Prepare and ask questions of foreman, architects and engineers regarding useful life of construction materials and energy use.	*I wonder if we can think again of all the important things that almost every animal needs to live?* *Please describe your family's house. Now please think about the kinds of houses in which people live in other parts of the world. How are houses in other states and other countries different from your house? How are they similar?* *I wonder if we can figure out which animal homes on campus are temporary (a place where an animal lives for a short time), and which homes are more permanent (a place where an animal lives for a long time)?* *Have you ever noticed an animal shelter that was poorly constructed? How did the home look as if the animal hadn't built the shelter very well?* **Suggested Lessons** Build forts out of natural ma-terials found on campus. Research the different styles of homes people build around the world. Build a "vermiculture bin" (worm farm), care for worms. Construct a small garden, see what animals build homes (prefer the habitat here). Sew a web that is almost identical to one built by an orb spider (sew each web "fiber" in the same order that a spider does).	*Why do people live in houses? I wonder if other animals also need houses (or "shelters")?* *I'm curious to know what you like most about your house? What don't you like about your house? If you and your family could turn your house into a "dream house," what changes would you have to make?* *What do you like most about your classroom? If you and your classmates could turn your classroom into a "dream classroom," what changes would you have to make?* *I wonder if animals think like we do? Do you think that a bird/caterpillar/spider tries to build a "dream nest"/"dream cocoon"/"dream web" each time it builds a home? What parts of their separate homes do you think are most important to these animals?* **Suggested Lessons** Animal role-playing: pretend to build a "dream home." Design personal "dream home" and "dream classroom." Make a collage of personal drawings and magazine pictures of different animal and human homes in the world. Help to construct a "worm farm" in the best way possible (knowing needs of worms), feed/water worms. Construct a small garden, see what animals build homes. Build various homes for toads, ants, ladybugs, etc. and see if animals prefer these homes. Why or why not?

7.2 Buildings

2.2 Site Selection

REF. 3.1 Overall Water Reduction

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if you have any ideas about the most appropriate location for a new building on a piece of land? What do you think is important when selecting a building site? *Where would you place the new buildings on campus? I am curious why you selected those spots?* *Do you think a lot of earth will need to be moved to build here?* *How about the animals' homes? Will they have to move, or perish, so we can build here?* **Suggested Lessons** Make a three-dimensional model of the campus and create blocks from recycled styrofoam to simulate existing/planned buildings. Use model to design several plans of the new campus. Which works best? Why? What is the current zoning of the building site? Does our construction comply with the general plan? What agency dictates how much of the land can be built upon? What is the maximum square footage that can be built on the site(s)? Should we build the maximum allowable?	*If you were an architect, where would you ask the builders to construct the new campus buildings? Why?* *Is it okay for an architect to decide to build a new building where most people want a new building? Or, what could be other important things for an architect to think about?* *Where were the animal shelters we discovered located on campus? Why do you think the animals made the decision to build their homes where they did?* **Suggested Lessons** Explorations to look for many different habitats, at school and on field trips. Intro. to ecology (biotic and abiotic aspects of habitat). Intro. to communities, populations, and biomes. Intro. to how geology and climate influence shelters. Place a partially-submerged clay pot [filled with dried leaves] at several locations on campus. Determine what "site" a toad prefers the most. Why?	*If you became an architect and could decide where the new school buildings were going to be built, where would you tell the builders to construct the buildings? Why?* *I wonder how a bird/caterpillar/spider decides where to build a new nest/cocoon/web?* *How long do you think it takes a bird/caterpillar/spider to build its shelter? How long does its shelter last before it is destroyed somehow?* **Suggested Lessons** Construct a map, showing where new school buildings should go.... Why place buildings in certain locations? Introduction to habitat. Animal role-playing: pretend to build a "dream home." Discuss Hawaiian *amakua,* or "totem animal"; student explains why they relate to animal/its needs/its habitat. Play "Me Tree" where student finds a tree that best reflects their personality, tries to identify what animals/plants live in/on/with this tree. Select building locations for, and build, "wee homes" for small action figures and/or for figures you make.

7.3 Resources: Water

3.1 Overall Water Reduction
3.2 Reduced Wastewater
3.3 Water Conserving Landscaping

"The great spirit Kane was the spirit of *wai,* fresh water. The Hawaiians believed that all fresh water was sacred. No one was allowed to tamper with *wai.* Like sunlight, no one owned this water, not even the king.... *Wai*...was so valuable that the word for wealth is wai wai. They took great care not to pollute the *wai.*
—from "Taro: The Life of the Islands" (www.library.thinkquest.org)

Themes for Younger Students:
A story that can meaningfully introduce the topics in this section is one that highlights one of the basic needs of all living creatures: **water**. The best story may be a poem or a song, and is a passage that celebrates the many uses of water and how communities of human and non-human animals, as well as plants, are often centered around water. The story may also focus on the cycle of water itself, and the many states and places in which a single drop of water finds itself (a focus on how we today may drink a drop of water lapped up by a dinosaur millions of years ago, for example, is very powerful as it shows a strong connection over a very long span of time).

Story Recommendations:

The Day the Ocean Came to Visit (Diane Wolkstein)
Wabo and Ip's Great Adventures (Michael Beck, Maui cartoonist)
A Drop around the World (Barbara Shaw McKinney)
A Swim through the Sea (Kristin Joy Pratt)
Water (Ken Robbins)
Alejandro's Gift (Richard E. Albert)
Water Dance (Thomas Locker)
The Secret of the Hawaiian Rainbow (Stacey Kaopuiki)

Themes for Older Students:
The importance of water in the daily life of all living things should be the overriding theme for older students. A good way to relate this importance is through the telling of **Hawaiian *wai* (fresh water) and *kai* (ocean)** stories. The importance of keeping the water supply clean was paramount to the Hawaiians, because there was always someone who depended on receiving fresh water downstream. The stewardship of the most precious resource, the *wai*, is at the heart of Hawaiian culture.

Story Recommendations:

Paddle-to-the-Sea (Holling C. Holling)
Secret Water (Arthur Ransome)
Three Days on a River in a Red Canoe (Vera B. Williams)
To Climb a Waterfall (Jean Craighead George)
The Water's Journey (Eleanore Schmidt)
Where the River Begins (Thomas Locker)
Come Back Salmon (Molly Crane)
A River Ran Wild (Lynne Cherry)
Story about Hawaiian families living in an *ahupua'a*, and how fresh water connects the families living and working in different regions of the valley.

3.1 Overall Water Reduction

REF. 2.2 Site Selection, 3.2 Reduced Wastewater

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious, are there qualities which are unique to water? *Do you ever wonder if there would be life on earth without water?* *I wonder if there is an infinite supply of fresh water on earth? Is nature, or for that matter, humankind, capable of making more water should we run out?* *I wonder if there are uses humans have found for water that plants and animals do not have? Are there alternatives to water for these human uses?* *Can you think of a way to reduce water use on campus?* **Suggested Lessons** Find out what government agency controls the issuance of water permits. Is there a way to get water out of the ground here on Maui without a permit? Find out what laws there are governing the water rights of landowners who border rivers on Maui.	*I wonder how we can make water?* *Well then, how can we destroy water?* *One reason that water is so important is that we can't make it or destroy it. The same water on Earth today was on the planet millions of years ago, too (!?). Can you imagine that?! What do you think Maui looked like millions of years ago?* *I'm curious as to the time of day that most water evaporates? I wonder if it's difficult for plants to catch or drink water when the water is evaporating so fast?* **Suggested Lessons** Discuss the water cycle by exploring campus and/or by following a stream off campus. Build a wave in a bottle and make a "waterspout" with two plastic bottles to illustrate the amazing properties of water, including the formation and power of waves. Study of demise of Easter Isle. Take temperature readings around campus at different times during the day. Research evaporation rates at certain temperatures. Discuss plant transpiration. Use glass of water as analogy for global water supply.	*I'm curious as to how we can make water?* *Well then, how do we destroy water?* *I wonder if we can figure out where water comes from when we turn on the faucet? How about where does water go when it disappears down the drain?* *One reason that water is so important is that we can't make it or destroy it. The same water on Earth today was on the planet millions of years ago, too (!?). Can you imagine that?! What do you think our school campus looked like millions of years ago?* **Suggested Lessons** Discuss/show the amazing properties of water: water can be a solid, a liquid, a gas, a solvent.... Build a wave in a bottle and make a "waterspout" with two plastic bottles to illustrate the amazing properties of water, including the formation and power of waves. Dinosaurs drank the same H_20 that we now drink!? Use glass of water as analogy for global water supply.

7.3 Resources: Water

3.2 Reduced Wastewater

REF. 2.2 Site Selection, 3.1 Overall Water Reduction

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if you could survive without a supply of fresh water? *Why do you think we should conserve water?* *I wonder if it is possible to water our gardens with water we have already used?* *I'm curious if we can re-use water from our showers and sinks in the garden?*	*For rain that isn't soaked up by plants or by the soil, where did we find that it collects, or floods, the school campus? I wonder what kinds of living creatures may use this water? I'm also curious as to how we might use this water?* *I wonder how we can collect rain for these activities before the water falls to the ground and forms a dirty puddle?* *Do you have any ideas as to some good places on campus where we can construct our "water catchment system?"* *I'm curious as to how we can prevent water evaporation in our own water catchment system?*	*I wonder if there are any animals that use the water in mud puddles—water that plants haven't "drunk" and that hasn't soaked into the soil? (mosquito larvae, toads, thirsty dogs, etc.)* *I wonder if there's a way that we might use this water?* *Do you have an idea as to how we can collect rain for these activities before it falls to the ground and forms a dirty puddle?* *How do plants "catch" water? I wonder which plants catch water the best? (e.g., the pineapple or bromeliad)*
Suggested Lessons Get a copy of the latest water tests performed by the county for your neighborhood. What is an acceptable level of pollutants? Do you think it is acceptable to have trace amounts of toxins in your water? What can you do about your water supply? Research water conservation and the *ahupua'a.* Design a water-saving garden. Design a water catchment system.	**Suggested Lessons** Study plant adaptations for catching and storing water. Design a water catchment system for the school campus, monitor its efficacy. Brainstorm what collected "gray water" can be used for. Intro. to drip irrigation (place a plastic jug in soil near roots of plants). Field trips to wastewater treatment facility, and to sites recycling wastewater. Visit a reservoir/water plant. Research history of local EMI. Study old Hawaiian system of conservation: *ahupua'a.*	**Suggested Lessons** Study different plant adaptations for catching and storing water. Study animal adaptations for catching and storing water. Design a water catchment device to use at school. Record rainfall with a rain gauge. Study how ancient Hawaiians conserved water in *ahupua'a* and how local farmers irrigate with "gray water" (or don't). Plant vegetables in jars of water and examine root growth (taproot vs. fibrous root).

7.3 Resources: Water

3.3 Water Conserving Landscaping

REF. 2.2 Site Selection, 3.1 Overall Water Reduction, 3.2 Reduced Wastewater

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I was wondering if there are types of plants that grow really well in this area? *Do you think there are plants that can grow here without artificial irrigation? How do the cane grasses and trees on the new land grow without irrigation?* *I wonder why the ancient Hawaiians were careful to only cut down a small number of trees at once on the mountain slopes of their ahupuaʻa?* **Suggested Lessons** Compile a list of appropriate plants and trees for the new campus. Determine how much water each needs to survive. Assign each plant a grade based on ease of maintenance, as well. Do a simple evaporation test using shallow dishes of water placed throughout campus. Where is water lost through evaporation most quickly? Why?	*When it's raining, do you ever wonder where all of the water goes?* *I wonder why the ancient Hawaiians were careful to only cut down a small number of trees at once on the mountain slopes of their ahupuaʻa?* *How can we describe a cycle? How can water be described as part of a cycle?* *I'm curious as to the time of day that most water evaporates? I wonder if it's difficult for plants to catch or "drink" water when water's evaporating so fast?* **Suggested Lessons** Grow a bean plant from seed noting what happens from week-to-week. Construct a garden and evaluate what grows fast/slow, how much care is needed, what animals find homes, etc. Native vs. introduced plants. Time of day to water/irrigate. Intro. to drip irrigation (place plastic jugs in soil near roots of plants). Study water cycle by following a stream.	*Can you help me think of the four most important things almost every animal needs to live? Now, can you help me think of the four most important things almost every plant needs to live?* *I wonder why animals and plants need water? How much of our bodies is water? How much of a honey bee is water? A toad? A palm tree? A marigold plant?* *I wonder how plants "drink water?" Can they curl a leaf or a branch around a glass of water, like we can grab a cup with our hands (!)?* *When it rains, I'm curious about where all of this water goes?* **Suggested Lessons** Grow a bean plant from seed. Construct a small garden Intro. to the water cycle by building a small "model" watershed with a container sealed with plastic [that shows condensation, etc.]. Test how different plants act like "straws," "sponges," "umbrellas." Plant vegetables in jars of water and examine root growth (tap-root vs. fibrous root).

7.4 Resources: Energy

4.1 Overall Energy Utilization
4.2 Commissioning
4.3 Daylighting
4.4 Electric Lighting
4.5 Building Envelope
4.6 Ventilation
4.7 Renewable Energy

"In the South American rainforest, ...the Desana...see the world as a fixed quantity of energy that flows between all creatures.... This way, the energy of the world [always] remains complete. What we take, we must replenish."

—Mitch Albom, *Tuesdays with Morrie*

Themes for Younger Students:

A meaningful story is one that introduces students to any of the many aspects of energy: forms of energy, transfer of energy, how energy is stored, etc. The best story may be one that discusses how the sun is the ultimate source of energy, how plants use solar energy (and carbon dioxide) to produce oxygen and sugar, and how this sugar is really stored energy, or fuel, that fulfills a basic need of all living creatures: **food**. A story that might best highlight the great importance of solar energy, as well as food as stored energy, is one that follows the transfer of energy through various trophic levels of an ecosystem.

Story Recommendations:

How Maui Slowed the Sun (Suelyn Ching Tune)
Maui and the Secret of Fire (Suelyn Ching Tune)
Where is Dinah Diatom? (Rita O'Clair & Katherine Hocker)
Story of photosynthesis.
Gilberto and the Wind (Marie Hall Ets)
Red Fox Running (Eve Bunting)
Who Eats What? (Patricia Lauber)
Catching the Wind (Joanne Ryder)

Themes for Older Students:

A meaningful story is one that focuses in some way on human **energy consumption**. Ideally, this story should lead students to question wise (or "sustainable") and unwise (or "unsustainable") energy use. Sustainability in the energy field is approached at two levels: (1) energy conservation and efficiency, and (2) the use of clean and renewable energy sources. Most experts agree that a combination of these two strategies could end our reliance on fossil fuel energy if we apply ourselves industriously. The best story is one that guides students to wonder where most of our energy comes from, and whether other methods and types of energy use make more sense.

Story Recommendations:

Stories of ancient mariners and explorers (like Polynesian mariners and Captain Cook who used the wind to power sails of their outrigger canoes/ships).
Warm as Wool (Scott Russell Sanders)
Story of a Canadian family who built a glider to lead Canada geese to their wintering grounds.
How Maui Slowed the Sun (Suelyn Ching Tune)
Stories of Benjamin Franklin (electricity) and Thomas Edison (light bulb).

7.4 Resources: Energy

4.1 Overall Energy Utilization

4.1.A Baseline Energy Performance

REF. 2.1 Overall Building Quality and Performance, 2.2 Site Selection, 4.1.B Optimized Energy Performance, 4.3 Daylighting, 4.5 Building Envelope, 4.6 Ventilation

SCALES AND CURRICULUM - Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if it might be useful to know our average energy usage before construction or remodeling? *I am curious if you believe it is more efficient to use all new, energy-saving appliances or practice energy conservation using existing appliances?* *I wonder if it is possible to have a traditional school day without using any off-campus energy?* *Can you imagine a campus that produces all of its own energy? Is this possible?*	*I wonder if you have any ideas as to what exactly energy is?* *How can we create or destroy energy?* *I'm curious as to how we can explore campus and figure out what type of energy we're using for lighting, heating, cooking, and transportation?* *I wonder if Cheryl in the office needs to pay someone for us to use these types of energy?* *I wonder if we can compare and contrast the different types of energy we use at school with the different types of energy the following use: an anole, a fan palm tree, a windsurfer, and an earthworm.*	*I'm curious as to whether we remember the four important things that almost every animal needs in order to live? What are the four things that almost every plant needs?* *I wonder if you have any ideas as to what exactly energy is?* *Boy, sometimes I feel really tired, even after I've slept really well. When do you feel the most tired, and like you have "no energy"?* *When do you feel like you have the most energy?* *What if a vegetable feels tired, and has "no energy?" Where do you think a plant can find more energy?*
Suggested Lessons Research and compare energy consumption per square foot of MOMI versus other schools on Maui,the United States and other places. Where do we rate? Compare energy costs of natural gas versus electricity for heating water. What are the unseen costs of each? Take field trips to the electric company, a windmill, a green energy building etc.	**Suggested Lessons** Discuss types of energy. Introduce the two Laws of Thermodynamics. Experiments that help demonstrate photosynthesis. Intro. to the concept of baseline. Lessons in diagnosing energy use and its measurement (e.g., reading a meter). Interview people on campus who pay energy bills. Draw Venn diagrams to compare/contrast human energy use with that of other plants and animals.	**Suggested Lessons** Introduction to the sun as the ultimate source of energy. Introduction to how plants "make food in their leaves." Introduction to different kinds of energy (including food). Compare calories of foods. Games in which children pretend to be animals and plants, and experience energy acquisition, transfer, and loss.

7.4 Resources: Energy

4.1 Overall Energy Utilization

4.1.B Optimized Energy Performance

REF. 2.1 Overall Building Quality and Performance, 2.2 Site Selection, 4.1.A Baseline Energy Performance, 4.3 Daylighting, 4.5 Building Envelope, 4.6 Ventilation, 4.7 Renewable Energy

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Do you set personal goals? I wonder if you think it is important for our school to set energy conservation goals? Why? *Do you ever wonder what kind of equipment we would need to track energy performance in our new buildings?* *I am curious if it takes more energy to build an energy- efficient campus than we could possibly save over the life of the new campus? How could we find out? What alternatives are there to "new" construction?* *I wonder if optimal energy performance in our school can effect the quality of life on Maui? In the United States? For the rest of the world?* **Suggested Lessons** Discuss the local, regional and global impacts of excessive energy consumption. Ask a local energy company about incentive programs or tax benefits for energy conservation programs in commercial buildings. Identify and acquire energy use/conservation stations for closely monitoring our daily consumption on campus. Place them where they will engage students on a daily basis.	*I'm curious if you remember what the word "baseline" means? Now, do you have an idea what the word "optimal" means?* *If you had to guess right now, what do you think it means to "conserve" energy? How do you think we can use energy "efficiently?" What do you think "renewable energy" is?* *I wonder how many ways we can think of to conserve energy at school? How many different ways can we use energy more efficiently at school? And how can we try to use more renewable energy at school?* **Suggested Lessons** Research inventors of energy use/conversion (e.g., Edison and Franklin). Employ energy conservation on campus, monitor meters. Field trips to Maui Electric (production of electricity from fossil fuels), to places using solar/wind energy.	*I wonder why energy is so important...why people say that energy is so precious?* *If something is important—really special—how do you treat it?* *To try your very hardest is to give an "optimal performance." How do you think we can use energy in an "optimal" way?* *I wonder if animals and plants use energy in an optimal way, or if they waste energy sometimes. Do you have any ideas?* **Suggested Lessons** Games to show the transfer of energy in food webs, as well as the loss/waste of energy. Pretend to be animals practicing energy conservation (e.g., a humpback whale that only eats for half the year, stores this food as fuel, and moves very slowly when fasting). Pretend to be a squirrel who is hoarding ("conserving") nuts for the long winter ahead.

7.4 Resources: Energy

4.2 Commissioning

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I was wondering if there might be a way to keep a record of campus energy consumption on a computer? *I'm wondering if it might be best to use an independent authority to review energy consumption records? Who do you think might be willing to be our "commissioning agent?"* *I wonder how we can be sure that everything on this campus is running the way it is supposed to?* **Suggested Lessons** Set goals for reducing electric usage, full recycling and non-toxic clean-up. One day each week, have one member of the classroom act as "commissioning agent." The agent will track electricity use, recycling compliance and cleaning materials and methods. Compare to goals. Create your own checklist targeting energy reduction strategies for existing buildings. Contact local designers, architects and suppliers to find out who they use for commissioning agents.	*What kinds of jobs do your parents have?* *Does your mom or dad have to record numbers or take measurements at their job?* *A "commissioning agent" is a person whose job it is to make sure that a school or store or company is doing good work. How do I check your work at the end of a nature lesson?* *Here are two tasks that are school wants to accomplish: (1) Ensure that all litter is placed in trash; (2) Ensure that lights are not used when not needed. Let's "go commissioning" and see if these goals are being met. We will record where, and how often, these goals are being met....* *What goals do you think our new construction should meet? How will a commissioning agent figure out if the new construction meets these goals?* **Suggested Lessons** Act as commissioning agents. Interview and shadow actual commissioning agent.	*What kinds of jobs do your parents have?* *Does your mom or dad have to record numbers or take measurements at their job?* *A "commissioning agent" is a person whose job it is to make sure that a school or store or company is doing good work. How do I check your work at the end of a nature lesson? Does your teacher in your class check your work? How?* *How can we pretend to be commissioning agents and record on our papers whether students are doing a good job of picking up litter on campus?* **Suggested Lessons** Discussion of dreams, goals and "standards." Write down big and small dreams and goals—and record achievements. Pretend to be "campus commissioning agents."

7.4 Resources: Energy

4.3 Daylighting

REF. 2.2 Site Selection, 4.5 Building Envelope, 4.6 Ventilation

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Do you ever wonder why our classrooms need lights? Do we need to use lights everyday? *Have you ever gone a whole day without seeing the sun? How did it make you feel?* *If you were an animal that lived underground, how might you adapt to low lighting levels? I wonder if we could adapt as well?* *I remember the feeling of strong sunlight on my skin...have you ever felt direct sunlight on your skin inside your classroom? Was it pleasant?* *I'm curious if you've noticed the way light bounces or reflects off certain surfaces more than others? Which type of surfaces do you have at school? At home?* **Suggested Lessons** Find north and lay a removable compass on the floor of the classroom. Orient all desks so the northern light falls unimpeded. Then orient the desks to each of the other three compass directions on each successive day. Keep a record of the way the lighting helped or hindered your work. On the fifth day, compile and compare all the results. Measure the overhangs on each of the eaves of your classroom. What is the effect of the overhangs on interior lighting? Which compass directions have the largest overhangs? Why?	*Let's quietly explore campus. I wonder what rooms have their lights on, and what rooms do not? I'm curious as to whether we can predict ahead of time whether rooms will have their lights on or off?* *For those rooms that had their lights on, do you think they needed the lights on? How might the building have been constructed differently so that lights would not have to be turned on very often?* *Have you ever had a day when you felt like you didn't get enough light?* **Suggested Lessons** Study north, south, east, and west by looking at several maps and a globe, and by singing songs that focus on the sun rising in the east, setting in the west. Map-making exercises where students must include the compass rose on the map. Practice walking around campus using a compass. Study evidence in nature of animal and plant behavior that is affected by light (e.g., termite mounds always face the same direction, and moss always grows on the same side of trees, etc.). Talk about circadian rhythms, and the importance of plants and animals (incl. humans) receiving enough sunlight each day). Build a "light/sound catcher." Build "sun traps" to discuss the concept of heat islanding.	*I wonder if you can point to where the sun rises in the morning? Now, can you point to where the sun sets at night?* *I'm curious if we can figure out what parts of the garden receive the most sun during the day? What parts of the garden receive the most shade during the day?* *Do you have any ideas as to what plants grow better in full sun, instead of in the shade? I wonder what plants prefer the shade?* **Suggested Lessons** Sing songs that focus on north, south, east, and west (especially songs that mention how the sun rises in the east and sets in the west). Build a compass, using a bowl of water, a needle, and small cork. Practice walking around campus using a compass. Talk about signs in nature that animal and plant behavior is affected by light (e.g., termite mounds always face the same direction, and moss always grows on the same side of trees, etc.). Talk about circadian rhythms. Pretend to be different plants and animals during daylight hours, twilight hours, and moonlight hours: morning glory, night-blooming cereus, coral polyp, gecko, hoary bat, anole lizard....

4.4 Electric Lighting

REF. 2.2 Site Selection, 4.1 Overall Energy Utilization, 4.1.B Optimized Energy Performance, 4.3 Daylighting

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder where electric power originates? *Do you ever think about what alternatives there might be for electric lights?* *I am curious if there is any way to provide electric lighting without buying energy from the electric company?* *Do you ever wonder how much energy goes into building solar-powered electric lighting systems? How could you find out?* **Suggested Lessons** Using a light meter, chart natural lighting levels at different times of the day in your classroom. Are there "brighter" and "darker" spots in the classroom? What areas might be best for which activities? Set aside one day each month as "no artificial illumination" day. For greater learning effectiveness, perform those tasks which need greater illumination in the places and times that provide the best light. Keep simple records of students' thoughts about the lack of electric lighting and its effect on their studies. If your classroom has fluorescent lighting, find out how it works. Is there a way to retrofit the ballasts to make the lighting more energy-efficient?	*Do you have an idea how electricity is produced?* *Why do we talk about "saving energy" when we turn the lights off in the room?* *I wonder how many different ways electricity is produced on Maui?* *Can you think of additional ways people produce electricity in other parts of the world?* *I wonder what type of electricity production uses the smallest amount of energy?* **Suggested Lessons** Introduce how electricity is produced (e.g., have students practice "doing work" in order to produce electricity with a small tool with which you can squeeze a trigger and thereby turn on a light bulb). Draw diagrams to show the different ways that electricity is produced on Maui (e.g., from burning biomass, from the conversion of solar energy in photovoltaic cells, etc.). Design (and possibly build) a machine that produces its own electricity. Introduce different types of energy measurement (calories, joules, watts, etc.) and compare the energy usage of common appliances (discuss "Energy Guide" tags that accompany products, as well).	*Do you have an idea just what makes a light bulb produce light?* *Isn't it amazing how water starts to run through the auwai when we turn the switch on? How does this happen?* **Suggested Lessons** Introduce how electricity is produced (e.g., have students practice "doing work" in order to produce electricity with a small tool with which you can squeeze a trigger and thereby turn on a light bulb). Experiments with static electricity. Read story of Ben Franklin's discovery of electricity when he went out one night with a kite in a thunderstorm.

4.5 Building Envelope

REF. 2.1 Overall Building Quality and Performance, 2.2 Site Selection, 4.1.A Baseline Energy Performance, 4.3 Daylighting, 4.6 Ventilation, 4.7 Renewable Energy

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Can you guess how many combined total miles each piece of wood, nail, shingle, piece of carpet, chair and mini-blind traveled before arriving at MOMI for construction of the new campus? How could you figure this number out? *I am also curious why we always use glass for windows? Do we really need windows here in Hawaii?* *Do you think we could build at least one school building with only Maui-made products?* *I wonder what percentage of the energy "embodied" in the building envelope is attributable to the energy consumed by transporting the materials from where they were manufactured to Maui?* **Suggested Lessons** Visit a local building supply contractor and ask if they have any Maui-made building materials for sale. Call several MOMI parents who are building contractors, architects, engineers, etc. and arrange an evening round table discussion on choosing locally-made products for MOMI construction, furnishings, and equipment. Go to the docks at Kahului Harbor for a tour of the cargo facilities.	*Let's remind one another what the term "habitat" means. What aspects of your "classroom habitat" are most important to you? What aspects of your classroom habitat would you like to change?* *Do you have an idea what the term "building envelope"* *might mean for an architect and a builder?* *I wonder why we try to "save" energy?* **Suggested Lessons** Discuss habitat. Dream of what "components" make up your "dream habitat." Include abiotic and biotic components of your ideal habitat. Practice reading the information reported on the energy tags that accompany appliances. Practice learning about the important components of the building envelope, by "drawing" pieces of paper [with these components written on the paper] out of an envelope (e.g., heat islanding, cooling load, embodied energy, etc.). Interview architects and engineers about their thoughts about the building envelope.	*Let's remind one another what the term "habitat" means. What parts of your "classroom habitat" are most important to you? What parts of your classroom habitat would you like to change?* *Let's take a closer look at our classrooms on campus. What are ways that the builders prevented the classrooms from becoming too hot? How do the classrooms allow breezes to enter the building?* **Suggested Lessons** Discuss habitat. Dream of what "components" make up your "dream habitat." Animal role-playing.Pretend o be a gecko that is too hot. What does the gecko do? Pretend to be an anole that is cold; what does he do? Pretend that you are too hot/too cold; what do you do? Build "wee homes" with objects from nature for action figures or for figures that you make. Make sure you allow for shade, allow for breezes (ventilation) to enter the home, and build with only local materials. Discuss that a builders think about things like shade, ventilation, and locally-made materials when they think about the building envelope.

4.6 Ventilation

REF. 2.1 Overall Building Quality and Performance, 2.2 Site Selection, 4.1.A Baseline Energy Performance, 4.3 Daylighting

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Do you ever wonder what life on Maui would be like without the trade winds? *I'm curious: do you ever "create" wind to cool yourself? Where does the energy come from to move air in the atmosphere? In your classroom?* *Have you ever been interrupted from your school work due to "stale air?"* *Do you ever wonder why we have so many fans on campus? Is there an alternative to fans for moving air? Do you have an idea what "convection cooling" is?* **Suggested Lessons** Discuss the relationship of the trade winds to weather patterns here on Maui. Why are the trade winds so advantageous to life here on Maui? Using the existing floor plan, show the main air flow patterns in your classroom using arrows. Does it change depending upon the strength of the trade winds? How would this be useful in orienting the new buildings?	*I wonder where on campus it feels the best to take a deep breath? Why? Is there a place on campus where it's difficult, or unpleasant, to take a deep breath? Is there a place on Maui where it's difficult to take a deep breath?* *I wonder if you have an idea what the word "ventilation" means?* *I'm curious as to why we often leave the doors and windows of our classroom open?* *I wonder why the trade winds that we feel almost everyday have been so important to Hawaiians for hundreds of years?* **Suggested Lessons** Compare and contrast the smell and "feel" of the air in several areas of the school campus (e.g., in the garden, under the banyan tree, in the office, in the parking lot, in the classroom, etc.). Discuss the relationship between indoor and outdoor environments. Introduce Admiral Beaufort's Wind Force Scale, and build/use a wind speed meter. Discuss air pressure and its measurement. Build a simple barometer to do "weather forecasting."	*I wonder where wind comes from?* *Do you have any idea why wind has always been so* *important to Hawaiians?* *I wonder if you have an idea what the word "ventilation" means?* *I'm curious as to why we often leave the doors and windows of our classroom open?* **Suggested Lessons** Discuss "where wind comes from." Discuss how humans are different from many other animals because we spend so much of our live indoors, as well as outdoors. Brainstorm other animals that seem to like to live both indoors and outdoors (e.g., house gecko, mouse, dog, etc.). Discuss the relationship between indoor and outdoor environments. Build a nethoscope to determine the direction in which the clouds are moving.

7.4 Resources: Energy

4.7 Renewable Energy

REF. 4.1.A Baseline Energy Performance, 4.1.B Optimized Energy Performance

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder what type of energy we need to live? Do you believe we could live without electricity? *I wonder where and how our electrical power is generated here on Maui?* *Do you think it might be possible to provide all the energy we need on campus from renewable sources?* *I'm curious why we call fossil fuel non-renewable, even when more of it is being made by the earth all the time?*	*What kind of energy does a plant need in order to grow and make food for us and other animals?* *I'm curious as to whether a plant can, one day, use up all of the sun's energy so that no solar energy is left?* *What does your mom or dad put in their car to make it move? Can a car use up all of its gas so that no "chemical energy" is left?* *I wonder if there are other kinds of energy, in addition to solar energy, that are always renewed, or they're never "used up?"* *In what ways have you seen people using renewable energy on Maui?*	*What does a plant need in order to grow and make food for us and other animals?* *I'm curious as to whether a plant can, one day, use up all of the sun's energy so that no solar energy is left?* *How does the flower pinwheel in the garden spin? I wonder if, one day, all the wind is used up so that no wind, not even a tiny breeze, blows into our garden?* *What does your mom or dad put in their car to make it move? Can a car use up all of its gas so that no "chemical energy" is left?* *Can you think of some animals that can re-grow, or "renew," missing body parts?*
Suggested Lessons Build a solar oven, cook meals or dry foods at least weekly. Contact the local college to obtain a solar radiation map for our area. Is it feasible to build solar energy systems here? Is wind generation feasible here? Talk to the county government about using bio-fuels produced on Maui in county vehicles. Design a system to wash clothing or dishes using only solar-heated water.	**Suggested Lessons** Construct a sundial. Build a "sun watch," and use the sun, shadows, and rulers on the ground to tell time. Build an anemometer. Create decorative wind socks, pinwheels, and flags. Hold a science fair to showcase renewable energy projects. Field trips to sites utilizing renewable energy.	**Suggested Lessons** Build a "solar oven" to bake cookies, eat with "solar tea." Make "sun silhouettes" using light-sensitive paper. Build an anemometer with paper cones and sticks. Create decorative wind socks.

7.5 Resources: Materials

5.1 Storage and Collection of Recyclables
5.2 Construction and Demolition Waste Management
5.3 Building Reuse
5.4 Resource Reuse
5.5 Recycled Content Materials
5.6 Local/Regional Materials
5.7 Rapidly Renewable Materials
5.8 Certified Wood
5.9 Termite Control

"There was a child went forth every day;
And the first object he looked upon,
That object he became;
And that object became part of him
For the day, or a certain part of the day,
Or for many years, or stretching
Cycles of years."
—Walt Whitman

Themes for Younger Students:

A story that can meaningfully introduce the topics in this section is one that focuses on the **lifecycle** of a living creature (plant or animal). This story should highlight how the life and gifts of a creature do not end with death; every living creature is part of a never-ending cycle of death, decay, new life, and growth.

Story Recommendations:

Seasons of the Circle: A Native American Year (Joseph Bruchac)
The Dandelion Seed (Joseph Anthony)
Lifetimes (David Rice)
An Elephant Never Forgets Its Snorkel: How Animals Survive Without Tools and Gadgets (Lisa G. Evans)
The Way of the Willow (Emery Bernhard)
What Rot! Nature's Mighty Recycler (Elizabeth Ring)
Forest Log (James R. Newton)
Creepy, Crawly Baby Bugs (Sandra Marlke)
Michael Bird-Boy (Tomie de Paola)

7.5 Resources: Materials *Continued*

Themes for Older Students:

A meaningful story is one that not only discusses the lifecycle of a plant or animal but also spurs students to contemplate whether humans always recognize and honor these cycles. The selection of building materials is a perfect time for students to study the lifecycles of each of the living components that make up the materials being considered for use. Building materials (such as wood, bamboo, plastic, polystyrene, steel, etc.,) are tangible items that can be imagined, observed, or even touched; thus, students can look at them or hold them in their hands as they think about all the individual pieces and work that went into making the materials. As students begin to look, for example, at the trees that died in certain regions of the world for lumber, at the bamboo that was grown ten miles from school, at the amount of water required to make a ton of steel, and at the milk jugs that were recycled in order to make pieces of plastic, their questions will move beyond the lifecycles of living things to the "lifecycles" (and durability and recyclability) of non-living things. They will also begin to think beyond the financial **costs** of materials to a builder, and onto other costs such as environmental costs incurred in the production and transportation of the materials.

Sustainable design considers the environmental impact, toxicity, life expectancy, and initial costs of materials. Material selection is extremely complex and a sustainable designer must weigh and balance several factors—including the lifecycles and all costs of building material components. For example, selecting sustainably-harvested lumber over steel may initially sound like the best choice; the wood is much less energy-intensive to produce and doesn't have the toxicity problems that steel has. However, steel is also much more recyclable and has a longer lifespan. Older students should begin to grasp the complexities involved with sustainable materials selection.

Story Recommendations:

The Giving Tree (Shel Silverstein)

Story about salmon, and how you can determine the health of particular salmon run by the height and density of the blueberry bushes, miles from salmon-spawning streams, because the blueberry seeds are fertilized by half-digested salmon carcasses found in the same piles of brown bear dung.

The Tree that Would Not Die (Ellen Levine)

McCrephy's Field (Christopher A. Myers and Lynne Born Myers)

The Man Who Planted Trees (Jean Giono)

The People Who Hugged Trees (Deborah Lee Rose)

Story about Easter Island

Earth Circles (Sandra Ure Griffin)

Giants in the Land (Diana Applebaum)

5.1 Storage and Collection of Recyclables

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Do you ever wonder where trash goes when you throw it away? Why do you think we (USA) have been called the greatest consumer society on Earth? *Do you ever think about where all the materials we recycle on campus end up? Is some of it never recycled at all?* *I wonder if any of the materials we collect are recycled right here on Maui? How can you help insure the success of a local recycling business?* *Do you think it is better to put recycling centers in the middle of campus, or hidden off to one side? Why?* **Suggested Lessons** Visit a recycling center. Start or expand a recycling program. Investigate what recycled products are used on campus. Hold a "recycled book" fair.	*What does it mean to recycle something? What does it mean to reuse something?* *What items do we recycle at school? What are other items that you and your family recycle at home?* *Why do we try to recycle some items?* *I wonder why we don't recycle the paper cups that we use at the big water bottles?* *I wonder why we don't recycle plastic bags?* **Suggested Lessons** Examine examples of things that were made with recycled products (e.g., "plumber," or plastic lumber, fleece jacket made out of plastic bottles, composted soil made from kitchen scraps, etc.). Write songs and/or perform plays about recycling. Introduce the Reduce-Reuse-Recycle symbol on items. Discuss the difference between reuse and recycle. Research where canvas/hemp bags made from recycled products can be purchased. Encourage school to sell them to parents at a profit, and encourage parents to use as grocery bags, instead of plastic (decorate bags). Students invite local speakers to lunch. Discuss recycling on Maui, and how kids, and their families, can become involved.	*What does it mean to recycle something?* *I wonder how many different things we can list that we recycle at school? Are there other things that you and your family recycle at home?* *Do you ever wonder what happens to those things that we put in the recycle bins at school—after workers take these things away in a truck?* *Why do you think it's important to recycle paper and aluminum cans and glass bottles?* **Suggested Lessons** Examine examples of things that were made with recycled products (e.g., notebooks with recycled paper, "plumber," or plastic lumber, fleece jacket made out of plastic bottles, composted soil made from kitchen scraps, etc.). Make a colorful, illustrated list of what items that can be recycled at school. Post these signs around campus, especially near trash cans and receptacles for recyclables. Write songs and/or perform plays about recycling.

5.2 Construction and Demolition Waste Management

REF. 1.3 Reduced Site Disturbance, 5.3 Building Reuse

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious…how much of the "waste" created by new construction is recycled? Can some of it actually be sold? *Do you ever wonder what the ancient Hawaiians did with their construction 'waste?'* *I wonder if we can separate the waste from our new construction so that it makes it easier to recycle or sell? How would you go about managing the recycling of construction waste?* *I wonder if it would help to keep a record of the type and amount of waste recycled or reused as a percentage of the total?* **Suggested Lessons** Design a "waste recycling station" for the new construction site. Make it user-friendly and large enough to accommodate large machinery. Research and make an easy-to-read list of potential construction waste users' names and contact numbers for contractors at MOMI. Make a plan for reusing construction materials, that would ordinarily be headed for the dump, in arts and crafts, fort building and maintenance. Even screws can be reused.	*How can we describe a cycle?* *What do we mean when we talk about the lifecycle of an animal or a plant? What is the lifecycle of a butterfly? A mosquito? A eucalyptus tree? A Hawaiian tree fern?* *We recycle items like paper and aluminum cans. Do paper and aluminum cans also have a lifecycle?* *I wonder if there's an end to a lifecycle?* *What does it mean to waste something?* *What are some ways that we can reduce waste at school?* **Suggested Lessons** Act out and/or illustrate the lifecycles of common plants and animals. Illustrate the "lifecycles" of white paper, aluminum cans, Styrofoam "peanuts," and plastic bottles. Introduce the word "waste." Examine common things that are "left over" [and often thrown away] after lesson. How can we reuse or recycle some of these items? What are some ways that construction workers can reuse "construction waste?"	*What do you always do with your work before you start to do a different task, or different work?* *I wonder if animals ever leave their work out or forget to clean up their mess?* *When you put your work away in your class, what kinds of things do you throw away in the garbage? Instead of throwing ______ away, do you think you could reuse it? Or, maybe you could recycle it?* *I wonder what kinds of things construction workers throw in the garbage after they finish their work? I wonder if they could reuse or recycle ______, instead of throwing them in the garbage?* **Suggested Lessons** Examine common things that are "left over" [and often thrown away] after a lesson. Being creative, how can we reuse or recycle some of these items? Observe common things that are "left over" as waste after new construction. Can we think of ideas as to how a construction worker can reuse "construction waste?"

5.3 Building Reuse

REF. 1.1 Erosion Control, 1.3 Reduced Site Disturbance, 2.2 Site Selection, 5.2 Construction and Demolition Waste Management

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious; do you reuse parts or entire things in everyday life? Why do you reuse these parts/things? *I wonder: If it was impossible to obtain any new items for construction of a new campus, could it still be built?* *Do you ever wonder how Hawaiians built their shelters before the arrival of westerners? Did they reuse parts of old buildings?* *I am curious if it might be possible to reuse parts of the existing buildings in the new campus? What parts of the buildings are most useful?* **Suggested Lessons** Build a fort or clubhouse using only recycled materials. Take a dilapidated or neglected structure on campus and devise a plan to rebuild/refurbish it using some new and some recycled materials. Estimate what percentage of the old structure will be reused before beginning reconstruction. Keep records and compare actual with estimated reuse of materials. Have each student bring in a small piece of rock to be added to the aggregate in the foundation of the new buildings.	*I'm curious as to how many things we reuse—or use many times—at school and at home every day?* *Why do you think it's a good idea to reuse items as many times as possible before we throw them away?* *Can you think of items that you could reuse, but that you don't right now?* *Out of what kinds of materials (things) are buildings constructed? I wonder where these materials come from?* *I really wonder whether we can reuse materials from old buildings when we construct the new buildings of our school?* **Suggested Lessons** Construct a fort with materials that (1) can be recycled OR that (2) can be reused. Field trip to the local landfill. Study birds (e.g., eagles and ospreys) that return to the same nest year after year. Reuse items in creative ways—each student gets to think of a way to reuse a common product at home that might otherwise be thrown away.	*Do you sometimes "reuse" a piece of paper, or use a piece of paper many times? Why or why not?* *What other things do you use over and over again before you throw them away?* *Why do you think it's a good idea to reuse some things before you throw them away?* *I wonder if we can think of some things that we throw away after we use them once, but we really could try to use them over and over again?* *I wonder if animals reuse some of the things they use each day?* **Suggested Lessons** Study birds (e.g., eagles and ospreys) that return to the same nest year after year. Look for bird nests (or mouse dens) that have recycled/reused products in them. Reuse items in creative ways—each student gets to think of a way to reuse a common product at home that might otherwise be thrown in the garbage (e.g., reuse an egg carton to store a seed collection; reuse old clothing for a scarecrow in the garden; reuse cardboard toilet paper rolls to make imaginary binoculars, etc.).

5.4 Resource Reuse

REF. 5.3 Building Reuse, 5.5 Recycled Content Materials, 5.6 Local/Regional Materials, 5.7 Rapidly Renewable Materials, 5.8 Certified Wood

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if there are any materials already on campus that we could incorporate into the new construction? Can you name a few? *Maybe we could find even more reusable construction materials if we expand our search to all of Maui?* *What about water used during construction? I wonder if we could capture and reuse it on campus?* *Can you imagine why keeping track of the percentage of reused materials out of total materials in the new construction would be useful?* **Suggested Lessons** Look on campus for materials that are currently available for reuse in new construction. Find out which buildings are going to be demolished and see what parts of them are reusable. Contact local waste management companies to see if they will provide a list of construction salvage companies. Look to them for help in finding markets for salvaged materials.	*I'm curious as to how many things we reuse—or use many times—at school and at home everyday?* *Why do you think it's a good idea to reuse items as many times as possible before we throw them away?* *Can you think of items that you could reuse, but that you don't right now?* *Out of what kinds of materials (things) are buildings constructed? I wonder where these materials come from?* **Suggested Lessons** Construct a fort with materials that (1) can be recycled OR that (2) can be reused. Field trip to the local landfill. Reuse items in creative ways—each student thinks of a way to reuse a common product. Brainstorm ways to reuse the wood from felled or pruned trees. Additionally, talk to an arborist and to architects about their ideas.	*What things do you use over and over again before you throw them away?* *Why do you think it's a good idea to reuse some things before we throw them away?* *I wonder if we can think of some things that we throw away after we use them once, but we really could try to use them over and over again?* *I wonder if animals reuse some of the things they use each day?* **Suggested Lessons** Study birds (e.g., eagles and ospreys) that return to the same nest year after year). Reuse items in creative ways—each student gets to think of a way to reuse a common product at home that might ,otherwise be thrown in the garbage (e.g., reuse an egg carton to store a seed collection; reuse old clothing for a scarecrow in the garden; reuse cardboard toilet paper rolls to make imaginary binoculars, etc.). Try to build your own nest with at least some reused/recycled items, and see if a bird likes it—or steals the materials.

5.5 Recycled Content Materials

REF. 5.4 Resource Reuse, 5.6 Local/Regional Materials, 5.7 Rapidly Renewable Materials, 5.8 Certified Wood

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious about the contents of our construction materials: Do they contain any reused materials? What materials are more likely to contain reused materials? *Do you believe our goals that our new buildings will contain at least twenty percent recycled materials can be achieved? Are there examples elsewhere that we could use as a guide? I wonder how each one of us could help achieve the goal through our own labor?* *I wonder if using recycled content materials is better for the local environment? For the US? For the world?* **Suggested Lessons** Visit an architect or a designer to get a hands-on feel of recycled content carpet, furniture, wall coverings and composite wood. Which ones would you like to see in the new buildings? Keep a record of the exact amount or percentage of the new construction that is recycled content materials. Compare recycled material content at MOMI as compared to other green school buildings across the country. Can we do even better?	*Here is a box of ceiling tiles. These tiles are going to be used in one of the new buildings at school. Do you have an idea what ceiling tiles are made of? I wonder if we might find a list of "ingredients" or "contents" on this box?* *The box of ceiling tiles lists that these tiles contain some items, or "materials," that have been recycled. I wonder what this means?* *Why do you think it's important to our school that we buy construction materials, such as ceiling tiles, that are made from recycled materials?* *This box of ceiling tiles lists that some of the recycled materials used to make the tiles were either recycled "post-consumer" OR "post-industrial." What is a consumer? What is an industry?* **Suggested Lessons** Give examples of final products made from recyclables. Dream of uses for recyclables. Discuss consumer vs. industry.	*Here is a box of cereal and a box of tortilla chips. How can we find out what these foods are made out of, or what the "ingredients" are?* *Here is a box in which you can find ceiling tiles. These tiles are going to be used in one of the new buildings at school. Do you have an idea what ceiling tiles are made of? I'm wondering if we might find a list of "ingredients" or "contents" on this box?* *The box of ceiling tiles lists that these tiles contain some items, or "materials," that have been recycled. I wonder what this means?* **Suggested Lessons** Compare the lists of ingredients on several boxes of food. Next, begin to compare lists of contents on items such as paper products (toilet paper and paper towels). Introduce the Reduce-Reuse-Recycle symbol on boxes of food and other products. Provide clear examples of what products individual recycled items may become after manufacturing (e.g., plastic bottles can become plumber).

5.6 Local/Regional Materials

REF. 5.4 Resource Reuse, 5.5 Recycled Content Materials, 5.7 Rapidly Renewable Materials, 5.8 Certified Wood

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder if it is important to use local businesses during campus construction. Why? *I wonder what the average distance is that each nail, beam and shingle travels to get to Maui?* *I'm curious if there are Maui-harvested, Maui- manufactured or Maui- produced construction materials available?* *Can you imagine why the use of local materials might be important for Hawaii? Can you think of other ways to reduce the environmental cost of transporting building materials to MOMI?* **Suggested Lessons** Using a world map, trace the path of several MOMI building materials from their point of extraction through final assembly and delivery to Maui. Find average miles traveled for construction materials. Ask local construction supply companies if they have a list of locally-produced construction materials. If there's not one, make one, and give it to the industry. Devise a strategy to make a construction material from something found in the bioregion such as crushed coral concrete or sand for stucco to use in the new construction. Document the process	*Let's look at some of the items I've brought to our lesson today. I wonder if we can guess where each of these things were made?* *Let's look at a map of the world. First, can you find where we live on the map? How do things that are made if other places make it to where we live? How far do these items have to travel in order to reach us on the island of Maui?* *Pretend you are a building contractor who is in charge of building a new deck for a building at school. If you have to decide whether to use wood from pine trees in Canada or "plumber" (plastic lumber) that was made locally on Maui, how would you make your decision?* **Suggested Lessons** Introduce the words "local" and "regional." Games that involve guessing where items were made. Using a world map, pins, and yarn, physically trace how far items had to travel from where they were made to reach us here on Maui. Interview local building contractors to see how many local materials they use.	*Let's look at some of the items I've brought to our lesson today. I wonder if we can guess where each of these things were made?* *Let's look at a map of the world. First, can you find where we live on the map? How do things that are made in other places make it to where we live? How far do these items have to travel in order to reach us on the island of Maui?* *Now, let's look at a map of the State of Hawaii. How do things made on the island of Oahu make it to use here on Maui? How far do these items have to travel in order to get to Maui?* **Suggested Lessons** Introduce the word "local." Games that involve guessing where items were made. Using a world map, pins, and yarn, physically trace how far items had to travel from where they were made to reach us here on Maui.

5.7 Rapidly Renewable Materials

REF. 5.4 Resource Reuse, 5.5 Recycled Content Materials, 5.6 Local/Regional Materials, 5.8 Certified Wood

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious if the strength of a piece of wood for building is directly proportional to its age? *I wonder why some types of wood are more favored for construction than others?* *I am curious if people in Asia use the same type of wood for construction that we use here on Maui? In Hawaii?* *Do you think the tropics are a good place to produce rapidly renewable construction materials?*	*What does it mean to recycle something? What does it mean to reuse something? What do you think it means to renew something* *Let's explore the campus and look for signs of "renewal" in nature.* *If we really study the buildings at school, can we find building materials that were made from things in nature that renew very fast? We call these materials "rapidly renewable materials."*	*Can you think of some animals that re-grow, or "renew," missing body parts really fast?* *I wonder how many plants in our garden grow really fast? How many plants grow really slow?* *What do you think will happen when we cut a single leaf off of a plant, but don't hurt the rest of the plant? Will the plant die? Will the plant renew itself and grow a new leaf? Will the plant keep growing but not grow a new leaf?* *I'm curious as to why some plants (e.g., bamboo) grow very fast in Hawaii?*
Suggested Lessons Create a list of rapidly renewable materials which are available for use in our new construction. Find an appropriate spot on campus and grow a crop of bamboo that can be used for construction of a permanent structure within five years. Make a list, country by country, of at least ten other tropical nations and the top five construction materials in each. Which country uses the most rapidly renewable materials? Are they also the most sustainable?	**Suggested Lessons** Explore the campus and record all signs of *renewal* in nature. Study the buildings and school and determine what might comprise rapidly renewable materials. Plant a single bean seed in one pot, a bamboo cutting in one pot, and a longon tree seed in one pot. Compare and contrast the plants' growth over several weeks time. Make paper out of items on campus that grow quickly. Build a small fort composed almost entirely of rapidly renewable materials. Make "spore prints" from mushroom caps to show how mushrooms are always ready to renew themselves.	**Suggested Lessons** Explore the garden and look for all signs of renewal. Investigate how plants like sunflowers and cosmos flowers in a small garden "renew" themselves [quickly, by dropping their seeds next to the parent plant and with-out a person having to plant a seed for them]. Plant a single bean seed in one pot, a bamboo cutting in one pot, and a longon tree seed in one pot. Compare and contrast the plants' growth. Wear socks over shoes and go on an expedition around the campus. What seeds do you collect? What plants "renew" themselves by hitchhiking?

7.5 Resources: Materials

5.8 Certified Wood

REF. 5.4 Resource Reuse, 5.5 Recycled Content Materials, 5.6 Local/Regional Materials, 5.7 Rapidly Renewable Materials

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
When you look at a piece of wood, do you "see" the tree it came from? Where in the world did it grow? How did it get here? *I wonder if it would be possible to plant and grow our own trees on the new campus to be used in the construction of future buildings at MOMI? How would you select the type and number? Would you want to label them as such?* *I wonder if certified wood is more or less expensive than standard wood? Would you buy certified for your own home?* **Suggested Lessons** Do an analysis of possible tree species that would be appropriate to plant on campus to be used at some point in the future as wood for new construction. How long does it take to harvest? Find out if and where we could obtain certified wood for construction. Is it environmentally friendly, even if it has to be shipped thousands of miles? Design and build a plaque to display on the new campus declaring the use of certified wood.	*Have you ever been given a special certificate? What was the certificate for?* *Let's explore the campus and count how many trees of each species we have on our campus. We'll pretend that we work for the Forest Stewardship Council and we'll give a special certificate to the species of tree that is most common, or the most numerous.* *If you want to cut down several trees, what other things are important about a tree in addition to how common a tree is?* **Suggested Lessons** *Design special plaques for the trees on campus (e.g., a few facts about the most numerous and the most rare, label trees as endemic, native, or introduced to Hawaii, etc.).* *Field trip to a lumber store to see what lumber is certified by the F.S.C.*	*Have you ever been given a special certificate? What was the certificate for?* *I wonder if animals or plants have ever been given special certificates?* *If you were going to give a special certificate to an animal or plant in the garden, what would you give it to? Why would you give ______ a special certificate?* **Suggested Lessons** *Create and present special certificates to plants in the garden and around campus.* *Play "Me Tree" in which a student finds a tree that best reflects their personality, appearance, etc. Make a special certificate for this tree that explains why it's special.*

5.9 Termite Control

REF. 2.1 Overall Building Quality and Performance

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Do you ever wonder why we have termites on earth? What is their favorite food choice? *I am curious if there is a type of wood that is not eaten by termites? What about alternatives to wood?* *I wonder if termites are just doing their "job" (decomposition) and we are actually creating a perfect habitat and food source for them by building with "dead" wood?*	*I'm curious as to what "pests" we sometimes find in the garden or in our classrooms? Why do we call these animals pests?* *How would you describe the lifecycle of a butterfly?* *How would you describe the lifecycle of a termite?* *I wonder how many different kinds, or species, of termites we find on our campus?*	*I'm curious as to what "pests" we sometimes find in the garden or in our classrooms? Why do we call these animals pests?* *Have you ever heard of an insect called a "termite" that some people call a pest? Why do you think many people think that termites are pests?* *I wonder if anyone can describe the lifecycle of a butterfly?* *I wonder if a termite also has a lifecycle?*
Suggested Lessons Study the lifecycle of termites and the role they play in decomposition and soil building. Research possible landscape plants or soil microorganisms to repel termites/pests (biocontrol). Talk to maintenance personnel about past termite damage and successful strategies for reducing or eliminating termite damage to new structures. Study the techniques and science behind termite barriers and the non-toxic treatment of lumber.	**Suggested Lessons** Research different kinds of social insects (bee/ant/termite). Role-play as different individuals in a termite colony; determine the needs and jobs of each of these individuals. Scientific expedition: explore the campus and look for signs of termites, as well as other social insects. Interview an insect exterminator and a builder to understand how they attempt to keep termites from infesting buildings. Draw the different stages of a termite lifecycle.	**Suggested Lessons** Play the game, "Go Metamorphosis." Role-play as different individuals in a social insect colony (bee/ant/termite). Hold an "Insect Olympics" to help students understand the extraordinary capabilities of insects (e.g., termites build the largest nests in parts of the world and cockroaches are the fastest runners). Scientific expedition: explore the campus and look for signs of termites, as well as other social insects. Termite dissection. Draw the different stages of a termite lifecycle.

7.6 Indoor Environmental Quality

6.1 Material Selection
6.2 Environmental Quality Management in the Construction Process
6.3 Ventilation
6.4 Lighting, Acoustical and Thermal Quality

"You need to start with the relationship between you and the earth being healthy. For this, the earth needs to be healthy…."
—Eric Enos, Cultural Learning Center at Ka'ala Farm, Inc.

Themes for Younger Students:
A story that can meaningfully introduce the topics in this section is one that discusses one of the basic needs of all living creatures: clean air (oxygen). An ideal story is one that compares life in a city to life in the country—and describes the factors that lead to healthier ecosystems outside urban areas (less atmospheric pollution, more trees, people outside more often, etc.). A good story is also one that talks about how polluted air can travel great distances; atmospheric wind, wind at cloud levels, storms, etc. mean that pollution in other countries may reach communities of living things thousands of miles away.

Story Recommendations:

The Town Mouse and the Country Mouse (Aesop fable)
Air (Ken Robbins)
The Mountain that Loved a Bird (Alice McLerran)
Something is Growing (Walter Lyon Krudrop)

Themes for Older Students:
Older students can relate intellectually to the importance of clean air with their greater knowledge of biology and chemistry. These students already have a basic understanding of the laws of chemistry and physics. This enables them to understand that the changes humans are capable of making in the atmosphere are difficult, if not impossible, to undo. Stories that tell of the incredibly fragile balance of elements in the atmosphere which gave rise to all life on Earth are recommended, as well as any creation myths which speak of the earth as it evolved.

Story Recommendations:

The Garden in the City (Gerda Muller)
Crinkleroot's Guide to Knowing Animal Habitats (Jim Arnosky)
Tlingit First Nation [of Southeast Alaska] stories of how they called certain kinds of lichen "lungs of the earth" because they only grow in areas where air is the cleanest.
The Empty Lot (Dale H. Fife)
Stories, myths, and legends about the creation of the earth, and about the massive changes Earth has experienced through time.
The Sacred Balance (David Suzuki)
Story of the pepper moths near New York City whose wings changed to darker hues over generations, in response to dark pollution covering their habitat (they changed colors in order to camouflage in with their surroundings).

7.6 Indoor Environmental Quality

6.1 Material Selection

REF. 2.1 Overall Building Quality and Performance, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder how many breaths you take everyday at school. How could you figure out? *Do you ever think about the materials used in your class floor, walls or ceiling having an effect on your health?* *I wonder if we could use only natural, locally-made materials to cover our walls, ceiling and floors? Are there any building materials that we could collect and prepare right here on campus?* *Do you believe that your health can be affected by unseen elements?*	*Why do you think it's important for us to breathe air that is clean, instead of air that is "dirty," or "polluted?"* *I wonder why air sometimes has a funny or bad smell, but we can't see what part of air has this strong smell?* *I'm curious if you can think of an animal or a plant that smells bad? Why do you think they produce this smell?* *I'm curious if you can think of something that a human makes that smells bad?*	*Why do you think it's important for us to breathe air that is clean, instead of air that is "dirty," or "polluted?"* *I wonder why air sometimes has a funny or bad smell, but we can't see what part of air has this strong smell?* *I'm curious if you can think of an animal or a plant that smells bad? Why do you think they produce this smell?* *I'm curious if you can think of something that a human makes that smells bad?*
Suggested Lessons Complete a survey of all cleaning products currently used in your classroom. Can you find any pollutants in them? Do they have warning labels? Are there any non-toxic alternatives? Contact your local Health Department to find out what the maximum allowable level of indoor air pollutants is in a public building. Do you think any level of a known pollutant is safe? Research indoor air pollutants to find out which have been proven to have negative health consequences. Do we have any sources of these pollutants on campus? Could we remove them permanently? Will they be present in the new buildings?	**Suggested Lessons** Introduce man-made objects and substances that might pollute the air. Interview a building contractor about man-made materials. Compare/contrast man-made chemicals that smell bad with foul-smelling things found in nature (e.g., what is the purpose of paint or resin versus the purpose of a chocolate lily flower that smells bad to attract the pollinating flies or a skunk that emits a chemical to deter predators?).	**Suggested Lessons** Introduce man-made objects and substances that might pollute the air. Compare/contrast man-made chemicals that smell bad with foul-smelling things found in nature (e.g., what is the purpose of paint or resin versus the purpose of a chocolate lily flower that smells bad to attract the pollinating flies or a skunk that emits a chemical to deter predators?).

6.2 Environmental Quality Management in the Construction Process

REF. 1.3 Reduced Site Disturbance, 5.1 Material Selection, 6.1 Material Selection

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I'm curious; have you ever lived, worked or played near a building under construction? Did you notice any particular smells or tastes? *I wonder…do you have any idea how we might control the dust, noise and smells of construction equipment and materials while building a new campus? Are "dust barriers" and high fences good enough, or could we do more?* *Have you ever noticed a musty, moldy smell in your classroom? Do you think it might have a negative effect on your well-being?* **Suggested Lessons** Go underneath your classroom and look for signs of rot and mold. Are there any methods of removing these hazards? Come up with a design for the new construction barriers that removes the threat of noise and dirt pollution to the existing classrooms. Find out which construction materials are rot, mold and mildew-proof. Can we build only with these materials? Are there any materials that do not need constant cleaning or repeated treating with chemicals and cleaners?	*Why do you think it's important to have a plan before you start to do difficult work?* *I'm curious as to whether you can describe the smell of each of these things that is used in the construction of a new building: a piece of bamboo, a steel can, a piece of pine wood, a piece of gypsum wallboard, a piece of glass?* *Can you describe what gasoline smells like when your mom or dad is filling up their car at the gas station?* *I wonder if it's possible for air to smell bad, but we can't actually see what smells awful?* **Suggested Lessons** Conduct a planning activity, such as clearly planning how we're going to build a small fort, and how we're going to clean up "our work" when we're finished. Demonstrate a solid, a liquid, and a gas by first setting out a glass of water and an ice cube. Next, boil water on stove and watch steam evaporate. Discuss the lack of smell of water in solid, liquid, and gaseous states.	*Why do you think it's important to have a plan before you start to do difficult work?* *I'm curious as to whether you can describe the smell of each of these things that is used in the construction of a new building: a piece of bamboo, a steel can, a piece of pine wood, a piece of gypsum wallboard, a piece of glass?* *Can you describe what gasoline smells like when your mom or dad is filling up their car at the gas station?* *I wonder if it's possible for air to smell bad, but we can't actually see what smells awful?* **Suggested Lessons** Conduct a planning activity, such as clearly planning how we're going to build a small fort, and how we're going to clean up "our work" when we're finished. Demonstrate a solid, a liquid, and a gas by first setting out a glass of water and an ice cube. Next, boil water on stove and watch steam evaporate. Discuss the lack of smell of water in solid, liquid, and gaseous states.

6.3 Ventilation

REF. 1.3 Reduced Site Disturbance, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection, 6.1 Material Selection, 6.2 Environmental Quality Management in the Construction Process, 6.4 Lighting, Acoustical and Thermal Quality

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
Have you ever wondered how long it takes for the air to completely flush your classroom out? How many cubic feet of air space are in your class? Estimate the total air flow, in cubic feet per second, your windows and doors provide. Can you control the flow to avoid construction pollutants, while still remaining comfortable? *I would like to know if you like to feel the air move in your classroom? If you will have to keep the outside air from entering you class during construction, will it make you uncomfortable, even irritable?* *I wonder if it is possible to "flush" all of the air and hidden pollutants out of your classroom after construction ends?* **Suggested Lessons** Make a graph showing the levels of possible air pollutants in your classroom on a normal day, versus the possible pollutants airborne in your class during construction. Is it hazardous to be present near a large construction site? Talk to local scientists and engineers about air flow. Try and determine if there are certain times/events during construction that are more hazardous than others? Could we schedule those events during holidays/breaks?	*Do you have an idea what air is composed of?* *What does it mean to say that air is "clean" or that air is "dirty?" I wonder if you can always tell when air is dirty, or "polluted?"* *I wonder if animals or plants might sometimes give us clues about how clean (or dirty) the air is? (e.g., lichen distribution on trees and rocks)* *I wonder where on campus it feels the best to take a deep breath? Why? Is there a place on campus where it's difficult, or unpleasant, to take a deep breath? Is there a place on Maui where it's difficult to take a deep breath?* *I'm curious as to why we often leave the doors and windows of our classroom open?* **Suggested Lessons** Discussion of habitat (*biotic* and *abiotic* factors). Determine the amount of "hidden poisons" in a region (e.g., a town) by placing pieces of paper smeared with petroleum jelly on trees, signposts, street corners, etc. Examine lichen distribution on rocks and logs on campus, and on field trips to more urban and rural areas. Compare and contrast the smell and "feel" of the air in several areas of the school campus (e.g., in the garden, under the banyan tree, in the office, in the parking lot, in the classroom, etc.). Discuss the relationship between indoor and outdoor environments.	*I wonder why living creatures need air in order to survive?* *Do you have an idea what is in air…what air is made out of?* *I wonder if you have an idea what the word "ventilation" means?* *I'm curious as to why we often leave the doors and windows of our classroom open?* **Suggested Lessons** Create an illustration of what air is made out of. Engage in activities that demonstrate how people and animals prefer "clean air" as opposed to "dirty air." Compare and contrast the smell and "feel" of the air in several areas of the school campus (e.g., in the garden, under the banyan tree, in the office, in the parking lot, in the classroom, etc.). Discuss the relationship between indoor and outdoor environments. Discuss how humans are different from many other animals because we spend so much of our lives indoors, as well as outdoors. Brainstorm other animals that seem to like to live both indoors and outdoors (e.g., house gecko, mouse, dog, etc.).

6.4 Lighting, Acoustical and Thermal Indoor Quality

REF. 2.1 Overall Building Quality and Performance, 4.3 Daylighting, 4.4 Electric Lighting, 4.5 Building Envelope, 4.6 Ventilation, 5.1 Material Selection

SCALES AND CURRICULUM – Emergent Questions and Lessons

MACRO: Social Action Middle School (ages 12-15)	**MESO: Exploration** Elementary (ages 7-11)	**MICRO: Empathy** Primary (ages 3-6)
I wonder...have you ever closed your eyes for ten minutes straight, just to discover all the smells, sounds and touches (temperature, wind) in your classroom? Can you think of any examples in nature of animals or plants controlling or choosing their habitat to control wind, rain, light and temperature ranges? How? Can we learn anything from this? I'm curious if the way your senses perceive the environment has an effect on your mood? Does temperature change the way you study? Talk? Play? Eat? Drink? Why? Do you ever feel that it is too loud to concentrate in class? How can we change the sound level in your classroom? **Suggested Lessons** Take a survey of at least one hundred students and get their opinions on indoor versus outdoor environments. Which is most comfortable? Most conducive to quiet study? Most conducive to play? Learn about sound. Get a decibel meter and find out the average sound level at various points around campus. Correlate sound levels to activities taking place in various locations. Do a survey of lighting levels in each classroom. Are some classrooms brighter than others? Why? Does the age level of the students have any bearing?	*I'm curious as to whether you and your teacher can control the "indoor habitat" of your classroom? Can you control the temperature or the lighting or the flow of air (the breeze)? How?* *How does an earthworm/caterpillar/gecko control the temperature or lighting or air flow of its habitat?* *Can you think of aspects of your indoor or outdoor habitat that help you to focus on your work the best? For example, have you noticed that you are able to better concentrate on your work when it's a certain temperature or when the lighting is "just so?"* **Suggested Lessons** Study the ideal body temperatures of several animals (including humans). Discuss the range of environmental temperatures in which animals function best. Introduce ecological zones in which different animal populations are found on the planet. Compare and contrast warm-blooded animals and cold-blooded animals. Introduce *homeostasis.* Study evidence in nature of animal and plant behavior that is affected by light (e.g., termite mounds always face the same direction, and moss always grows on the same side of trees, etc.). Talk about circadian rhythms, and the importance of plants and animals receiving enough sunlight each day.	*I wonder if you have any idea what a "habitat" is?* *I'm curious as to whether you and your teacher can control the "indoor habitat" of your classroom? Can you control the temperature or the lighting or the flow of air (the breeze)? How?* *How does an earthworm/caterpillar/gecko control the temperature or lighting or air flow of its habitat?* *What is the temperature of our bodies when we're healthy? I wonder what you do when you feel too hot? What do you do when you feel too cold?* *Have you ever had a day when you felt like you didn't get enough light? I'm curious about whether you prefer to have the lights on in your classroom or whether you prefer to use the daylight that comes through the windows and doorways?* **Suggested Lessons** Construct a personal favorite habitat in a shoebox. Study the ideal body temperatures of several animals (including humans). Role-play as a gecko that seeks shade to cool down during the day, as an anole lizard that seeks sun in order to warm up during the day, as a butterfly that seeks sun in order to regain its energy to fly, etc. Compare and contrast warm-blooded animals and cold-blooded animals. Talk about signs in nature that animal and plant behavior is affected by light (e.g., termite mounds always face the same direction, and moss always grows on the same side of trees, etc.).

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