IV. Facilities

A. Guiding Principles

Planning, construction and maintenance of physical facilities constitute a significant component of FSML operations. While it is true that bricks and mortar facilities are not necessary for good science, it is equally true that environmental science cannot thrive without various kinds and degrees of field support. Well managed habitat and field sites are critical for successful field science endeavors. See **Figure IV.A** for a conceptual model illustrating the relationship between facilities and stewardship.

Experienced FSML directors suggest that there are some fundamental underlying principles that should guide facilities planning and development. These include:

1. If you can't maintain it don't build it.

2. Temporary facilities are permanent.

3. Don't expect user fees to fully cover operational costs.

4. Facility design requires flexibility to meet changing programs and technologies and the resulting impacts (i.e. more people = more poop). Consider that there might be a limit to the carrying capacity of the FSML.

5. Green technologies are desirable but the capital outlay and operational and technical requirements should be factored into any decision to use these construction techniques.

6. Volunteers are not free and cannot be relied upon for operations.

7. Deferred maintenance is often the most overlooked component to operations.

8. Facility planning requires personnel with appropriate skills and experience.

9. The operational seasonality of a FSML needs to be incorporated into facility planning.

10. Access to skilled maintenance assistance options, whether on campus or in town, needs to be factored into facility development considerations.

11. Keeping a written history of facility construction is of utmost importance. Maps and construction plans that show the location of septic cleanouts and foundation drains or illustrate wall interiors, etc. can save untold future anguish. Documenting the process that led to construction is also important. Some FSMLs have historic structures, and records relating to them assist with securing funding for renovations. Since several FSMLs are over 100 years old, and hopefully all will eventually reach that age, current modern structures will one day be historic, and written records provide an important archive.

12. Most FSMLs own the land on which their facility and research areas are located. However, some lease part or even all of their land resource. Additionally, some manage their own land or leased land, and some do not. Each of these ownership configurations affects the nature of facility development.

B. Buildings

Buildings refer to physical structures, whether permanent or temporary. See **Table IV.B** for some field station facility suggestions. The following categories describe facility functions requiring specific design criteria. Some of these uses may overlap depending on site- and program-specific considerations.

1. Research Facilities

   Laboratories, lab/offices, greenhouses and other research facilities may need to accommodate a variety of equipment and uses requiring sufficient space, electrical service (120 TO 440v), water supply, waste discharge and other utilities. Specific research and sample preparation needs should be taken into account. Perhaps certain sample processing would be better done at a campus or other laboratory with more reliable quality controls. Sample archiving may require special storage such as cryopreservation. Reliable power backup systems are important. Laboratory safety features should be considered, such as showers, fume hoods or hazardous waste disposal.

   Some field labs can be primitive, without water or even power, whereas others need a full array of utilities. Animal care and use facilities are of critical importance at FSMLs. Another consideration is whether research space is to be shared or private. The provision of storage for research gear is important. Does the FSML provide research equipment or do visiting researchers bring everything they need? All of these issues describe different levels in the spectrum of FSML facilities, from primitive field research sites to technologically sophisticated research centers.

2. Education and Training Facilities

   Attention should be paid to the specific kind of educational exercises to be conducted. Appropriate facilities include everything from formal large lecture classrooms to small research labs for individualized training in specific techniques. Different educational programs will determine lab bench/counter configuration and utilities needs such as gas, air and distilled water. Research training materials such as field guides and laboratory manuals may be housed in teaching labs or a library.

3. Support Facilities

   Facilities that support research and educational programs include animal care facilities, museum collections, herbaria, climate controlled environments, libraries, seminar rooms, meeting rooms, computer rooms and storage areas. Some of these facilities may have special needs, such as separate HVAC systems or humidity control features. Air handling systems will require special attention as FSMLs engage in increasing amounts of research involving invasive species, including microbes, in containment facilities.

4. Administrative Facilities

   Administrative offices are technically support facilities for research and educational programs, but often are considered separately as administrative areas on a land use plan. A FSML will need a reception area, director and staff offices, an area for office equipment functions, and appropriate storage for the accumulated history of applications, forms, decisions made, maps, plans, etc.

   Other necessary administrative functions include those related to buildings and grounds maintenance, construction, fabrication of field equipment, docks, vessel repair, vehicle maintenance, etc.

5. Housing

Consideration of housing needs requires attention to station use patterns (research use vs. classes of various levels), type of clientele (resident vs. visiting) and level of service (individual or shared space/camping vs. apartments, kitchens or none). Length of stay patterns (short- vs. long-term) are also important variables to consider.

The configuration of housing is currently a topic for dynamic discussion among FSML directors. Many FSMLs have turned away from the traditional dormitory housing in favor of more flexible offerings appropriate to site and climate. For example, a small cabin can house one person desiring solitude, two unrelated students, or a couple, whereas a dormitory can be difficult for student or researcher couples. Family housing has become more important as an amenity for attracting teaching faculty, long-term visiting or staff researchers, or older students.

Construction costs and operating and maintenance requirements are considerations for planning housing. Some “green” technologies are labor-intensive and require knowledgeable residents in order to function, such as “Earthships”. Other more traditional construction can result in high on-going utility expenses. Any planning for housing facilities should take into consideration these secondary expenses.

6. Food Service

Whether or not to provide food service is a significant decision. Most FSML directors suggest that food service provision is an operational nightmare and should only be done if absolutely necessary. However, a dining hall can be a “cash cow” if the problems of reliable food delivery, storage and refrigeration, staffing, and inspections as a commercial kitchen can adequately be overcome.

Like housing and laboratories, a dining hall represents a demand for reliable electricity and heating or cooking fuel. Utility expenses should be considered during cost evaluation, and also in designing mechanical systems to increase efficiency and reduce expenses.

7. Public Spaces

Spaces to which the public will have access range from reception areas to picnic facilities to specialized interpretive facilities for public educational programs. These public uses need careful design and siting considerations to mirror the FSML mission and vision, as well as to minimize conflicts with researchers and students. Design criteria for public spaces are often different then those for research settings. Often crowd control architecture is a consideration.

It is easy for a FSML to make large expenditures for elaborate structures to handle public program needs because there are numerous donation opportunities available for these programs. However, usually informal public education constitutes only 15% or less of a FSML’s activity in a year. Designing public facilities to be flexible enough to accommodate other FSML programs is one way of utilizing these funding opportunities effectively. For example, a donation might be secured to fund a lecture hall for programs and evening events that interpret science to the general public, but the same facility would be available for class meetings, invited symposia, or scientific seminars.

8. Aquatic and Marine Facilities

   A FSML with aquatic and marine activities requires some specialized facilities to handle research, teaching and equipment needs. Wet labs need water supplies, purification and treatment systems, and disposal systems (drained floors or water tables) requiring attention to corrosion resistant materials. Many other issues relate to docks, such as road access, proximity of maintenance areas, and whether gas tanks, electricity, water, or storage are nearby. Diving activities require another set of facilities, such as dive lockers, training pools, gas mixes, and numerous safety features.

9. Roads, Parking and Trails

   These transportation issues often generate the most over-looked and underestimated space requirements and environmental impacts. Many FSMLs want to minimize the number of roads on their property, but access for construction vehicles, parcel truck deliveries, food service deliveries, heavy research equipment, etc. is important to consider. Parking areas need to be established in appropriate areas. Perhaps there is no parking in front of every building, but loading and unloading is acceptable.

   Trail location and maintenance involves another set of potentially contentious issues. Is only foot traffic allowed? Can bicycles use foot trails? Is walking only allowed on established trails or does it matter? Must pets be on leashes? Are trails private or open to the public? Should researchers set up plots along trails? Are trails maintained for horses? Are motorcycles or motorbikes allowed on trails? All of these policies affect the nature and location of trails at a FSML.

10. Security

   Like parking, security is often overlooked during FSML facility design phases. Security can take numerous forms from fencing and signage to dogs and intrusion sensors. Keying systems for buildings and gates are valuable places to invest funds during design and construction.

C. Communication and Connectivity

Information acquisition and management require a full range of facility design considerations. Individual software platforms can support multiple functions, with the potential to integrate building, environmental and research information. Designs for new buildings and for remodels should incorporate redundant wire and fiber optic conduits or cable trays and chases to accommodate future change. The evolution of digital technology for voice communication allows for other connectivity options. Sensors for fieldwork and remote sites, including offshore moorings, can now utilize packet cell technologies for efficient real-time data acquisition. Graphic user interface (GUI) software provides new opportunities to economically support public education and outreach with local area networks or web-based data displays. All of these emerging capabilities are especially useful to FSMLs, which typically need to interpret local research and education activities with minimal or non-existent staff.

Technology developments need to be factored into the skill base of station personnel. For example, a few years ago building mechanics did not have to cope with digital devices. Now air, water flow and temperature sensors and controls are routinely based on programmable logic controllers. These same devices can be used to continuously monitor and control individual research projects. Station management needs to understand the increasing sophistication of their facilities to properly recruit, train and supervise employees. One positive feature of digital skill development is that FSML facilities staff and research data managers can begin to assist each other to some degree.

Storage, backup and protection devices have to be planned and designed to support FSML activities and the uncertainty of climate and extreme environments usually found at field sites. Station remoteness also influences the frequency of power interruption and repair response time. Specialized equipment, such as back up power generation and appropriately sized uninterruptable power devices are often critical to a FSML's research resources.

Connectivity planning considerations include:

1. Internet wiring plans for locating hubs, hublets and routing devices.

2. How to accommodate cable or fiberoptic runs for current and future needs.

3. How to accommodate the internet access needs of users. For example, if a station has overnight accommodations is it feasible or desirable to provide LAN or WAN ports in housing?

4. How much data infrastructure is feasible before an onsite network administrator (full- or part-time) is required?

5. Can a LAN and environmental sensors serve as fire or intrusion alarms?

6. Can programmable logic controllers and environmental sensors serve as a remote interrogation capability for researchers at their home institution?

7. How can a FSML participate in regional or national information acquisition and management initiatives? What is the best configuration for becoming a node on the national FSML network?

D. Equipment

Equipment inventory at a FSML ranges from hand tools to vessels and vehicles to multi-user research equipment. Equipment accessible to users is a major benefit to FSML clients, if it is properly maintained and policies are in place to make certain that it is available when users need it. In the case of multi-user equipment (e.g. chromatographs, gas analyzers, autoclaves, air stations/SCUBA cylinders, lawn mowers, field vehicles etc.) FSML administrators are faced with decisions requiring a balance between offering the right array of instrumentation versus the cost of acquisition, service contracts and eventual replacement.

FSMLs should be responsive to user needs that allow their time at the station to be efficient and productive. Sometimes items as mundane as screwdrivers and handsaws can make the difference between a week well spent and a week wasted. Hand tools have a remarkable ability to walk and can require a frustrating amount of time to locate if policies are not effective in maintaining a useful accessible inventory.

Major classes of station equipment include:

1. Vehicles and vessels.
2. Tools and shop support.
3. Multi-user research equipment.
4. Administrative, computing and office support.

E. Habitat Resources

FSML resources include the inventory of land, water and marine habitats accessible to the station. Habitat resources vary widely among FSMLs. Some FSMLs own large areas of essentially undisturbed habitat, but others may own no land at all. FSML administrators need to consider how current user activities will affect future use and site potential. There are, however, a few general considerations that should be followed by FSMLs irrespective of ownership of the land that is used for research and teaching:

1. Research and teaching should not foreclose future options for use of the land.

2. The future should be viewed through the lens of cumulative impacts.

3. All sites are not appropriate for experimental manipulation or perturbation.

These issues can be addressed in Stewardship Management Plans, Zoning and Land Use Plans, and through careful consideration of access infrastructure.

The availability of water and the infrastructure costs of supplying potable water to a FSML are essential considerations for locating facilities and determining a carrying capacity for the station. An additional consideration is that water exploitation and management may also have a significant impact on the habitats surrounding the FSML.

Habitat resources vary from small to extremely large parcels of land. The stewarding of these resources needs careful attention from FSML leadership. Usually a number of conservation values important to the general public, beyond the scientific community traditionally served by the FSML, are inherent in the FSML habitat resources. Information and resources are available from local and national land trusts that will assist with preserving and managing land resources. The use of conservation easements, stewardship management plans, baseline documentation reports, and other standard land trust documents can be appropriate to FSMLs. The Land Trust Alliance provides a great deal of very useful information and guidelines (**www.lta.org**).

F. Operations and Maintenance

FSML operations and maintenance often represent the single largest category of ongoing administrative expense. Efficient building and energy systems design can make or break a station financially. Intelligent and creative design can also increase user investment in a station, assisting with generating a loyal and dependable client group over time. Good design and pleasant climate control increases the enjoyment of the FSML experience.

Energy efficient systems allow station research and education staff to illustrate conservation and stewardship values. There are increasing opportunities for securing funds from foundations that support new construction or renovation that addresses energy conservation or uses alternative technologies.

For the purposes of planning an expenses analysis, the following categories are often used to describe operational or maintenance activities:

1. Annual Maintenance
   This category refers to the yearly support necessary to keep a FSML operating. These funds are structured into annual operating budgets and typically provide support for

facilities and custodial personnel, and for replacement of non-capital items such as plumbing and lighting fixtures, door/ window hardware, etc.

2. Deferred Maintenance
Routine projects that aren't addressed by annual O&M budget allocations are called deferred maintenance. Examples include painting or staining of exterior exteriors, reroofing or other major roof repairs, paving or graveling of roads and driveways, and other significant maintenance activities that don't occur annually. This category maybe funded out of FSML reserves, a specified fund accumulated for this purpose, or from emergency funds.

3. Minor Capital Projects
These are one-time projects of a significant nature requiring special appropriations up to $250,000 that may need a focused budget category or perhaps a campaign or grant proposal to fund. Examples include replacement of small boats, or research or administrative vehicles, and renovation or replacement of buildings such as cabins, sheds, shops or other small buildings. Larger capital construction is considered separately in most budgets.

4. Recurring Expenses
This category may include snow removal, road or dock repair, or similar activities in response to seasonal wear and tear which are predictable in occurrence but variable in severity. There may be overlap with annual maintenance operations. Some FSMLs may include recurring expenses with annual costs. The advantage of creating distinct accounts is that if unused funds can roll over to successive fiscal years then the station may be equipped to deal with severe storm events and the resulting high costs of appropriate response and repairs.

5. Utilities
These include electrical, water, gasoline, diesel (for generators or pumps), propane or natural gas. Underground tank storage for fuel is an important siting and environmental compliance consideration. FSMLs can often benefit from special utility configurations. For example, boilers specified to operate on both diesel or propane can provide a backup fuel option if deliveries of one commodity are interrupted or road conditions create access problems. Consideration should be given as to whether utilities are buried or not, whether they services all areas of the central FSML facility or not, whether docks are served by utilities, etc.

G. Facility Policies

Policy needs have been mentioned throughout the foregoing discussion of FSML facilities. It is important for the FSML administration to incorporate users and their needs into the operation of a safe working environment. Most FSMLs develop a "User's Manual" or similar handbook that incorporates facility policies. Specific FSML policies should at a minimum cover the following considerations:

1. Environmental health and safety.

2. Land use.

3. Equipment and vehicle use.

4. Administrative support.

5. Public access and behavior.

6. User behavior.

   In addition to the many other aspects of appropriate resident or visitor behavior, FSML users should be educated as to their individual role and responsibility regarding emergencies, including:

   a. How various functions are monitored for failures and how to respond, both during weekday times when stations typically are staffed and during evening and weekend hours.
   b. The location of emergency response equipment (e.g. fire suppression gear, first aid).
   c. Primary and secondary contact information for which type of emergency.

H. Site Issues

1. Site Selection for New FSMLs

   A number of new FSMLs have been established over the past few years. Some have the fortunate opportunity to consider a variety of sites for their new facility. Experienced FSML directors offer some suggestions for issues to consider during the site selection process.

   a. Type of programs that will be conducted at the FSML.

   b. Ability to separate spatially any incompatible uses (eg. research labs from housing, classrooms from research labs, children's activities from research labs, etc.).

   c. Access for construction vehicles and delivery vehicles.

   d. Easy access for FSML users to research areas.

   e. Minimal impact from natural disasters (flooding, storm surge, landslides, etc.).

   f. Reasonable access to laundry, mail and package delivery, food supplies, a labor pool, and other operational services.

   g. Compatibility with neighboring properties.

2. New Sites for Existing FSMLs

   Some existing FSMLs may need to select new sites for expanded operations, or may be offered properties for acquisition. In addition to many of the above considerations, the FSML administration should consider how management of the new site will fit into current operations, and what additional resources may be needed. The financial and logistical impacts could be greater than the potential benefits for some sites in comparison to others.

3. Appropriate Land Holdings for FSMLs

   Often FSMLs are offered donations of real estate for the purpose of research or education. It is tempting to accept any and all properties, but careful evaluation needs to be made of the potential liabilities and other impacts. Sometimes the best option is to sell the gift, but donors can place restrictions that prohibit property sales.

Another issue to consider is the likelihood of a FSML becoming a large landowner with all of the stewardship obligations that are entailed. Perhaps another organization such as The Nature Conservancy or a local land trust would be a more appropriate owner, and lease arrangements for scientific use of properties could be made.

Local residents can become irritated if a nonprofit such as a FSML or its sponsoring institution acquires land that is then removed from the property tax roles. Many FSMLs make payments in lieu of taxes (called PILT) to offset their local financial impact.

<u>Tables, Figures and Documents for Section IV – Facilities</u>

Figure IV.A – Conceptual Model of the Relationship between Facilities and Stewardship *(Source: P. Siri and S. Lohr)*

Table IV.B – FSML Facility Suggestions *(Source: S. Lohr, R. Lawrenz, P. Siri, S. Tonsor, D. White)*

Examples (fill in list as examples are provided):

IV. General Facilities Handbooks
IV.B. Building Design Criteria (Including Green Architecture)
IV.C. Communication and Connectivity Specifications or Criteria
IV.D. Equipment Lists, Specification, Criteria
IV.E. Habitat Resources
IV.F. Facility Maintenance
IV.G. Facility Policies
IV.H. Site Selection
IV.I. Regulatory Environment