

REPORT

to

***THE NORTH CAROLINA
DEPARTMENT OF
ADMINISTRATION***

by the

**Sustainable, Energy Efficient Buildings
Advisory Committee**

in re:

**N.C.G.S. 143-135.35 thru 143-135.40
(Senate Bills 668 and 1946)**

October 1, 2008

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INTRODUCTION

The 2007 session of the N.C. General Assembly ratified Senate Bill 668 (Session Legislation 2007-546), which became codified as General Statute (G.S.) 143-135.35 through 143-135.40 through Senate Bill 1946. *This legislation established a new Sustainable, Energy Efficient Buildings Program, with specific energy and water efficiency requirements for major new and renovated State-funded facilities that enter their schematic design phase on or after August 8, 2008.* The legislation applies to public agency buildings, including buildings owned by The University of North Carolina and its regional institutions and community colleges.

G.S. 143-135.39 requires the Department of Administration to develop and issue policies and technical guidelines to implement this new legislation. It also requires that the Department create a "Sustainable, Energy Efficient Buildings Advisory Committee" with representatives from the design and construction industry involved in public works contracting, personnel from the public agencies responsible for overseeing public works projects, and others at the Department's discretion, to provide recommendations on implementing this legislation. Thus, this advisory committee was established and its members appointed by the Department of Administration.

Specifically, the Advisory Committee is charged by the legislation with providing recommendations in four areas:

1. Recommendations for technical and procedural requirements relative to achieving the performance goals established by the legislation.
2. Recommendations regarding the education and training appropriate to the various roles with respect to, and level of involvement in, a major facility construction or renovation project or the roles regarding the operation and maintenance of the facility by the following:
 - a. Chief financial officers of public agencies.
 - b. Facility managers of public agencies.
 - c. Capital project coordinators of public agencies.
 - d. Architects.
 - e. Mechanical design engineers.
3. Recommendations regarding developing a process whereby the Department receives ongoing evaluations and feedback from stakeholders to assist the Department in implementing the legislation.
4. Recommendations to the Department regarding whether it is advisable to strengthen standards for energy efficiency or water use under this Article, whether it is advisable and feasible to add additional criteria to achieve greater sustainability in the construction and renovation of public buildings, or whether it is advisable and feasible to expand the scope of this Article to apply to additional types of publicly financed buildings or to smaller facility projects.

The educational recommendations by the Advisory Committee will be developed after the technical and procedural recommendations are presented to public agency chief financial officers and capital project coordinators, along with designers, at a two-day conference

scheduled for October 29-30, 2008 in Durham, North Carolina. It is anticipated that participant feedback from this conference will help define the scope and methodology of follow-up training and education for each target audience. Recommendations by the Advisory Committee will be developed and made to the Department in late 2008.

Recommendations relative to the training and education of facility managers of public agencies will be developed and made to the Department in early 2009.

Finally, as the legislation requirements are implemented for new major state facilities and renovations, experience is gained, and feedback from stakeholders is obtained, the Advisory Committee will monitor the implementation process and evaluate the success of the legislation. During this time, the Advisory Committee shall serve as an advisory role to the Department of Administration and may:

1. Recommend modifications and improvements to technical requirements and procedures, including recommendations for strengthening standards for energy efficiency or water use and whether it is advisable and feasible to add additional sustainability criteria.
2. Recommend modifications and improvements for the training and education of public agency personnel and/or designers.

This first report of the Advisory Committee provides detailed technical and procedural recommendations relative to achieving the performance goals established by the legislation. This report is organized in two parts. Part 1 is designed to provide public agency owners and their designers with an introduction to the basic concepts and potential options, with appropriate guidelines for application, for sustainable design options and procedures that can be applied to achieve the performance goals established by the legislation. Part 2 presents the specific compliance and reporting requirements required by the Department of Administration.

The legislation defines a "major facility" as (1) a new construction project larger than 20,000 gsf of occupied or conditioned space or (2) a building renovation project when the cost is greater than 50% of the insurance value and the renovated area encompasses greater than 20,000 gsf of occupied or conditioned space. The buildings exempted from the legislation's requirements are (1) transmitter buildings and pumping stations (probably a moot point since these buildings would almost never meet the minimum size criteria specified by the legislation) and (2) buildings having historic, architectural, or cultural significance under G.S. 143B, Article 2, Part 4.

The legislation establishes three very specific performance goals for major state facilities :

1. **Energy:** Currently, under the State Construction Office guidelines, facilities must be designed to meet the energy performance goals established by ASHRAE/IESNA Standard 90.1-2004, as defined in Chapter 7 of the 2006 *North Carolina Energy Conservation Code*. ***The new legislation, however, stipulates that energy efficiency by major facilities must be at least 30% (20% for renovated facilities) greater than the ASHRAE requirements.***
2. **Indoor Water:** Currently, state facilities must be designed in accordance with the plumbing requirements of the 2006 *North Carolina State Building Code*, which sets specific maximum flow limits for various types of plumbing fixtures. ***The new***

legislation, however, stipulates that indoor water consumption by major facilities must be at least 20% less than code requirements.

3. **Outdoor Water:** There are, currently, no codes or standards relative to the application of irrigation systems for building landscaping and, thus, there is no codified limitation on the use of water outdoors by state facilities...in many cases, the entire landscaped site is irrigated, with no limitations imposed. ***This legislation, however, stipulates that outdoor water consumption by major facilities must be reduced by at least 50%.***

To ensure that the goals of the legislation are met, two additional requirements are imposed:

1. Commissioning must be employed to verify that design requirements have been met.
2. Energy and water consumption meters, and other measurement methods, must be installed and the actual energy and water consumption of the facility over the first year must be verified by the owning agency.

None of these performance requirements, from a technical point of view, are particularly difficult to achieve, but meeting the goals of the legislation requires a fairly significant change in the design process typically applied in the past. *To comply with the legislation, the design team must work in an "integrated" manner...meaning that design decisions are made only after analysis and input by each member of the design team.* This process is somewhat alien to many designers and both a reduced "ego" and commitment to the process is required by each member of the design team.

REPORT EXECUTIVE SUMMARY

PART 1

GUIDELINES FOR MEETING PERFORMANCE GOALS

1. BUILDING ENERGY PERFORMANCE

The current criteria for energy performance for buildings designed in North Carolina is ASHRAE Standard 90.1-2004, as required by the State Building Commission and the 2006 *North Carolina Energy Conservation Code*. However, North Carolina General Statute 143-135.37(b) requires that major new or renovated state facilities operate with at least 30% less energy consumption that allowed by this current standard.

ASHRAE Standard 90.1-2004 defines **process energy** as energy consumed in support of a manufacturing, industrial, or commercial process other than conditioning spaces and maintaining comfort and amenities for the occupants of a building. Process energy is exempt for the requirements of the ASHRAE standard and, therefore, is exempt from the performance requirements of the legislation. Process energy should not be included in either the baseline or design building analysis *unless the design team specifically targets process energy for reduction*.

To reduce energy consumed by major state facilities for space conditioning, lighting, and service water heating, four major elements of the building must be evaluated during the design process:

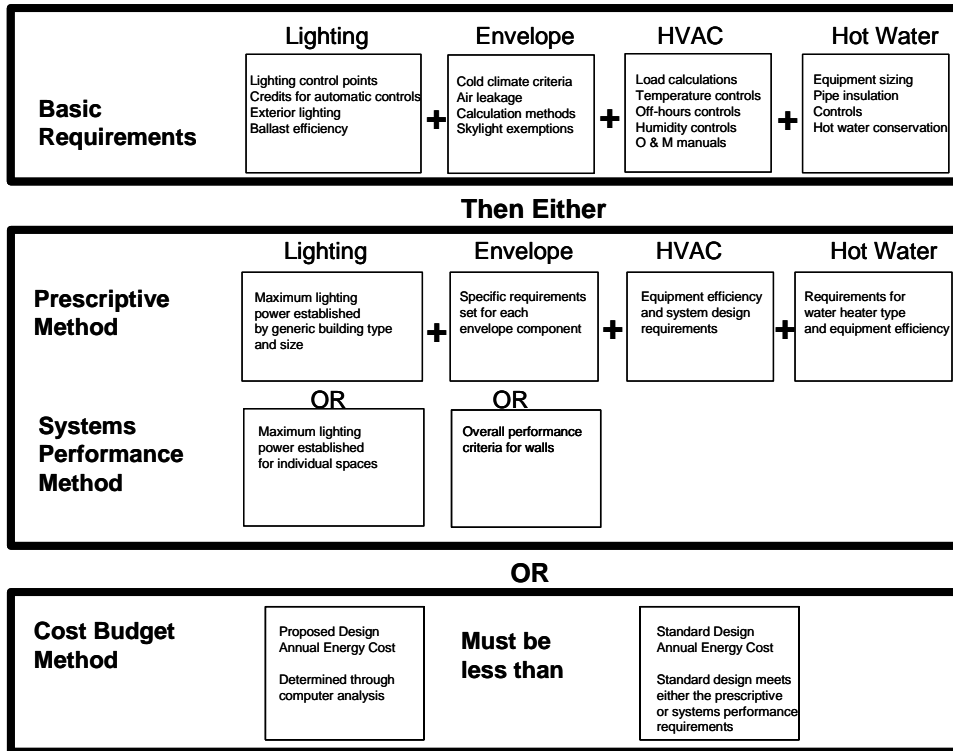
- **Architecture:** Building massing, shape and orientation on the site; envelope thermal and lighting performance; space planning; etc.
- **Lighting:** Type and arrangement of artificial lighting systems; application of daylighting; lighting controls; etc.
- **Heating, Ventilating, and Air-Conditioning (HVAC):** Energy sources; type and efficiency of primary heating and cooling systems; zoning and secondary systems performance; ventilation air control; humidity control; waste heat recovery; etc.
- **Service Water Heating:** Energy sources; type and efficiency of water heating equipment; waste heat recovery; etc.

The design of these major elements cannot be done via independent, isolated or single discipline efforts. Rather, an integrated or "whole building" evaluation of each element's design alternatives must be done to ensure that the energy performance goal for the entire building is met with each element working with each of the other elements to achieve this goal.

To comply with these requirements, the Advisory Committee recommends the following and, pursuant to these recommendations, modifications to the *State Construction Manual* are proposed in Appendix A.

1-1.1 COMPLIANCE WITH ASHRAE STANDARD 90.1-2004

There are multiple "paths" that can be taken to achieve compliance with Standard 90.1, as shown in the following figure:



Each component (envelope, HVAC, lighting, etc.) may have as many as three compliance criteria:

- a. *General and mandatory criteria* that must be satisfied.
- b. *Prescriptive criteria* that must be met. There is some flexibility here in that overall component performance is usually specified and the designer may satisfy these measures by any method he chooses.
- c. *Alternative performance criteria* is specified for lighting and envelope components.

As an alternative to applying these methods to determine compliance, Chapter 11 of the standard offers the “Energy Cost Budget” approach to compliance. Under this method, the designer must compute and compare the design energy budget for the proposed building design to the energy budget for a building meeting all of the prescriptive and performance criteria. *This method may be used to justify the use of one or more alternative components or systems in the building design and would be the most commonly applied compliance methodology for major facility projects.*

1-1.2 BUILDING ORIENTATION, MASSING, AND SPACE PLANNING

The building's shape, orientation and location on the proposed site need to be studied in the early design phase to determine how these factors may effect heating and cooling loads.

The building's shape can greatly impact the cost of the structural and HVAC systems required, depending on the complexity of the shape, the building's height, and its length to width ratio.

The greater the distance of the floor to floor heights, the taller the building becomes, requiring a more expensive structural system as well as the cost for the increased in area of the exterior building envelope.

How the building is oriented on the site will effect the heating and cooling loads required to condition the interior spaces. Southern exposures increase heat gains in the summer and winter while northern exposures increase heat loss in the winter. East and west orientations result in heat gains in the morning and afternoon respectively. Orientation can also increase or accelerate the scheduled maintenance and repair costs to the exterior skin. This is due to environmental factors such as sun, wind and rain.

Massing of the building should be explored in conjunction with passive solar systems to lessen the energy costs for heating and cooling. Solar thermal, and their associated energy storage systems, should be evaluated and incorporated where feasible.

Many facility maintenance costs can be attributed to poorly designed, constructed, or maintained building envelopes. The composition of the building envelope should be carefully studied to ascertain the thermal and performance characteristics of the proposed materials and their intended applications.

The enclosure on each side of the building has to deal with different conditions based on its exposure to sun and wind. Southern exposures must accommodate a large swing in temperatures from day to night. East and west facades must be suitable for shorter periods of sun exposure, but at angles that are more difficult to control.

Space arrangement and circulation need to be studied not only to solve program and life safety egress requirements but also to address future flexibility and reconfiguration of the spaces. Permanent building core elements such as mechanical rooms, stairs, elevators, toilets etc., should be located such that non-core spaces can be easily reconfigured with minimal disruption to the core elements. Core elements should also be located so that they are easily accessible and maintainable. Transient spaces such a corridors, waiting rooms, conference rooms, etc. may work better placed at the perimeter of the building to reduce the need for heating or cooling since these spaces are more tolerant of wide temperature swings. Likewise, lighting levels are less critical in these spaces and natural light may suffice the majority of the time.

1-1.3 BUILDING ENVELOPE DESIGN

There is no "specific" building envelope design criteria for sustainable design because there is no specific sustainable performance goal established for the building envelope. Rather, the envelope design will be such that, in conjunction with the building site, massing, and lighting and HVAC systems design, allows the building to meet the energy efficiency, daylighting, etc. goals established for the building...along with aesthetic considerations. Envelope alternatives, with corresponding alternative thermal and solar performance, must be studied to select an envelope that design that reduces heating and cooling loads, enhances solar heat gains to offset winter heat losses, provides for natural lighting, and, overall, helps reduce the energy consumed by the building for lighting, heating, and cooling. *And, most importantly, the envelop design must eliminate moisture intrusion under all environmental conditions.*

1-1.4 DAYLIGHTING

When properly designed and effectively integrated with the electric lighting system, daylighting can offer significant energy savings by offsetting a portion of the electric lighting load. A related benefit is the reduction in cooling capacity and use by lowering a significant component of internal gains. (In addition to energy savings, daylighting generally improves occupant satisfaction and comfort. Recent studies are implying improvements in productivity and health in daylighted schools and offices. Windows also provide visual relief, a contact with nature, time orientation, the possibility of ventilation, and emergency egress.)

High daylight potential is found particularly in those spaces that are predominately daytime occupied. Site solar analysis should assess the access to daylight by considering what is "seen" from the various potential window orientations. What proportion of the sky is seen from typical task locations in the room? What are the exterior obstructions and glare sources? Is your building design going to shade a neighboring building or landscape feature that is dependent on daylight or solar access?

It is important to establish which spaces will most benefit from daylight and which spaces have little or no need for daylight. Within the spaces that can use daylight, place the most critical visual tasks in positions near the window. Try to group tasks by similar lighting requirements and occupancy patterns. Avoid placing the window in the direct line of sight of the occupant as this can cause extreme contrast and glare. It is best to orient the occupant at 90 degrees from the window. Where privacy is not a major concern, consider interior glazing (known as relights or borrow lights) that allow light from one space to be shared with another. This can be achieved with transom lights, vision glass, or translucent panels if privacy is required.

The floor plan configuration should maximize the perimeter daylight zone. This may result in a building with a higher skin-to-volume ratio than a typical compact building design. A standard window can produce useful illumination to a depth of about 1.5 times the height of the window. With lightshelves or other reflector systems this can be increased to 2.0 times or more. As a general rule-of-thumb, the higher the window is placed on the wall, the deeper the daylight penetration.

Daylighting can be introduced to the interior via roof monitors and/or skylights, however; careful attention must be given to the design and detailing of the skylight unit, curb height and composition and flashing. Many leaks that occur at roof penetrations or membrane termination points are due to poor detailing and or construction of the roof system and its flashing components.

1-1.5 ENERGY-EFFICIENT HVAC SYSTEMS

Design of energy-efficient HVAC systems is relatively straightforward and includes the following elements:

1. Design HVAC systems to meet, but not exceed, temperature and humidity design criteria for each individual thermal zone in the building.
2. Design HVAC systems to provide acceptable indoor air quality without "over ventilating" any thermal zone in the building.

3. Select the most energy efficient and versatile type of secondary system to provide adequate thermal zoning.
4. Select the most efficient and versatile type of primary system to minimize energy consumption. Water-cooled systems are always more efficient than air-cooled systems, often by as much as 40%. Ground-coupled systems are more efficient than water- or air-cooled systems.
5. Any waste energy created by facility processes or HVAC systems should be utilized to the maximum extent possible. This includes potential exhaust air heat recovery and heat recovery from other waste energy streams.
6. Utilize cooling thermal storage or other technology to reduce the peak electrical loads imposed on the power grid by the facility. Any reduction in peak load growth reduces the need for power companies to construct new generating capacity since it is peak load, or demand, rather than consumption that dictates power plant needs.

1-1.6 ENERGY EFFICIENT LIGHTING

Lighting is a major element of energy use in any major facility. Researchers estimate that lighting energy consumption can be reduced by 30% to 50% if energy-efficient systems are utilized in lieu of conventional lighting technology, making lighting far more sustainable. Sustainable artificial lighting has many elements, but the following major elements must always be incorporated:

Architectural Elements for Efficient Lighting: Three major architectural elements have a significant impact on lighting design...space plans, interior finishes (and resulting reflectance), and ceiling heights. The lighting designer must work closely with the architect and interior designer to evaluate lighting impacts of general building design alternatives.

Space planning can be a major factor in lighting design as daylighting is incorporated. Space planning defines the levels of ambient lighting required in the building and efficient space planning translates into efficient lighting design:

1. Interior spaces should be regularly shaped...the more uniform the space shape the more efficient the resulting lighting layout.
2. Interior spaces should not be mixed use, i.e., different tasks in the same space, as this complicates the requirements for task plane lighting levels (footcandles) and complicates the lighting design, often resulting in "over-lighting" and wasted energy consumption.

Interior finish selection is critical to lighting efficiency. The ability of a ceiling to reflect light is indicated by its *light reflectance* value (LR), or the percentage of light striking the surface that is reflected. Commonly used acoustical ceilings have an LR of 0.70 to 0.81, but high light reflectance ceilings have an LR of 0.82 or higher.

High light reflectance ceilings can increase a designer's ability to use indirect lighting more efficiently. Indirect lighting systems provide a brighter, more evenly distributed light with fewer shadows and less glare than direct systems. To complement these features, high light

reflectance ceilings provide balanced lighting diffusion due to their consistent surface finish and lower lighting loss factor because their soil-resistant surfaces remain reflective. In addition, high reflectance ceilings provide a significant increase in light level. High reflectance ceilings also increased the benefits of daylighting because the principal light distribution mechanism is the ceiling.

Aside from being highly reflective, ceilings should also be as low as possible to reduce the distance between lighting fixtures and the task planes they must illuminate. Lighting energy distribution is inversely proportional to distance. Thus, a fixture that can light a surface adequately with a 9 foot high ceiling, would have to have almost twice the lumen output when located in a 12 foot high ceiling. Thus, lower ceiling heights translate directly into energy savings for lighting (and HVAC systems).

Energy Efficient Lighting Sources: The energy efficiency of lamps is defined in terms of “watts/ lumen”...how much energy is required per measure of useful light. The following lighting options can be considered as part of sustainable lighting design:

Fluorescent lamps are widely used in state facilities and the T8 fluorescent tube is most commonly applied. The new T5 fluorescent lamps are 12% to 18% more efficacious than T8 lamps and their use should be evaluated.

High intensity discharge (HID) lamps are generally energy efficient, producing 50-100 lumens per watt. Lamp manufacturers have recently developed new HID lamps that produce higher-quality light color and are twice as efficient as older mercury vapor lamps and four to five times as efficient as halogens. These improved HID lamps can be used in lieu of incandescent (which are still much-loved by many architects) and halogen lamps.

Light emitting diodes (LED's) are becoming available as building lighting sources. LED's currently dominate the exit sign market. In the architectural market, the development of a visible/white light LED has opened this light source to general lighting applications. White light LED's, however, currently do not produce enough lumen output to make them competitive with most general light sources. This restricts their use in buildings to applications where small lumen packages are needed and where the characteristics of a lower CRI rating and high color temperature are acceptable.

LED's are very energy efficient. Performance of 100 lumens per watt has already been achieved under laboratory conditions and researchers are saying that it is not unrealistic to expect these solid-state sources to achieve 150-200 lumens per watt as this light source develops. Finally, LED's have the advantage of having no mercury to deal with when the lamps are replaced.

Task-Ambient Lighting: Uniform lighting layouts aim to provide a predetermined, even level of illuminance within a space across a fixed task plane. However, uniform layouts may also be wasteful from an energy perspective, even when meeting the requirements of Chapter 9 of the ASHRAE/IESNA Standard 90.1-2004.

Task-ambient lighting layouts, unlike uniform layouts, are concerned with distributing different levels of light energy to task and non-task surfaces. Task surfaces are those locations where the visual task being designed around actually occurs, such as a series of desktops, a marker board, or a drafting table. Non-task surfaces include areas of circulation and surfaces which require a very small amount of or, in some cases, zero light for tasks or safety purposes. Such

surfaces may include the tops of bookshelves in a library, the carpet in a small office, or the walls of a corridor.

Lighting Controls: The most efficient lighting source is the one that is de-energized. Therefore, control systems designed to automatically regulate the operation of lighting systems, lighting zones, and even individual luminaries to reduce energy consumption is an important part of sustainable lighting design and should be part of the design analysis for major state facilities. (Note that ASHRAE/IESNA *Standard 90.1-2004* already requires that spaces larger than 5,000 gsf have "automatic shutoff" lighting controls.)

Outdoor Light Pollution: Designers light outdoor environments to increase safety and security, enhance economic development, highlight landmarks, and facilitate nighttime use of roads and built areas. The primary design criteria for sustainable outdoor lighting is to utilize the most efficient light sources. However, sky glow, glare, and spillover from outdoor light often creates substantial "light pollution" that must also be addressed...glare from excessive light can create dangerous roadway conditions and floodlight spilling onto adjacent property ("light trespass") can be not only a nuisance, but can create adverse affects on people, plants, and animals.

1-1.7 SERVICE HOT WATER HEAT RECOVERY

Efficient service hot water heating systems must be evaluated. In addition, the following energy waste recovery methods can be cost-effective in facilities with significant service hot water requirements:

1. **Refrigerant Hot Gas Heat Recovery:** A refrigerant-to-water heat exchanger, sometimes called a *desuperheater*, can be installed in the hot gas refrigerant line between the compressor and the condenser in any refrigeration system. This heat exchanger, then, uses incoming service water as a condensing medium and serves as the first stage of condensing in the refrigeration cycle. Overall energy savings, assuming all of the rejected refrigerant heat can be used to heat service hot water, can be as high as \$250/ton-year.
2. **Wastewater (Drainline) Heat Recovery.** Hot wastewater produced by kitchens, laundries, and many industrial processes can be a significant source of heat energy to heat service hot water, either partially or totally. dormitories, athletic centers, etc. are the best candidates for the application of wastewater heat recovery. Many industrial processes produce large wastewater flows, with a corresponding need for large quantities of service hot water.

1-1.8 ENERGY MODELING AND SIMULATION

The design process to meet energy performance goals begins and ends with "modeling" of building to predict the performance of all elements of the building while evaluating a myriad of potential design alternatives. Typical modeling begins with a computer simulation of the weather at the site, developing a map of the solar path and prevailing wind direction and speed. These data are required to evaluate daylighting, the application of photovoltaics or wind energy systems, and to model fenestration incorporating exterior shading devices.

Next, a "model" of a conventional building, meeting the functional requirements and complying with the requirements of ASHRAE/IESNA *Standard 90.1-2004* must be created. This means that the design must meet all of the mandatory, prescriptive, and, as applicable, performance requirements imposed by the standard. Based on this model, the anticipated energy consumption of the building must be computed. *This establishes the baseline (Baseline 1) for the sustainable design and defines the requirements for meeting the minimum 30% lower energy consumption.* See Appendix G of ASHRAE/IESNA *Standard 90.1-2004* the requirements from comparing performance ratings.

Then, modeling of the building envelope to assess the relevant energy-efficiency measures, including high-performance glazing and building envelope construction, external solar shading devices, and daylight-responsive lighting controls is required. For the building envelope, for example, the engineer might compare dual-pane clear glass and dual-pane Low-E glass. Lighting simulations might compare lower lighting power density (i.e. 10-percent reduction) and daylight-responsive controls. Daylighting, which is affected by the glazing system, shading system and lighting control system, is a shared metric involving the building envelope and electrical lighting. Again, Appendix G of ASHRAE/IESNA *Standard 90.1-2004* defines the requirements to building performance simulation programs.

Based on the results of the building envelope and lighting models, a cumulative model of the building envelope and lighting measures are run to form a new baseline (Baseline 2). Baseline 2 becomes the baseline for comparison of HVAC measures, such as increased efficiency equipment and alternative HVAC systems such as under floor air distribution or ground coupled cooling and heating. Then a cumulative model is run of all the HVAC metrics and compared with Baseline 2. This yields the final "design case."

It should be noted that data input to these models must be accurate in order to yield reliable results. The "garbage in, garbage out" ("GIGO") rule applies to building simulation as it does to every other domain of computing. Also, every computer program has limitations, and the user must understand these, or else it is easy to misinterpret the results. *Finally, it should be remembered that simulation tools are no substitute for sustainable, high performance design expertise, they merely supplement it.*

1-2. BUILDING WATER PERFORMANCE

North Carolina General Statute 143-135.37(c) requires specific water consumption reductions as follows:

1. **Indoor Water:** "...the water system shall be designed and constructed so that the calculated indoor potable water use is at least twenty percent (20%) less than the indoor potable water use for the same building as calculated using the fixture performance requirements related to plumbing under the 2006 *North Carolina State Building Code*."
2. **Outdoor Water:** "...the water system shall be designed and constructed so that the calculated sum of the outdoor potable water use...is at least fifty percent (50%) less..."

To comply with these requirements, the Advisory Committee recommends the following and, pursuant to these recommendations, modifications to the *State Construction Manual* are proposed in Appendix A.

1-2.1 INDOOR WATER CONSUMPTION

Plumbing Systems Design: Table 604.4, 2006 *N.C. Plumbing Code* imposes the following maximum water use rates for plumbing fixtures:

Water Closets:	1.6 gpf
Urinals:	1.0 gpf
Showerheads:	2.5 gpm at 80 psi
Faucets:	2.2 gpm at 60 psi (private), 0.5 gpm at 60 psi (public)
Metering faucets:	0.25 gallons per cycle, maximum

However, there are numerous design options for reducing water consumption that should be evaluated for each major state facility:

1. **High Efficiency Water Closets and Urinals:** Gravity or tank type flush water closets, referred to as "high efficiency toilets" are now available that require 1.3 gallons per flush or less, saving about 20% in water consumption. Thus, using these fixtures in lieu of code-compliant water closets, tank type or flush valve type, should be evaluated. (As yet, though, there are no equivalent high efficiency flush valve water closets.)

High efficiency urinals reduce water consumption from 1.6 gpf to 0.25-0.5 gpf. To achieve this water efficiency, these urinals typically require automatically controlled flush valves and special fixture design.

2. **Dual Flush Water Closets:** Flush valve water closets can be specified with dual flush mechanisms. When only liquid waste must be flushed, the flush handle is moved in one direction and the water closet consumes only about 0.8 gallon of water. When solid wastes must be flushed, the flush handle is moved in the opposite direction and 1.6 gallons of water is used.

A study conducted in 2003 by California authorities indicates that the potential savings in water consumption by utilizing dual flush water closets is significant:

Type of Building	Ratio of Short to Long Flushes	Net Water Consumption (GPF)
Office Building	1.7 to 1.0	1.10
Restaurant	1.3 to 1.0	1.15
Residential (Multi-Family)	4.0 to 1.0	0.96

Thus, water savings over plumbing code requirements range from 28% to 40%, depending on the type of building occupancy.

3. Composting Toilets: A composting toilet is any system that converts human waste into an organic compost and usable soil, through the natural breakdown of organic matter into its essential minerals. Aerobic microbes do this in the presence of moisture and air, by oxidizing the carbon in the organic material to carbon dioxide gas, and converting hydrogen atoms to water vapor.

"Self-contained" composting toilets complete the composting "insitu", while "central unit" systems flush waste to a remote composting unit below the toilet.

All composting toilets eventually need some end-product removal. A full-size composting toilet does not need to have solids removed for several decades if the active tank volume is at least three times the yearly addition. This is because the waste dramatically decreases in volume: after around 5 years only 1-2% of the original volume remains. It is then a mineralized soil, which will not decompose any further. Other smaller systems may need to remove solids several times a year.

Composting toilets have entered the mainstream plumbing realm by being tested and, if approved, certified to the ANSI/NSF-41 Standard. They can be tested and certified for ANSI/NSF-41 by any ANSI accredited testing laboratories such as Canadian Standards Association, CSA International, National Sanitation Foundation, and Underwriters Laboratories.

4. Waterless Urinals: Waterless urinals save almost 95% water consumption, using water only as part of routine maintenance wash-down. These devices have been in use since the 1970s in Europe, but only arrived in the United States in mid-1990s. Waterless urinals have been found to be more hygienic than conventional ones since the aerosol effect by which bacteria can be spread is eliminated.

Typically, these urinals utilize a trap insert filled with a sealant liquid instead of water. The lighter-than-water sealant floats on top of the urine collected in the U-bend, preventing odors from being released into the air. (Other designs do not use a cartridge; instead, using an outlet system that traps odors.

Maintenance on waterless urinals is higher than on conventional urinals since routine cleaning and deodorizing (usually once per week) is required and the trap cartridges have to be replaced periodically (trap life depends on the number of uses, typically 7,000 - 15,000, not on the length of time it has been in use, which makes it somewhat more difficult to establish a replacement schedule). But, considering the flush valve maintenance that is eliminated, there little net increase in maintenance requirements.

5. **Showers:** Shower head flow can be reduced from the current limit of 2.5 gallons/minute by incorporating time-controlled valves to terminate water flow at the end of a fixed period, usually 3 to 5 minutes. Thus, water savings can easily reach 50-75% when compared to water use with a 10-15 minute shower.

The best newer showerheads also allow control of water flow rate separately from flow *temperature* via a separate shut-off valve near the showerhead. This allows water-conscious users to reduce water flow during soaping and scrubbing and use full flow only for rinsing, all without changing the flow temperature. Users, once informed of this capability, readily adopt this water-saving practice.

6. **Electronic Controls for Plumbing Fixtures:** Electronic controls for plumbing fixtures usually function by transmitting a continuous beam of infrared (IR) light. With faucet controls, when a user interrupts this IR beam, a solenoid is activated, turning on the water flow. Dual-beam IR sensors or multi-spectrum sensors are generally recommended because they perform better for users with dark skin.

Depending on the faucet, a 10-second hand wash typical of an electronic unit will consume as little as 1/3 quarts of water. A 10-second cycle is required as a minimum by the Americans with Disabilities Act. Choose the lowest-flow faucet valves available, typically 0.5 gpm. The additional cost for a low flow faucet with electronic sensors and controls will be \$100-125.

At sports facilities, where urinals experience heavy use over a relatively short period of time, the entire restroom can be set up and treated as if it were a single fixture. Traffic can be detected and the urinals flushed periodically based on traffic rather than per person. This can significantly reduce water use.

Electronic controls can also be used for other purposes in restrooms. Sensor-operated hand dryers are very hygienic and save energy (compared with conventional electric hand dryers) by automatically shutting off when the user steps away.

7. **Commercial Dishwashers:** The design of commercial spray-type dishwashers allows for cleaning of dishes, flatware and glassware by washing with detergent and water, and sanitizing by application of hot water or chemical solutions. There are several types of commercial dishwashers for different volumes of dishes and utensils.

In a stationary-rack machine, dishes are loaded into a rack that fits inside the machine; complete wash and rinse cycles average from 1 to 3 minutes. In a conveyor-type machine, dishes are loaded onto a conveyor belt that travels through the machine at speeds from 5 to 8 feet per second (fps). The final dishwashing rinse is accomplished with either hot fresh water or with a chemical sanitizing agent mixed with water.

Dishwashing machines that use chemical sanitizing agents for the final rinse use about the same amount of water as machines using only hot water for the final rinse.

The NSF has established minimum wash and rinse requirements for dishwashers: 4.5 to 6.0 gallons per cycle of wash and rinse for stationary rack machines using water for the final rinse and about 2.5 to 3.0 gallons per cycle for similar machines using a chemical sanitizing agent. Typically, commercial dishwashing machines reuse the final rinse water to wash the next rack of dishes.

But, there are a few ways to save on water use in commercial dishwashers:

- Reuse final rinse water in the following wash cycle or elsewhere for low-grade uses such as pre-wash, garbage disposals, or food scrapers. (This also offers energy savings.)
- Use pressure and flow regulators to maintain the desired flow during periods of high water-supply pressure.
- Specify conveyor-type dishwashers with an automatic shutdown device to deactivate the water pumps when dishes are not passing through the system.
- Use 1.0-1.6 gpm pre-rinse spray valves prior to wash cycles.

8. Commercial Garbage Disposals: Commercial garbage disposals grind solid wastes into small particles for disposal into the sewer system. The ground garbage passes into a mixing chamber where it blends with water for disposal. In larger systems, a scraping and pre-flushing system may precede grinding and carry the materials to the garbage disposal. Some larger systems use a conveyor instead of a scraper to transport waste to the disposal.

Typical water-consumption rates for various garbage disposals and disposals combined with scrapers or conveyor equipment are as follows:

EQUIPMENT	TYPICAL FLOW RATE (gpm)
Disposal	5 to 8
Scraper/disposal	7
Conveyor/disposal	10

First, *consider eliminating garbage disposals to reduce water use and maintenance.* An option is to utilize garbage strainers in lieu of garbage disposals. A strainer-type waste collector passes a recirculating stream of water over food waste held in a basket. This reduces waste volume as much as 40 percent by washing soluble materials and small particles into the sewer. The water use for strainers is about 2 gpm, much less than the 5 to 8 gpm requirement of garbage disposals. Strainers can use wastewater from the dishwasher, eliminating added water consumption.

When a disposal is used, installation of flow regulators end excess flow due to high water pressure and timers with automatic shut-off limit disposal over-operation. A solenoid valve can also be used to control water flow to the disposal.

The cost impact alternative designs to reduce indoor water consumption are summarized in the following table:

Code Compliant Design	Alternative Design	Min.
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Description	Cost (3)	Description	Cost (3)		
Conventional WC, tank type, floor mounted	\$1,530	High efficiency tank type WC	\$1,830	20	-\$300
Conventional flush valve WC, floor mounted	\$1805				+\$25
Conventional flush valve WC, wall hung	\$1,813	Dual flush valve WC	\$2,003	28	+\$190
Conventional urinal, flush valve, wall hung	\$1,235(1)	Waterless urinal	\$919	95	-\$316
Conventional shower	\$420	Shower with flow timer control	\$495	50	+\$75
Conventional shower	\$420	Shower with separate flow and temperature control valves	\$720	20	+\$300
Conventional lavatory faucet	\$215	Low flow (0.5 gpm) lavatory faucet with flow controls	\$215	80	\$0

(1) Includes cost of water supply piping to the urinal.

(3) Cost data from R.S. Means *Plumbing Cost Data, 2008*.

The recovery and recycling of wasted water is also an option, as follows:

1. Air-Conditioning Condensate Recovery: Normal operation of cooling coils produces condensate water that typically drains to the sewer. But, condensate is clean water that can be captured and reused for non-potable water applications. Typical applications include cooling tower make-up, flushing fixtures, and landscape irrigation.

Design considerations for condensate recovery systems include:

- a. Condensate recovery works by gravity flow; A drain line runs from each air handling unit to a central connection point in the penthouse, and from there a single line runs to the cooling towers.
- b. Collected condensate water is at temperatures between 50 and 60°F.
- c. To use condensate as cooling tower make-up, a 3-way valve in the line feeding make-up water to the cooling towers is required to allow the system to draw from reclaimed condensate or service water as needed for level control. Normally, the cooling towers need more make-up water than can be recovered from the condensate, in which case the system uses supplemental domestic water.
- d. When occasionally there is some excess condensate, it can be diverted to waste or a cistern can be used to store the excess for later use.

The amount of condensate produced by cooling will range from 0.005 to 0.0167 gpm/ton, based on the amount of outdoor air and the climatic conditions that exist. Thus, a 100 ton commercial HVAC system, operating for 2000 equivalent full load hours

annually, will produce about 70,000 gallons of condensate that can be captured and used in lieu of other water sources.

2. Gray Water Systems: *Gray water* is the wastewater discharged from lavatories, bathtubs, showers, clothes washers, and laundry sinks, excluding the discharge from kitchen sinks. (The wastewater from flushing fixtures and kitchen sinks is generally referred to as *black water*.) North Carolina's building codes allow the use of gray water for flushing toilets and urinals and in subsurface landscape irrigation systems for nonresidential buildings.

Field research shows that it is feasible to move away from traditional plumbing designs, which use potable water in all fixtures, and substitute gray water from bathtubs, showers, lavatories, clothes washers, and laundry trays for flushing water closets and urinals. Gray water plumbing system designs reduce demand on the potable water supply. Key requirements of a gray water plumbing system typically allowed by building codes are that the gray water must be filtered and disinfected, must be dyed (blue or green) to differentiate it from potable water, and may not be stored for longer than 72 hours (see Appendix C, 2006 *North Carolina Plumbing Code*).

The cost of a gray water system varies with its application. A system that includes a separate collection system for irrigation use will increase conventional waste systems costs by \$2.00-\$3.00 per gallon of storage capacity. A more extensive system that recycles the water for flushing fixtures will be somewhat more expensive due to additional filtration, pumps, etc.

3. Rainwater Harvesting: A rainfall harvesting system consists of the following basic components:

1. Catchment surface, typically the roof of the building.
2. Collection system...the gutters and downspouts that collect and transfer the rainwater to a storage tank.
3. Leaf screens, first-flush diverters, and/or roof washers that remove dust and debris from the initial catchment runoff. First-flush diverters are designed to divert or waste a portion of the initial rainfall to eliminate contaminants that were on the catchment surface when the rainfall started.
4. Storage tanks, called "cisterns".
5. Filtration, to make the water potable, if required by the application. Given the local regulatory requirements, either cartridge filtration or RO may be required. (No filtration is required if the water is not used for human consumption.)

In theory, about 0.62 gallons/sf of catchment area can be collected per inch of rainfall. However, considering first flush losses, evaporation, splash, etc., a value of 0.50 gallons/sf of catchment area per inch of rainfall is typically used for system sizing. The catchment area is based on the "horizontal projection" of the building roof and is independent of roof pitch. To ensure a year-round water supply, the catchment area and storage capacity must be sized to meet the water demand through the longest expected span of continuous dry days.

The capital cost of rainwater harvesting systems is highly dependent on the type of catchment, conveyance and storage tank materials used. However, the cost of harvested rainwater in North Carolina varies from \$2.00 to \$3.00 per gallon of water storage.

The primary reference for the design of rainwater harvesting systems is *The Texas Manual on Rainwater Harvesting*, available as a free download at http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf.

4. Fire Sprinkler Systems: Fire sprinkler systems waste a significant amount of potable water during routine testing and maintenance as required by NFPA Standard 25. These losses increase dramatically where a fire pump is utilized as part of the system.

Almost all test water can be captured for reuse by designing (1) capture cisterns at test points in the system and/or (2) piping systems from the test points to storage tanks installed as part of another water recovery system(s) and these measures should be evaluated during the project design.

HVAC Systems Design: For HVAC systems, water consumption can be defined as "direct" or "indirect". Direct water consumption is generally confined to two types of systems: open cooling towers used for condenser water heat rejection and steam boilers. Indirect water consumption is defined by the electrical energy consumption by the HVAC system and the water losses resulting from the production of electricity by a fossil-fired or nuclear power plant.

To minimize the use of indirect water consumption, the electrical power consumption by the HVAC system should be reduced by reducing HVAC cooling loads through energy saving strategies, installing the very efficient primary cooling equipment, and *minimizing the use of air-cooled heat rejection systems for cooling*. The typical air-cooled system, even meeting 2004 ASHRAE requirements, is allowed to consume 1.267 kWh/ton-hour, compared to water-cooled limits of 0.576 to 0.703 kWh/ton-hour. Thus, water-cooled systems can save over 50% of indirect water losses in the generation of electrical power for cooling (on top of the energy and greenhouse gas emissions savings). ***When the evaporation and drift losses associated with water-cooled systems are considered, the overall water savings for water-cooled systems over air-cooled systems is at least 30%.***

Water is lost by HVAC cooling systems due to evaporation and, to a lesser extent, drift. The only way to reduce these two losses in any system is to reduce cooling water flow rates. Decreased flow rates will increase the temperature rise by the water, which may not be possible in areas with high design wet-bulb temperatures. But, in the western half of the state, this certainly should be a design option.

Typical cooling tower and evaporative condenser design flow rates are typically about 3.0 gpm per ton of refrigeration load, resulting in a 10°F temperature difference. However, selecting for a 12°F temperature difference reduces the water flow rate by 20% to 2.4 gpm/ton. This effectively reduces the evaporation and drift losses by 20% also.

A second loss for water-based cooling systems is the water lost intentionally through "blowdown" for water treatment. The hardness and alkalinity of the condenser water, the key factors to deposition fouling and corrosion control, is defined by (1) the hardness and alkalinity

of make-up water, (2) the amount of evaporation and drift loss from the cooling tower operation, and (3) the blowdown or purposeful loss of water...throwing away condenser water with high solids concentrations to allow the introduction of make-up water with low concentrations of solids.

As shown by the following table, it is clear that the amount of cooling tower make-up water is reduced significantly as the number of cycles is increased from 2 to 6:

Cycles	Water Flow Rate (gpm/ton)			% Make-up
	Evaporation	Blowdown	Make-up	
2	0.0300	0.0300	0.0600	100
3	0.0300	0.0150	0.0450	75
4	0.0300	0.0100	0.0400	67
5	0.0300	0.0075	0.0375	63
6	0.0300	0.0060	0.0360	60
10	0.0300	0.0033	0.0333	55
15	0.0300	0.0023	0.0323	54
20	0.0300	0.0015	0.0315	53

However, there is only a further 5% reduction as the cycles is increased from 6 to 10, and only a further 2% reduction as cycles is increased to 20. *Therefore, in cooling tower applications, cycles of concentration should be maintained between 8 and 12 to reduce blowdown and the resulting make-up water requirement.*

To reduce blowdown losses further, more aggressive use of deposition inhibitors may be utilized as part of the chemical treatment program (depending on local water chemistry). The cost-effectiveness of this approach must be carefully evaluated by the designer. For cooling towers of 500 tons and greater, the design engineer should evaluate water conservation opportunity in the cooling tower as part of the life-cycle cost analysis. The designer should evaluate the cost effectiveness of providing control and monitoring equipment, with a computer program possibly integrated with the Building Automation System. The equipment to be considered should measure flow and conductivity of the makeup water and blowdown.

A water treatment model should be provided, with a calculated dosage and cost of chemicals, saturation conditions of substances in the water, and the optimum cycles of concentration. Case studies have shown optimum cycles of concentration of nine, compared to the industry standard of six, and a maximum conductivity of 2400 micromhos. However in designing a system that operates closer to the stress condition with risk of damage to equipment, the potential cost of equipment damage should be considered. The cost of repairing equipment due to damage from corrosion and scale will likely be much higher than the benefit gained from water conservation.

1-2.2 OUTDOOR WATER CONSUMPTION

Outdoor water use is primarily for irrigation of lawns (turfgrass) and other landscaping. Thus, the first step in design of landscaping for state facilities is to reduce the amount of outdoor water required after the plantings are established by *landscaping with site appropriate, drought-tolerant plants and grasses that can thrive with only normal rainfall*. The architect and/or landscape designer is charged with providing a near-greenspace environment for state facilities, utilizing plants adaptive to the local environment, which require only the amount of water they would normally receive if grown wild (after an initial period in which to they become established).

Only the following types of turfgrass should be utilized for lawn plantings for state facilities:

Region (2)	Acceptable Turfgrasses
Mountains	Tall fescue, tall fescue/Kentucky bluegrass, fine fescue (as part of a mixture with tall fescue or tall fescue/Kentucky bluegrass), or zoysiagrass
Piedmont	Tall fescue, bermudagrass, zoysiagrass, or centipedegrass
Coastal Plain	Bermudagrass, zoysiagrass, centipedegrass, or St. Augustinegrass

(2) These regions shall be in accordance with the designations of the Crop Science Department, North Carolina State University.

Permanent landscape irrigation systems connected only to potable water supplies, which includes underground water sources (wells), should not be installed at state facilities.

Permanent landscape irrigation systems installed at state facilities should utilize captured water (rainwater, runoff-fed onsite ponds, etc.) or recovered water (HVAC cooling condensate, local gray water, treated municipal non-potable water, etc.) to provide as much of the irrigation water supply as feasible.

1-3. BUILDING COMMISSIONING

North Carolina General Statute 143-135.37(d) requires commissioning of major projects, as follows:

"...The construction contract shall include provisions that require each building component and each energy and water system component to be commissioned, and these provisions shall be included at the earliest phase of the construction process as possible and in no case later than the schematic design phase of the project. Such commissioning shall continue through the initial operation of the building. The project design and construction teams and the public agency shall jointly determine what level of commissioning is appropriate for the size and complexity of the building or its energy and water system components."

To comply with these requirements, the Advisory Committee recommends the following and, pursuant to these recommendations, modifications to the *State Construction Manual* are proposed in Appendix A.

1-3.1 DEFINITION AND SCOPE OF COMMISSIONING

Commissioning is a quality assurance process that verifies and documents that building components and systems operate in accordance to the owner's project requirements and the project design documents. The party responsible for the commissioning process is defined as the *commissioning authority (CxA)*.

Historically, commissioning is provided by the building contractor(s)...testing, adjusting, balancing, systems start-up, and operational verification is provided by the installing parties under the control and direction of the building contractor(s). The designers establish criteria for system and component performance, for accuracy and extent of testing and balancing, but, to only a very limited extent, for actual performance testing. Consequently, for many major state facilities, owners have been less than satisfied with the resulting performance of building systems and the operations and maintenance documentation and training received.

A better level of commissioning can be provided under the direction and supervision of the designers when they establish specific start-up tests and documentation, followed by required detailed performance tests and documentation, to be preformed by the installers and, then, participate in conducting these tests and evaluating the result. This is typically referred to as *designer-led* commissioning. This level of commissioning is typically acceptable for smaller, simpler facilities.

The best level of commissioning is that performed by an independent, third party. In general, third party commissioning of major facilities will be necessary if any of the following conditions are satisfied:

1. Building exceeds 40,000 gsf in area. However, buildings of the following occupancy classifications, as defined by the *North Carolina State Building Code*, typically do not require this level of commissioning since they have limited energy impact,;

Group F-1 and F-2 (Factory Industrial)
Group H-1 through H-5 (High-Hazard)
Group S-1 and S-2 (Storage)
Group U (Utility and Miscellaneous)

2. Building has central energy equipment such as chillers and boilers, data centers, laboratory buildings, and other complex buildings, as well as buildings connected to central energy plants.
3. Building is less than 40,000 gsf in area, but is complex in nature. Typical building classifications, as defined by the *North Carolina State Building Code*, meeting this criteria are as follows:

Group A-1 and A-3
Group B (Educational facilities above the 12th grade and laboratories)
Group I-2 and I-3
Group R-2

4. Building renovation, as defined by NCGS 143-135.35(6), to existing buildings that have multiple zone control HVAC systems.

Building commissioning shall include the whole building and, specifically, the following systems:

1. Mechanical systems, including HVAC systems and equipment, building automation systems, laboratory systems, energy recovery and renewable energy systems, and testing, adjustment and balancing validation.
2. Lighting systems and controls, including daylighting, and renewable energy systems.
3. Potable hot water systems and rainwater harvesting and/or gray water systems.
4. Irrigation systems coverage and controls.

Other systems that should be tested and evaluated during commission include normal, standby and emergency power systems, potable water and booster pump systems, and the building envelope.

During the early design stages of each major facility, preferably during advance planning, but certainly no later than the beginning of the Schematic Design Phase, the design team and the public agency must jointly determine what level of commissioning is appropriate for the size and complexity of the building and/or its energy and water system components. Verification of the project commissioning level and, as applicable, a copy of the third-part commissioning contract, will be required for the Schematic Design submittal to the State Construction Office.

1-3.2 DESIGNER-LED COMMISSIONING

In smaller, less complex buildings, designer-led commissioning may be sufficient. In this case, the designer serves as the CxA. In these cases, commissioning of the facility HVAC systems represents 90+% of the commissioning requirement. Designer-led HVAC commissioning is a process defined by ANSI/ASHRAE Standard 111, *Practices for Measurement, Testing, and*

Balancing of Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; ASHRAE Guideline 1-2007, *The HVAC Commissioning Process*; and Section 3.3 of ASHRAE Guideline 0-2005.

Basically, the designer-led commissioning process begins with the HVAC designer to developing the Basis of Design (BOD) document. The BOD document should be developed during the Schematic Design Phase and updated with the Design Development and Construction Document submittals. A final as-built BOD document must be completed following building occupancy and the designers must provide training to the owner's operating staff on the BOD document.

The next step, during the Design Documents Phase, is develop detailed specifications for TAB requirements, start-up procedures, and functional tests of HVAC components and systems.

In general the designer should at a minimum include the following commissioning processes in the project.

1. Specify and ensure proper start-up of HVAC components and systems, and functional testing to ensure that these components and systems are operating in conformance with the design requirements and the manufacturer's specifications.
2. Monitor the Testing Adjusting and Balancing (TAB) to ensure that HVAC components and systems are operating at their specified capacities...airflow, water or steam flows, temperatures, etc. and follow proper TAB "set-up" procedures applicable to the designed operation.
3. Witness Functional testing by the contractor to ensure components and systems respond to variations in imposed loads, etc. and that the component and system controls are operating properly. The result of function tests is the demonstrate that required environmental conditions are maintained under the full range anticipated load conditions. Functional tests must also prove that fire safety, life safety, and failure/backup interlocks operate as designed.

The installing contractor(s), then, are charged with the responsibility for performing the specified test procedures, with witnessing by the designer, and reporting the results to the designers, with certification by all required contracting parties that the results are correct.

1-3.3 THIRD PARTY COMMISSIONING

If third part commissioning is determined to be necessary, the CxA must be retained as early as possible, preferably at the same time designers are selected, and be involved in discussions relating to energy performance and HVAC issues during the facility design. The CxA must be an independent party, under contract to the owner and not be affiliated with either the design or construction team on the project.

The CxA must be a registered engineering firm in the State of North Carolina and the owner must select the CxA using a *qualifications based selection process*, similar to that used to retain other engineers. The following is a listing of the basic qualifications that a CxA should exhibit:

1. Has acted as the principal CxA for at least three projects of comparable size, type, and scope, with demonstrated experience in "total building" commissioning, including building envelope; heating, ventilating, and air-conditioning (HVAC) systems; electrical power and lighting systems; data and communication systems; and other specialized building systems.
2. Has extensive experience in the operation and troubleshooting of HVAC systems and components and direct digital control (DDC) systems.
3. Has at least five (5) years field experience in this type of work.
4. Knowledgeable in building operation and maintenance (O&M) and in O&M training.
5. Knowledgeable in the requirements of the *North Carolina State Building Code* and other codes and standards related to building systems.
6. Experience in energy-efficient equipment design and control strategy optimization.
7. Has direct experience in monitoring and analyzing building systems operation using DDC control systems trending functions and stand-alone data logging.
8. Has excellent verbal and written communication skills.
9. Is highly organized and able to work with designers, contractors, and owners.
10. Has experience in writing commissioning specifications, particularly well-defined and start-up procedures and functional test procedures.

Depending on the complexity of the project, the owner may want to negotiate the contract with the CxA in two parts. Part one of the contract would start at the beginning of design and end upon completion of the project bidding process. After the scope and costs for the project are finalized, a second part of the contract would then be executed for the construction and occupancy phases of commissioning. The contract with the CxA typically is in the form of a letter agreement approved by the State Construction Office.

The Commissioning Process and CxA Responsibilities: In general, the following are the basic requirements for the commissioning process. Refer to ASHRAE Guideline 0-2005, *The Commissioning Process*, for more detailed information.

1. **Design Phases:** The CxA will help develop the Owner's Project Requirements (OPR) to ensure the OPR is complete and appropriate for the project. The OPR will be maintained and updated throughout the project. The CxA reviews Schematic Design, Design Development and Construction Documents. The CxA will submit to the design team for inclusion in the Design and Construction Documents draft commissioning specifications for the systems to be commissioned. The CxA may provide examples of start up and functional tests typical of those to be used in the project, to help inform potential contractors of the testing assistance required during the construction phase of the project.
2. **Construction Phase:** The CxA efforts will include review of component and equipment submittals by contractors, review of systems to be commissioned, and review

the contractor’s pre-functional/start up check lists. The CxA will provide the projects functional testing procedures, validate the test, adjust, and balance (TAB) effort, and lead functional acceptance testing of commissioned systems. The CxA will also review and approve training agendas, O&M manuals, and project as-built documentation. Functional testing must be completed satisfactorily prior to final acceptance of the project.

3. Occupancy and Operations Phase: The CxA will perform opposite seasonal testing, coordinate a 10-month warranty review, and participate with the owner in collecting building data for the 12 month measurement and verification of energy performance. The CxA will deliver a complete Cx and systems manual to the owner and provide specific recommendations relative to the need for future re-commissioning of components and systems.

Designer Commissioning Responsibilities: The design team members will participate in the commissioning team. The designer will be responsible for providing the Basis of Design (BOD) document. The BOD document should be developed provided during the Schematic Design, and updated with the Design Development and Construction Document submittals. A final as-built BOD document will be completed following building occupancy and the designers will provide training to the owner's operating staff on the BOD document.

Owner Commissioning Responsibilities: To help ensure that the commissioning process is successful requires active participation by the owner in the commissioning process. A representative of the owner who will be involved in the operations and maintenance of the building shall participate in the design, construction and occupancy phases of the commissioning process. The owner’s assigned project planning/ design staff and the Capital Project Coordinator will also participate in all commissioning phases.

To ensure the project budget is sufficient to support third party commissioning, it is recommended that the following commissioning costs be incorporated into the budget:

Systems Commissioning:

System(s)	Approximate Commissioning Cost (Percent of Total Systems Cost)
HVAC and Controls	2.0-3.0
Electrical	1.0-2.0
HVAC, Controls, and Electrical	0-1.5

Whole Building Commissioning:

Project Complexity	Approximate Commissioning Cost (Percent of Total Construction Cost)
Simple	0.5
Moderate	1.0
Very	1.5

PART 2

PERFORMANCE COMPLIANCE AND REPORTING

2-1. DESIGN AND DELIVERY PROCESS

2-1.1 ADVANCE PLANNING AND THE OC-25

The most efficient way of achieving this goals established by the legislation is to use the integrated design approach to design in which the architect and engineers work from the very beginning of the project in close collaboration. The need to gain a solid understanding of the project goals, challenges, and opportunities must take place at the earliest stages of the project to have the impact desired. Therefore, Advance Planning phase takes on a new level of importance.

In this expanded Advance Planning phase:

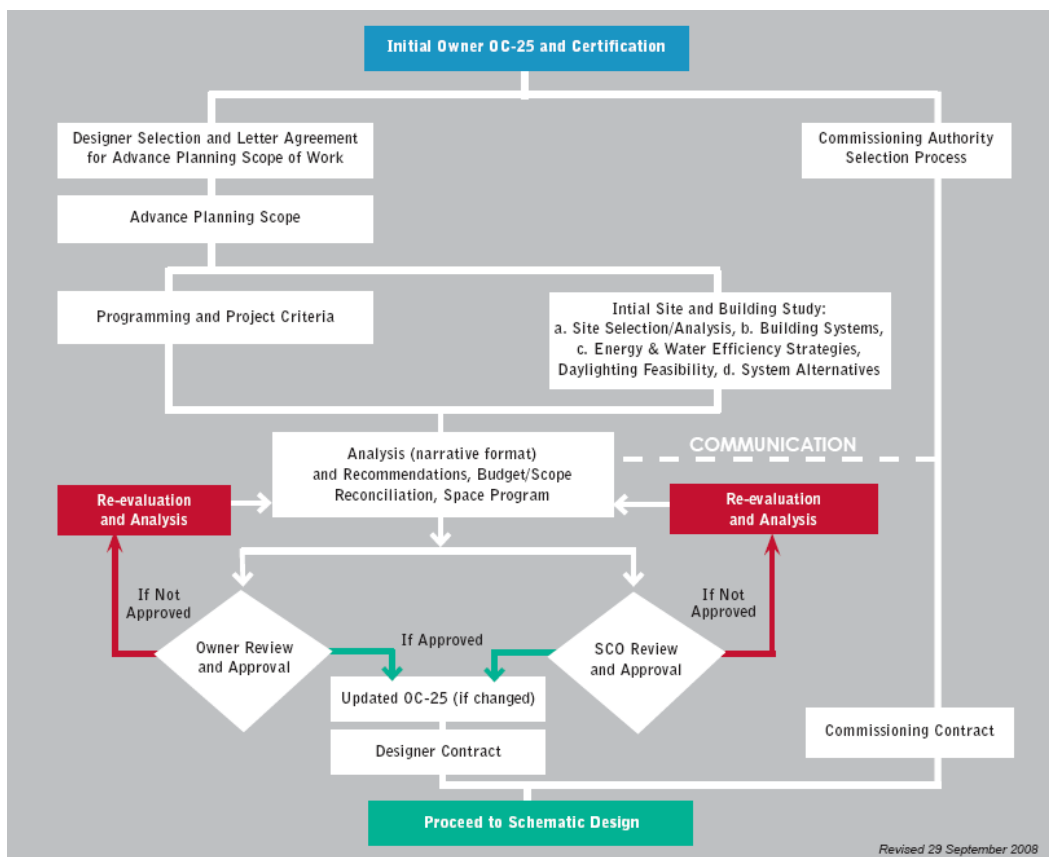
1. The OC-25 is prepared to determine general scope and description of the project.
2. The design team is identified.
3. Site analysis and site selection is done.
4. Letter Agreement defining the scope and cost of the Advance Planning effort is executed.
5. Space program for the building (including building features and design considerations) is developed.
6. The energy and water reduction strategies are considered and how the site conditions and constraints impact the application of these strategies is evaluated.
7. Systems are identified that will be part of the life cycle cost analysis in terms of energy and water use.
8. Budget and Scope are reconciled.
9. State Construction reviews the report and approves it prior to the project moving from Advance Planning to Schematic Design.
10. The commissioning method is selected and, if third party commissioning is required, a Letter Agreement is executed.
11. The OC-25 is updated and verified to be accurately describe the scope and budget.

The goal of Advance Planning is to set the roadmap for the rest of the project, to get a firm understanding of what can be and will be achieved, and to establish the broad-stroke measures that will be used to achieve the goals. The actual design of the building still starts in Schematic Design phase.

Advance Planning is a front-end study of project conditions, feasibility studies, and establishing the project scope and budget. It is not a part of Basic Services and it is premature to negotiate a Design Contract at this point in time. Therefore, the work of this phase will be agreed upon and executed between State Construction or the Owning Agency and the Designer by Letter Agreement. It is anticipated the Designer that performs Advance Planning will become the Designer for Basic Services, unless terms of agreement between State Construction or the Owning Agency and the Designer cannot be reached. Therefore the process used for selecting the team for Advance Planning phase services needs to be aware they are also probably selecting the design team for the project and the proper steps and process need to be followed.

To achieve the stated energy and water goals, additional work is required by the design team to study the projected energy and water use and various alternative designs, including earlier and more interaction between team members, computer simulations, and an ongoing check, re-check, and adjustments of building design and systems. In this project approach, some of the Design Team's work has shifted from Schematic Design to Advance Planning. Similarly, some of the work that typically has occurred in Design Development shifts to Schematic Design. The reason for this change is the critical nature of doing more earlier, such as running energy modeling during Schematic Design to test out the design strategies to achieve the reduction goals, and the need to make revisions to the design at this earlier time. Consequently, the schedule of payments to Designers has been revised in recognition of the additional work being performed and the greater efforts of the design team earlier in the project.

The following flowchart has been developed to assist the design team in understanding the sequence and requirements for advance planning:



2-1.2 DESIGN TEAM AND PROCESS

The design team must have demonstrable expertise and experience with design strategies and techniques for incorporating energy efficiency and sustainable design practices that meet life-cycle economic criteria. This expertise can be demonstrated by previously documented projects and by partnering with recognized energy and sustainable design experts. The consideration for energy efficiency and environmental quality should begin at the earliest stages of planning and continue through construction and operation. There should also be scheduled reviews of energy and environmental strategies throughout the design process.

To maximize energy performance, the A/E team should be supportive and knowledgeable. An architect unconcerned with energy performance, even coupled with an engineering firm with impeccable energy credentials, is unlikely to produce an optimal building design. The same would be true if an energy-conscious architect were to work with an unconcerned engineering firm. It is, therefore, vital to select a team that is prepared to work together to achieve superior building performance.

In the conventional design process, an architect typically hands a completed architectural design to the mechanical and electrical engineers and says, "Make this work." The engineers then size the mechanical and electrical systems to meet the building's peak requirements and proceed with their designs.

However, by that time, decisions regarding building orientation, massing, and fenestration—all of which affect energy use—have already been made. This late in the process, there is little or no opportunity to optimize the building as a whole system.

For sustainable design, the mechanical and electrical engineers must analyze system options as the architectural design is developing, informing the architect about energy use and cost implications of architectural design options. Similarly, in order to implement proper daylighting, the electrical engineer must be consulted during the earliest design stages.

In addition to architects and engineers, the design team may also require an energy analyst, knowledge in the use of computer based simulation, and, as applicable, a CxA as members.

During pre-design, the *energy analyst* develops the code-compliant reference case, helps identify and then evaluates energy efficiency and renewable energy strategies, and sets performance goals (with the owner) based on a case in which all cost-effective strategies are implemented. During the schematic design phase, the analyst evaluates schemes and the sensitivity of results to variable inputs, such as utility rates, and selects strategies for further development. In the schematic design, rough sizes of components are determined. During design development, the analyst assists in determining precise sizes and complete design descriptions.

The analyst has the most input before the design is 35% complete (i.e., during the schematic design phase). By the time design is 90% complete, the analyst's role has been reduced to confirming that performance goals have been met, sometimes in cooperation with the CxA.

The design team must work in an "integrated" manner...meaning that design decisions are made on the basis of analysis and input from each member of the design team. This process is

somewhat alien to many designers and both a reduced "ego" and commitment to the process is required by each member of the design team.

To establish and maintain good communication with all team members, it is necessary to conduct planning/ review workshops at key phases of the project design and routine meetings during design, construction, and post-occupancy, as follows:

- Workshops ("charettes") during the pre-design and Schematic Design phases to define project parameters and design alternatives to be studied and evaluated.
- Convene frequent, routine review and coordination meetings during the design phases, especially during schematic design.
- At the completion of design, convene a contractors' meeting for pre-construction to review the sustainability goals and objectives of the projects and requirements that will be imposed during construction.
- Incorporate discussion about the progress toward meeting project sustainability goals during every construction meeting.
- After occupancy, the design team shall meet annually to review performance verification reports, operation practices, complaints, and building maintenance issues.

2-2. ENERGY PERFORMANCE MODELING AND REPORTING

In order for compliance with the energy performance goals to be demonstrated, specific methodologies and reporting is required, as follows:

Energy Modeling Simulation

Computer simulations must be performed for energy modeling comparisons. ASHRAE Standard 90.1-2004, *Appendix G – Performance Rating Method*, must be used as the calculation methodology to establish a percentage improvement of the proposed building over the baseline model.

Pre-approved energy modeling simulation software includes "DOE-2", "Blast", "EnergyPlus", "eQUEST", "EnergyPro", Carrier's "Hourly Analysis Program (HAP)", and Trane's "Trace".

Designers wishing to utilize other simulation software must submit documentation to the State Construction Office for approval in the pre-planning stage indicating how the software complies with ANSI/ASHRAE *Standard 140-2004, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs*.

Energy model reports must be submitted beginning in the Schematic Design Phase and are to be completed no later than the Design Development Phase. (Refer Appendix A, Section 300 of the *State Construction Manual*.)

Energy strategies shall be utilized for variable building elements as applicable for each project. Each of the following categories shall be evaluated and decisions on which items will be pursued shall be defined in the Energy Model summary:

1. Building envelope.
2. Lighting design and control.
3. HVAC systems design and control.
4. Service hot water heating systems design and control.

Simulation Conditions and Constraints

The following constraints shall apply to the energy modeling at each program run:

1. Only one building geometry shall be used for a given project analysis.
2. Process energy, including "plug load" energy, is exempt for the requirements of ASHRAE Standard 90.1-2004 and, therefore, is exempt from the performance requirements of the legislation. Process energy should not be included in either the baseline or design building analysis if these loads will be identical in both the baseline building and the energy efficient building option(s). *However, plug and process loads must be included in the analysis if they differ between the baseline and the energy*

efficient building option(s) in a documented way and result in building energy use reduction.

3. The cost of energy (energy rate) must be the same for all modeled options.
4. The same energy simulation software program shall be used for each phase (SD,DD,CD) of the project submittal, as well as for each energy conservation strategy.

Exceptions are allowed for the above constraints provided those exceptions are requested in writing from SCO during the schematic design submittal phase, and written approval has been granted.

An unlimited number of options can be modeled for each building, but the designers must use good professional judgment to determine those options resulting in the best energy savings and lowest first costs to compare in the required LCCA to provide an overall lowest building cost for the long term.

Submittal Information and Forms

The energy model information and the life cycle cost analysis shall be submitted at each phase as a stand-alone document. This should not be bound with the soils report, cost estimate, comment responses, or other documentation items.

Designer shall submit the following information at each project submittal, starting at the schematic design phase:

1. Cover Sheet and fly sheet with the following information at a minimum:
 - a. Indicate this is an Energy Model and a Life Cycle Cost Analysis for “Agency Name” and “Project Name”.
 - b. Date of Report and Project Phase (SD,DD,CD)
 - c. SCO ID#
 - d. Code and Item
 - e. Project Location
 - f. Design Team company names, addresses, telephone numbers and email addresses. Provide company web address if available.
 - g. Seals and Signatures of Designers of Record
 - h. Optional:
 - (1) Design Team firm logos
 - (2) Agency Logos
2. Table of Contents
3. Narrative: Discuss the project criteria, design recommendations and decision rationale, and the building elements that are modeled in the energy model, and how those elements are combined to create a composite building that is compliant with requirements of the Statute. Building Elements shall include at least two options for each of the following components:
 - a. Building Envelope: The base case shall be labeled A-1, and the options shall be numbered A-2, A-3, etc.

- b. Domestic Water Heating Systems: The base case shall be labeled P-1 and the options shall be numbered P-2, P-3, etc.
 - c. HVAC systems and controls:
 - (1) Primary Systems: The base case shall be labeled H1-1 and the options shall be numbered H1-2, H1-3, etc.
 - (2) Secondary Systems: The base case shall be labeled H2-1 and the energy strategies shall be numbered H2-2, H2-3, etc.
 - d. Lighting control and lighting design: The base case shall be labeled E-1 and the energy strategies shall be numbered E-2, E-3, etc.
 - e. Additional strategies may be required to meet the energy efficiency requirements: Use sequential numbering for additional strategies.
 - f. Name and version of the simulation program utilized to model the building energy use, as well as the life cycle cost analysis.
4. Completed calculation forms are located at the end of this Section.
 5. Software reports indicating base building compliance with ASHRAE 90.1-2004.
 6. Software reports for all strategies indicating compliance with the requirements of the Statute.
 7. Life Cycle Cost Analysis for base ASHRAE Standard 90.1-2004 compliant building and the two or more alternate buildings with varying strategies resulting in required energy savings:
 - b. Include and use Table 2-1 from the LCCA manual.
 - c. Use the same numbering system noted above for the design alternatives.
 - d. Provide a "General Building Energy Model Information" sheet for each building with all alternate energy strategies.
 - e. Provide a "Baseline And Proposed Design Input Parameters" sheet for each alternate building.
 - f. Provide a LCCA spreadsheet for each alternate building.
 - g. Provide a SIR (Savings-to-Investment) Analysis for the base case and alternate building designs.
 8. Provide Summary of the selected design approach.

The following forms should be used as described above to demonstrate that the energy performance goals of the legislation are met:

GENERAL BUILDING ENERGY MODEL INFORMATION

Performance Rating Method Compliance Report			
Project Name:		SCO ID #:	
Project Address:		Date:	
Designer of Record:		Telephone:	
Contact Person:		Telephone:	
City:		Principal Heating Source: <input type="checkbox"/> Fossil Fuel <input type="checkbox"/> Electricity <input type="checkbox"/> Solar/Geo Recovered <input type="checkbox"/> Other	
Weather Data:			
Climate Zone:			
Space Summary			
Building Use	Conditioned Area (sf)	Unconditioned (sf)	Total (sf)
1. Office (Open Plan)			
2. Office (Executive/Private)			
3. Corridor			
4. Lobby			
5. Restrooms			
6. Conference Rooms			
7. Mechanical/Electrical Room			
8. Copy Room			
9. Classrooms			
10. Laboratories			
11. Assembly Areas			
12. Dormitories			
13. Other:			
14. Other:			
15. Other:			
Additional Building Information			
Quantity of Floors			
Simulation Program			
Utility Rate: Electricity			
Utility Rate: Natural Gas			
Utility Rate: Steam or Hot Water			
Utility Rate: Chilled Water			
Utility Rate: Other			

BASELINE AND PROPOSED DESIGN INPUT PARAMETERS

Performance Rating Method Compliance Report			
Comparison of Proposed Design versus Baseline Design Energy Inputs:			
Building Element	ASHRAE 90.1 Baseline Building Input Data	Proposed Design Building (1) Input Data	Proposed Design Building (2) Input Data
Envelope			
Above Grade Wall Construction(1)			
Above Grade Wall Construction(2)			
Above Grade Wall Construction(3)			
Below Grade Wall Construction			
Roof Construction			
Exterior Floor Construction			
Slab-On-Grade Construction			
Window-to-Cross Wall Ratio			
Fenestration Type(s)			
Fenestration Assembly U-factor			
Fenestration Assembly SHGC			
Fenestration Visual Light Transmittance			
Fixed Shading Devices			
Automated Movable Shading Devices			
Electrical Systems & Process Loads			
Ambient Lighting Power Density, and Lighting Design Description			
Process Lighting			
Lighting Occupant Sensor Controls			
Daylighting Controls			
Exterior Lighting Power (Tradable Surfaces)			
Exterior Lighting Power (Non-Tradable Surfaces)			
Receptacle Equipment			
Elevators or Escalators			
Refrigeration Equipment			
Other Process Loads			

**BASELINE AND PROPOSED DESIGN INPUT PARAMETERS
(CONTINUED)**

Performance Rating Method Compliance Report			
Comparison of Proposed Design versus Baseline Design Energy Inputs:			
Building Element	ASHRAE 90.1 Baseline Building Input Data	Proposed Design Building (1) Input Data	Proposed Design Building (2) Input Data
Mechanical & Plumbing Systems			
HVAC System Type(s)			
Design Supply Air Temperature Differential			
Fan Control			
Fan Power			
Economizer Control			
Demand Control Ventilation			
Unitary Equipment Cooling Efficiency			
Unitary Equipment Heating Efficiency			
Chiller Type, Capacity, and Efficiency			
Cooling Tower			
Boiler Efficiency			
Chilled Water Loop and Pump Parameters			
Condenser Water Loop and Pump Parameters			
Hot Water Loop and Pump Parameters			
Service Hot Water System(s)			

ENERGY MODEL RESULTS: Percentage Improvement (Separate form needed for each proposed building model)

Performance Rating Method Compliance Report						
Energy Summary by End Use						
End Use	ASHRAE 90.1 Baseline Building			Proposed Building #		
	Energy Type	Energy [10 Btu]	Peak [10³ Btu/h]	Energy [10 Btu]	Peak [10³ Btu/h]	Energy [%]
Interior Lighting (Ambient)						
Interior Lighting (Process)						
Exterior Lighting						
Space Heating (fuel 1)						
Space Heating (fuel 2)						
Space Cooling						
Pumps						
Heat Rejection						
Fans - Interior						
Fans - Parking Garage						
Service Water Heating (fuel 1)						
Service Water Heating (fuel 2)						
Receptacle Equipment						
Refrigeration (food, etc.)						
Cooking (commercial, fuel 1)						
Cooking (commercial, fuel 2)						
Elevators and Escalators						
Other Process						
Total Building Consumption						
<i>Note: Energy Consumption is listed in units of site energy 10³ Btu = kWh x 3.413 10³ Btu = therms / 100</i>						
	Baseline Building		Proposed Building		% Improvement	
Type	Energy Use [10 Btu]	Energy Cost [\$ /yr]	Energy Use [10 Btu]	Energy Cost [\$ /yr]	Energy %	Cost %
Energy Use (Regulated & Unregulated)						
Electricity						
Natural Gas						
Steam or Hot Water						
Chilled Water						
Other						
Total Nonrenewable Regulated & Unregulated						
Total:						
Percentage Improvement = 100 x [1 - (proposed Building Performance / Baseline Building Performance)]						

2-3. WATER PERFORMANCE CALCULATIONS AND REPORTING

In order for compliance with the water performance goals to be demonstrated, specific methodologies and reporting is required, as follows:

Since there are no criteria within the 2006 *North Carolina Building Code* relative to outdoor water use, to minimize water consumption by irrigation systems, the following limitations should be imposed on state facilities. These limitations are both "feasible", as required by the legislation, and guarantee that the water reduction goals intended by legislation are met:

1. **Limited Irrigated Area:** Often, the entire project site not covered by buildings, parking lots, walks, roads and drives, or other impervious surfaces is both landscaped and irrigated. Thus, to reduce outdoor water use, the first step must be to reduce the area that is irrigated. A 50% reduction in water use by sprinkler systems, with an 80% coverage factor, is guaranteed by limiting the net irrigated area to 40% of the area that would be sprinklered under past designs. *Thus, the total irrigated area for major state facilities shall not exceed 40% of the "net lot area", which shall be computed as the total project site area, less the total area of impervious surfaces within the project site area.* Permanent outdoor athletic venues are exempt from this limitation. However, irrigation systems for athletic venues must meet all other requirements of this section.

It is recommended that irrigation systems utilize captured water (rainwater, runoff-fed onsite ponds, etc.) or recovered water (HVAC cooling condensate, local gray water, treated municipal non-potable water, etc.) to the maximum extent feasible. *To the extent that these systems are utilized, the irrigated area limit defined above may be increased upon approval of the State Construction Office.* (Thus, if 20% of the irrigation water requirement is met by non-potable systems, the irrigated area limit may be increased by 20% to 48% of the net lot area.)

2. **Maximized Irrigation Systems Efficiency:**

a. To the maximum extent possible, underground low volume irrigation systems, such as micro-sprayers or drip tubes, shall be utilized to minimize evapotranspiration losses.

b. Sprinkler systems shall be limited to turfgrass irrigation only, shall be designed to achieve at least 80% planting coverage, minimizing sprinklering impervious surfaces and the associated runoff losses, and shall be controlled on the basis of soil moisture sensors, evapotranspiration (ET) controllers, etc. Wind speed sensors shall be used to shut-off water flow when wind speeds exceed 10 mph. ***Time-clock controls shall not be utilized as the sole method of irrigation system control.***

3. **Monitoring and Verification:** Individual totalizing flow meters must be provided for each irrigation water supply (potable, captured, recovered, and/or ground source).

The following forms and associated calculation methods are used to demonstrate that the water performance goals of the legislation are met:

INDOOR WATER CONSUMPTION

Fixture Type	No. of Users		Daily Use		Days/Yr	Code Basis		Design Basis	
	M	F	M	F		Water Rate	Total	Water Rate	Total
Water Closet, Tank			1	3		1.6 gpf			
Water Closet, Flushvalve			1	3		1.6 gpf			
Urinal			2	0		1.0 gpf			
Shower			5 min	10 min		2.5 gpm			
Faucet (Private)			0.75min			2.2 gpm			
Faucet (Public)			0.50 min			0.5 gpm			
Faucet (Public, Metering)			2			0.25 gal/cycle			
Dishwasher (Res)	(a)		18 min			2.75 gpm			
Dishwasher (Comm)	(a)		(c)			(b)			
Kitchen Sink (Res)	(a)		20 min			2.2 gpm			
Kitchen Sink (Comm)	(a)		(b)			3.0 gpm			
Service Sink	(a)		10 min			3.0 gpm			
Garbage Disposer (Res)	(a)		5 min			2.2 gpm			
Garbage Disposer (Comm)	(a)		(b)			3.0 gpm			
Other:	(a)								
	(a)								
	(a)								
	(a)								
	(a)								
Total Use (Gallons/Year)									
Savings (Gallons/Year)									
Less: Gray Water Re-Use (Gallons/Year) (d)									
Rainwater Use (Gallons/Year) (d)									
Total Savings (Gallons/Year)									
Total Savings (Percent...20% or Greater Required)									

- Notes:**
 (a) Number of fixtures
 (b) Based on kitchen capacity.
 (c) Based on number of meals/day, etc.
 (d) Applied to flushing fixtures, only.

OUTDOOR WATER CONSUMPTION

Total Project Site Area (sf)

- Less: Building footprint areas (sf)
- Parking areas (sf)
- Roadway areas (sf)
- Walks, patios, and other paved areas (sf)
- Other:
- Other:

Net Lot Area (sf)

Allowable Irrigated Area: %

Sq. Feet

	40

Non-Potable Water Use (%)

--

Total Project Irrigated Area: %

Sq. Feet

Sprinkler System:

- Sprinkler Coverage (%)
- Controls: Time Clock (Y/N)
- Soil Moisture Monitoring (Y/N)
- ET Control (Y/N)

2-4. BUILDING PERFORMANCE VERIFICATION

North Carolina General Statute 143-135.37(e) requires performance verification for major projects, as follows:

"In order to be able to monitor the initial cost and the continuing costs of the energy and water systems, a separate meter for each electricity, natural gas, fuel oil, and water utility shall be installed at each building undergoing a major facility construction or renovation project. Each meter shall be installed in accordance with the United States Department of Energy guidelines issued under Section 103 of the Energy Policy Act of 2005 (Pub. L. 109-58, 119 Stat. 594 (2005)).

Starting with the first month of facility operation, the public agency shall compare data obtained from each of these meters by month and by year with the applicable energy-efficiency standard under subsection (b) of this section and the applicable water use standard for the project under subsection (c) of this section and report annually no later than August 1 of each year to the Office of State Construction.... If the average energy use or the average water use over the initial 12-month period of facility operation exceeds the applicable energy-efficiency standard under subsection (b) of this section or exceeds the applicable water use standard under subsection (c) of this section by fifteen percent (15%) or more, the public agency shall investigate the actual energy or water use, determine the cause of the discrepancy, and recommend corrections or modifications to meet the applicable standard."

To comply with these requirements, the Advisory Committee recommends the following and, pursuant to these recommendations, modifications to the *State Construction Manual* are proposed in Appendix A.

2-4.1 DESIGNER REQUIREMENTS

During the project design, the designers must locate and specify the requirements for energy supply and water meters that meet the requirements of the legislation. For stand-alone buildings, typically this will mean that the designers must coordinate their systems to ensure that metering supplied by serving utility companies is adequate. For buildings that have energy or water services not provided by a utility or have their energy supply or water provided from a centrally-metered distribution system, the designers must ensure that the require metering is incorporated into the design.

For more complex buildings, sub-metering of specific areas or services of the building may be necessary to ensure accurate verification of the building performance. For example, to ensure that the HVAC systems performance meets design requirements, it may be necessary that the electrical power supply to HVAC systems be segregated and separately metered. Likewise, where daylighting is utilized, the lighting power service must be segregated and separately metered so that other electrical energy use does not "mask" lighting performance. Likewise, major use of water such as for cooling tower make-up and landscape irrigation must be individually measured.

HVAC, plumbing, and electrical design engineers for the project must coordinate the requirements for both master-metering and sub-metering required and develop a Measurement and Verification (M&V) Plan during the Design Document phase. The M&V Plan will be updated during the Construction Document phase. The designers and the CxA will review the M&V Plan and ensure all required building parameters are monitored and measured, and that the building direct digital control is capable of trending all required parameters.

2-4.2 OWNER REQUIREMENTS

During the 12-month measurement and verification period following the completion of construction, the owner will be responsible for collecting and validating all utility metering data and ensure that needed building data is collected.

At the completion of the first 12 months of building operations, the owner is required to compare the actual energy and water use data with the energy model results and assumptions. If energy and/or water usage exceeds the model projections by 15% or more, the owner will further investigate and resolve any issues found, or recommend further corrections or modifications to meet the efficiency standards. The results of the comparison (and any additional investigation and modifications) will be documented and sent to the State Construction Office no later than 1 August following the end of the 12-month measurement and verification period.

Appendix A

The following changes to the *State Construction Manual* and certain forms are recommended to integrate the requirements of GS 143-135.35 thru 143-135.40 for Sustainable, Energy Efficient Buildings into the State Construction process. *(Note: These changes will not become effective until approved by the State Construction Office and published in the online edition of the State Construction Manual.)*

Section 109.2 Added a brief description of the requirements of GS 143-135.35 – GS 143-135.40 to the OC-25 CHECKLIST to reflect that the work involved in planning a Sustainable, Energy Efficient Building must begin at the inception of the planning process as follows:

Section 109.2 OC-25 CHECKLIST

A worksheet/checklist, obtained from the SCO website, is to be attached to the OC-25 Form and was developed by SCO to assist Owners in preparing their budget request. The checklist presents the Owner different categories of projects such as new construction, renovation/repair, roofing, etc. within which questions are posed about issues or conditions that may have a significant impact on the project which might otherwise not have been considered. Issues such as site conditions, available utilities, historic district, flood plain, etc. can impact program budgets if not considered early in the design process.

- A. In accordance with requirements from State Statute GS 143.135 – Article 8C, designers for all State projects are required to submit an energy model for any new building over 20,000 gross sq. ft. (gsf), or any major renovation of an existing building over 20,000 gsf. Refer to the drop down menu under Guidelines on the State Construction Office website for energy performance modeling and reporting, water conservation, building commissioning and building performance verification guidelines.

This State Statute mandates a 30% energy savings for new construction over 20,000 gsf and a 20% energy savings for major renovations over 20,000 gsf against the standard ASHRAE 90.1-2004 baseline for a code compliant building.

A major renovation project is defined in the statute as a renovation project where the cost of the project is greater than 50% of the insurance value of the building prior to the renovation, and the renovated portion of the building is larger than 20,000 gsf of occupied or conditioned space as defined by the North Carolina State Building Code.

Buildings with historic, architectural, or cultural significance under Part 4 of Article 2 of Chapter 143B of the General Statutes are excluded from the Statute requirements.

GS 143-135.35 -.40 also mandates that an independent Commissioning Authority shall be contracted by the owner for all projects that are over 20,000 gsf. The project design and construction teams and the public agency shall jointly determine what level of commissioning is appropriate for the size and complexity of the building and its components.

Section 109.4 Revised to add paragraph 109.4 D to the ADVANCE PLANNING Section as follows

D. Advance planning is required for buildings that are required to comply with GS 143-135.35 - .40(Article 8C), Sustainable, Energy Efficient Buildings. The extent of this advance planning shall be determined in consultation with the State Construction Office. A flowchart to assist design team with the advance planning process for energy and water efficient buildings is available in the drop down menu under “Guidelines” on the State Construction website. (Advanced Planning Flowchart – GS 143-135.35 -.40)

Section 112 Revised title of the Section and included reference to other owner agents as follows:

SECTION 112 EMPLOYMENT OF DESIGNERS AND OTHER OWNER AGENTS

Procurement of Architectural, Engineering, Surveying, Construction Manager at Risk, Materials Testing Agency, and Commissioning Authority services by all public entities shall be advertised publicly.

Section 202.2A. Added Review times for SCO review of Advance planning documents as follows:

The times are:

Advance Planning----- 15 days

Section 301 Added paragraphs I and J to the introductory information for the paragraph as follows:

I. An Integrated Design approach shall be utilized by the design and owner team. This approach should include team meetings early in the design process, which will better enable the team to provide the owner with a fully-integrated design of the most energy efficient and cost effective building. Refer to www.wbdg.org for more information on the Integrated Design approach.
J. A checklist to assist design team with requirements of energy and water efficient buildings is available in the drop down menu under “Forms” on the State Construction website. (Sustainable Buildings Deliverables Checklist - GS 143-135.35 - .40)

Section 301.2A. Added Review times for SCO review of Advance planning documents as follows:

The times are:

Advance Planning----- 15 days

Section 303.5 Provided a listing of additional Guidelines available on the State Construction Office website as follows:

303.5 GENERAL

- A. *Energy Perf. Modeling & Reporting*
- B. *Water Conservation*
- C. *Building Commissioning*
- D. *Building Performance Verification*

Section 305 G Added description of the advance planning efforts required for buildings that must meet the Sustainable, Energy Efficient Building criteria as follows:

- G Advance Planning for Sustainable, Energy Efficient Buildings (GS 143-135.35 - .40) Programming Phase (Refer to Chapter 109.2A for applicability);
 - 1. All State projects that meet the limits stated above shall require that the Project Team identify the following items in the initial project phase:
 - a) Construction cost.
 - b) Design fee
 - c) Commissioning cost
 - 2. Designers shall submit written project criteria, design recommendations and rationale that led to their design recommendations to the SCO for the following programming phase design decisions.
 - a) Identify and review potential energy and water conservation strategies for the building type and location.
 - b) Evaluate building geometry, day lighting depth and site development implications for north and south exposure.
 - 3. A checklist to assist design team with commissioning requirements of energy and water efficient buildings is available in the drop down menu under "Guidelines" on the State Construction website. (Sustainable, Energy Efficient Buildings, GS 143.135.35 - .40, Commissioning Guidelines)

Section 306 B Added reference to Energy Modeling as follows:

The Designer and his consultants shall confer jointly and with the Owner on the most economical and appropriate location and orientation of the facility on the proposed site(s). This effort should consider the feasibility of the site and the implications for the various building systems. Energy Modeling (where required to satisfy the requirements of GS 143-135.35 -.40 for Sustainable, Energy Efficient Buildings) and LCCA results (civil/structural, general and PM&E) should be used as well as the space requirements, functionality and any special conditions should be reflected in the program. A code analysis should be initiated to confirm that the proposed facility is, at this level of development, within the current NC Building Code.

Section 306 E Clarified LCCA submittal requirements

For Sustainable, Energy Efficient Buildings (GS 143-135.35 - .40), the life cycle cost analysis (GS143-64.10 –15) shall be submitted at the Schematic Design Phase and for all other buildings in the Design Development Phase to ensure all preliminary decisions on site issues, orientation (including internal room arrangements and fenestration) are being optimized to accommodate early life cycle cost decision making for all building systems. The LCCA shall be sealed, signed, dated and then updated at each future submittal to reflect any changes to the project. The Designer shall use LCCA in all decisions throughout the project design process. Projects without the appropriate LCCA report for the appropriate submittal will not be approved to continue to the next phase.

Section 306 L Added Schematic Design submittal requirements for Sustainable, Energy Efficient Buildings as follows:

L. Sustainable, Energy Efficient Buildings, GS 143-135.35 - .40

1. Designers shall submit the following data, along with the forms provided in this section, to the State Construction Office with the Schematic Design Phase.
 - a) Daylight Factor Calculations to confirm proportion and characterize programmed spaces and areas where daylighting is desirable or allowed by the owner's program.
 - b) Base building characteristics that are to be used for an hourly energy performance simulation model based on specific building geometry.
 - c) A baseline energy simulation model to establish a base building that meets the ASHRAE 90.1 2004 baseline and is NC Code compliant.
 - d) LCCA report with preliminary calculations of the cost to construct the ASHRAE 90.1 baseline building and the alternate buildings, along with their projected payback.
 - e) Energy strategies for variable building elements that investigate each of the following categories:
 - (i) Building envelope.
 - (ii) Lighting control and lighting design.
 - (iii) HVAC system control and design.
 - (iv) Service water heating systems.
 - f) Submit a report of the integrated design process activities.

Section 306 M Added a description of Commissioning Authority's role in the Schematic Design phase for Sustainable, Energy Efficient Buildings as follows:

M. Commissioning Authority shall review the SD design package against the modeling assumptions and makes written comments to the design team for incorporation into the project by the design team. Refer to “Building Commissioning” in the drop down menu under “Guidelines” on the State Construction website.

Section 307 E Added referral information to the end of the paragraph for Sustainable, Energy Efficient Buildings as follows:

For all State buildings, the Designer shall comply with the NC Energy Code and State Construction Office's procedures for Implementation of Life-Cycle Cost Analysis for State Buildings. Compliance may be demonstrated by using the appropriate forms from the ASHRAE/IESNA Standard 90.1 User's Manual or other methods approved by

the State Construction Office. Refer to Section 307 H, for additional requirements for Sustainable, Energy Efficient Buildings (GS 143-135.35 - .40).

Section 307 H Added Schematic Design submittal requirements for Sustainable, Energy Efficient Buildings, including energy, water and commissioning requirements as follows:

H. Sustainable, Energy Efficient Buildings (GS 143-135.35 - .40)

1. Final submittal of Energy Model should be submitted at this phase, and should include a model of a baseline ASHRAE 90.1 building, along with lists of options and costs for up to two (2) alternate building models that result in a 20% (major renovations) or 30% (new construction) more efficient building than baseline model.
2. Designers shall submit the following data, along with the forms provided in this section, to the State Construction Office at the end of the Design Development Phase.
 - a) Revised energy simulation model developed in the SD phase, refining the proposed energy conservation options. Compare via software the proposed options with the base building that meets ASHRAE 90.1 2004 baseline and NC Building Code.
 - b) The incremental cost increases, if any, for each energy conservation strategy based on the difference of the cost of constructing the energy conservation option versus the cost of constructing the base ASHRAE 90.1-2004 building.
 - c) Updated LCCA comparing the energy conservation options for up to two composite buildings to the ASHRAE 90.1-2004 compliant base building.
 - d) Selection of the resultant the Energy Conservation Measures to be implemented and summarize the final building construction.
 - e) Water reduction calculation for both indoor and outdoor water use relative to baseline. Refer to “Water Conservation” in the drop down menu under “Guidelines” on the State Construction website.
3. The Commissioning Authority shall review the DD design package against the

modeling assumptions and shall make recommendations for incorporation into the project by the design team. Refer to “Building Commissioning” in the drop down menu under “Guidelines” on the State Construction website. (Sustainable, Energy Efficient Buildings Advanced Planning Process Flowchart, GS 143-135.35 - .40)

Section 308.1 G Added Construction Document Phase submittal requirements for Sustainable, Energy Efficient Buildings, including energy, water and commissioning requirements as follows:

G Sustainable, Energy Efficient Buildings GS 143-135.35 - .40

1. The design team shall incorporate the energy conservation options into the project. The energy model submittal from the design development phase shall be re-submitted with the documentation for this phase. If alterations have occurred due to site or building changes, the model shall be updated and indicated to contain altered information.
2. The LCCA shall be refined and updated and submitted in accordance with the requirements of the Life Cycle Cost Manual.
3. Designers shall refine, update and submit the water reduction calculation for both indoor and outdoor water use.
4. Commissioning Authority shall review the construction document package against the modeling assumptions and shall make recommendations for incorporation into the project by the design team. Refer to “Building Commissioning” in the drop down menu on the State Construction website under “Guidelines”.

Section 505.1 Revised the Section Title to include the Commissioning Authority and divided the section into Part A for Designer and Part B for Commissioning Authority as follows:

505.1 DESIGNER’S AND COMMISSIONING AUTHORITY’S RESPONSIBILITIES DURING CONSTRUCTION (NCAC 30A.0403)

A. DESIGNER’S RESPONSIBILITIES DURING CONSTRUCTION

Section 505.1 A4b. Included a provision to require the design team to review shop drawings to verify compliance with the energy conservation components of the project as follows:

- b) Design Team shall review shop drawings to verify compliance with the energy conservation options.

Section 505.1 B Provided a new Paragraph B to describe the role of the Commissioning Authority during construction as follows:

B. COMMISSIONING AUTHORITY'S RESPONSIBILITIES DURING CONSTRUCTION (FOR SUSTAINABLE, ENERGY EFFICIENT BUILDINGS, GS 143-135.35 - .40)

The Commissioning Authority efforts will include review of component and equipment submittals by contractors, review of systems to be commissioned, and review the contractor's pre-functional/start up check lists. The Commissioning Authority will provide the projects functional testing procedures, validate the test, adjust, and balance (TAB) effort, and lead functional acceptance testing of commissioned systems. The Commissioning Authority will also review and approve training agendas, O&M manuals, and project as-built documentation. Functional testing must be completed satisfactorily prior to final acceptance of the project.

Chapter 600 Revised chapter title to include post-occupancy as follows:

CHAPTER 600 RECORD DOCUMENTS, FINAL REPORT AND POST-OCCUPANCY

Section 601.2 Provided a new section to describe post occupancy requirements of Sustainable, Energy Efficient Buildings

601.2 POST OCCUPANCY PHASE REQUIREMENTS FOR SUSTAINABLE, ENERGY EFFICIENT BUILDINGS, GS 143-135.35 - .40

- A. Starting with the 1st month of operation of a building, the public agency shall compare data obtained from the building energy usage (via meters installed on-site) with the final energy model results.
- B. At the completion of the first 12 months of building operations, the owner is required to compare the actual energy and water use data with the energy model results and assumptions. If energy and/or water usage exceeds the model projections by 15% or more, the owner will further investigate and resolve any issues found, or recommend further corrections or modifications to meet the efficiency standards.
- C. The Commissioning Authority will perform opposite seasonal testing, coordinate a 10-month warranty review, and participate with the owner in collecting building data for the 12 month measurement and verification of energy performance. The Commissioning Authority will deliver a complete Cx and systems manual to the owner that includes a re-commissioning plan.

Appendix B

GS 143-135.35 -.40

"Article 8C.

"Performance Standards for Sustainable, Energy-Efficient Public Buildings.

"§ 143-135.35. Findings; legislative intent.

The General Assembly finds that public buildings can be built and renovated using sustainable, energy-efficient methods that save money, reduce negative environmental impacts, improve employee and student performance, and make employees and students more productive. The main objectives of sustainable, energy-efficient design are to avoid resource depletion of energy, water, and raw materials; prevent environmental degradation caused by facilities and infrastructure throughout their life cycle; and create buildings that are livable, comfortable, safe, and productive. It is the intent of the General Assembly that State-owned buildings and buildings of The University of North Carolina and the North Carolina Community College System be improved by establishing specific performance standards for sustainable, energy-efficient public buildings. These performance standards should be based upon recognized, consensus standards that are supported by science and have a demonstrated performance record. The General Assembly also intends, in order to ensure that the economic and environmental objectives of this Article are achieved, that State agencies, The University of North Carolina, and the North Carolina Community College System determine whether the performance standards are met for major facility construction and renovation projects, measure utility and maintenance costs, and verify whether these standards result in savings. Also, it is the intent of the General Assembly to establish a priority to use North Carolina-based resources, building materials, products, industries, manufacturers, and businesses to provide economic development to North Carolina and to meet the objectives of this Article.

"§ 143-135.36. Definitions.

As used in this section, the following definitions apply unless the context requires otherwise:

- (1) "ASHRAE" means the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
- (2) "Commission" means to document and to verify throughout the construction process whether the performance of a building, a component of a building, a system of a building, or a component of a building system meets specified objectives, criteria, and agency project requirements.
- (3) "Department" means the Department of Administration.
- (4) "Institutions of higher education" means the constituent institutions of The University of North Carolina, the regional institutions as defined in G.S. 115D-2, and the community colleges as defined in G.S. 115D-2.
- (5) "Major facility construction project" means a project to construct a building larger than 20,000 gross square feet of occupied or conditioned space, as defined in the North Carolina State Building Code adopted under Article 9 of Chapter 143 of the General Statutes. "Major facility construction project" does not include a project to construct a transmitter building or a pumping station.
- (6) "Major facility renovation project" means a project to renovate a building when the cost of the project is greater than fifty percent (50%) of the insurance value of the building prior to the renovation and the renovated portion of the building is larger than 20,000 gross square feet of occupied or conditioned space, as defined in the North Carolina State Building Code. "Major facility renovation project" does not include a project to renovate a transmitter building or a pumping station. "Major facility renovation project" does not include a project to renovate a building having historic, architectural, or cultural significance under Part 4 of Article 2 of Chapter 143B of the General Statutes.
- (7) "Public agency" means every State office, officer, board, department, and commission and institutions of higher education.

"§ 143-135.37. Energy and water use standards for public major facility construction and renovation projects; verification and reporting of energy and water use.

(a) Program Established. – The Sustainable Energy-Efficient Buildings Program is established within the Department to be administered by the Department. This program applies to any major facility construction or renovation project of a public agency that is funded in whole or in part from an appropriation in the State capital budget or through a financing contract as defined in G.S. 142-82.

(b) Energy-Efficiency Standard. – For every major facility construction project of a public agency, the building shall be designed and constructed so that the calculated energy consumption is at least thirty percent (30%) less than the energy consumption for the same building as calculated using the energy-efficiency standard in ASHRAE 90.1-2004. For every major facility renovation project of a public agency, the renovated building shall be designed and constructed so that the calculated energy consumption is at least twenty percent (20%) less than the energy consumption for the same renovated building as calculated using the energy-efficiency standard in ASHRAE 90.1-2004. For the purposes of this subsection, any exception or special standard for a specific type of building found in ASHRAE 90.1-2004 is included in the ASHRAE 90.1-2004 standard.

(c) Water Use Standard. – For every major facility construction or renovation project of a public agency, the water system shall be designed and constructed so that the calculated indoor potable water use is at least twenty percent (20%) less than the indoor potable water use for the same building as calculated using the fixture performance requirements related to plumbing under the 2006 North Carolina State Building Code. For every major facility construction project of a public agency, the water system shall be designed and constructed so that the calculated sum of the outdoor potable water use and the harvested stormwater use is at least fifty percent (50%) less than the sum of the outdoor potable water use and the harvested stormwater use for the same building as calculated using the performance requirements related to plumbing under the 2006 North Carolina State Building Code. For every major facility renovation project of a public agency, the Department shall determine on a project-by-project basis what reduced level of outdoor potable use or harvested stormwater use, if any, is a feasible requirement for the project, but the Department shall not require a greater reduction than is required under this subsection for a major facility construction project. To reduce the potable outdoor water use as required under this subsection, landscape materials that are water use efficient and irrigation strategies that include reuse and recycling of the water may be used.

(d) Performance Verification. – In order to be able to verify performance of a building component or an energy or water system component, the construction contract shall include provisions that require each building component and each energy and water system component to be commissioned, and these provisions shall be included at the earliest phase of the construction process as possible and in no case later than the schematic design phase of the project. Such commissioning shall continue through the initial operation of the building. The project design and construction teams and the public agency shall jointly determine what level of commissioning is appropriate for the size and complexity of the building or its energy and water system components.

(e) Separate Utility Meters. – In order to be able to monitor the initial cost and the continuing costs of the energy and water systems, a separate meter for each electricity, natural gas, fuel oil, and water utility shall be installed at each building undergoing a major facility construction or renovation project. Each meter shall be installed in accordance with the United States Department of Energy guidelines issued under section 103 of the Energy Policy Act of 2005 (Pub. L. 109-58, 119 Stat. 594 (2005)). Starting with the first month of facility operation, the public agency shall compare data obtained from each of these meters by month and by year with the applicable energy-efficiency standard under subsection (b) of this section and the applicable water use standard for the project under subsection (c) of this section and report annually no later than August 1 of each year to the Office of State Construction within the Department. If the average energy use or the average water use over the initial 12-month period of facility operation exceeds the applicable energy-efficiency standard under subsection (b) of this section or exceeds the applicable water use standard under subsection (c) of this section by fifteen percent (15%) or more, the public agency shall investigate the actual energy or water use, determine the cause of the discrepancy, and recommend corrections or modifications to meet the applicable standard.

"§ 143-135.38. Use of other standard when standard not practicable.

When the Department, public agency, and the design team determine that the energy-efficiency standard or the water use standard required under G.S. 143-135.37 is not practicable for a major facility construction or renovation project, then it must be determined by the State Building Commission if the standard is not practicable for the major facility construction or renovation project. If the State Building Commission determines the standard is not practicable for that project, the State Building Commission shall determine which standard is practicable for the design and construction for that major facility construction or renovation project. If a standard required under G.S. 143-135.37 is not followed for that project, the State Building Commission shall report this information and the reasons to the Department within 90 days of its determination.

"§ 143-135.39. Guidelines for administering the Sustainable Energy-Efficient Buildings Program.

(a) Policies and Technical Guidelines. – The Department, in consultation with public agencies, shall develop and issue policies and technical guidelines to implement this Article for public agencies. The purpose of these policies and guidelines is to establish procedures and methods for complying with the energy-efficiency standard or the water use standard for major facility construction and renovation projects under G.S. 143-135.37.

(b) Preproposal Conference. – As provided in the request for proposals for construction services, the public agency may hold a preproposal conference for prospective bidders to discuss compliance with, and achievement of, the energy-efficiency standard or the water use standard required under G.S. 143-135.37 for prospective respondents.

(c) Advisory Committee. – The Department shall create a sustainable, energy- efficient buildings advisory committee comprised of representatives from the design and construction industry involved in public works contracting, personnel from the public agencies responsible for overseeing public works projects, and others at the Department's discretion to provide advice on implementing this Article. Among other duties, the advisory committee shall make recommendations regarding the education and training requirements under subsection (d) of this section, make recommendations regarding specific education and training criteria that are appropriate for the various roles with respect to, and levels of involvement in, a major facility construction or renovation project subject to this Article or the roles regarding the operation and maintenance of the facility, and make recommendations regarding developing a process whereby the Department receives ongoing evaluations and feedback to assist the Department in implementing this Article so as to effectuate the purpose of this Article. Further, the advisory committee may make recommendations to the Department regarding whether it is advisable to strengthen standards for energy efficiency or water use under this Article, whether it is advisable and feasible to add additional criteria to achieve greater sustainability in the construction and renovation of public buildings, or whether it is advisable and feasible to expand the scope of this Article to apply to additional types of publicly financed buildings or to smaller facility projects.

(d) Education and Training Requirements. – The Department shall review the advisory committee's recommendations under subsection (c) of this section regarding education and training. For each of the following, the Department shall develop education and training requirements that are consistent with the purpose of this Article and that are appropriate for the various roles with respect to, and level of involvement in, a major facility construction or renovation project or the roles regarding the operation and maintenance of the facility:

- (1) The chief financial officers of public agencies.
- (2) For each public agency that is responsible for the payment of the agency's utilities, the facility managers of these public agencies.
- (3) The capital project coordinators of public agencies.
- (4) Architects.
- (5) Mechanical design engineers.

(e) Performance Review. – Annually the Department shall conduct a performance review of the Sustainable Energy-Efficient Buildings Program. The performance review shall include at least all of the following:

- (1) Identification of the costs of implementing energy-efficiency and water use standards in the design and construction of major facility construction and renovation projects subject to this Article.

- (2) Identification of operating savings attributable to the implementation of energy-efficiency and water use standards, including, but not limited to, savings in utility and maintenance costs.
- (3) Identification of any impacts on employee productivity from using energy-efficiency and water use standards.
- (4) Evaluation of the effectiveness of the energy-efficiency and water use standards established by this Article.
- (5) Whether stricter standards or additional criteria for sustainable buildings should be used other than the standards under G.S. 143-135.37.
- (6) Whether the Sustainable Energy-Efficient Buildings Program should be expanded to include additional public agencies, to include additional types of projects, or to include smaller major facility construction or renovation projects.
- (7) Any recommendations for any other changes regarding sustainable, energy-efficient building standards that may be supported by the Department's findings.

(f) Report on Performance Review. – Each year, the Department shall include in its consolidated report under subsection (g) of this section a report of its findings under the performance review under subsection (e) of this section.

(g) Consolidated Report Required. – The Department shall consolidate the report required under subsection (f) of this section, the report under G.S. 143-135.37(e), the report, if any, from the State Building Commission under G.S. 143-135.38, and the report under G.S. 143-135.40 into one report. No later than October 1 of each year, this consolidated report shall be transmitted to the Chairs of the General Government Appropriations Subcommittees of both the Senate and the House of Representatives, the Environmental Review Commission, and the Joint Legislative Commission on Governmental Operations. The Department shall include any recommendations for administrative or legislative proposals that would better fulfill the legislative intent of this Article.

(h) Authority to Adopt Rules or Architectural or Engineering Standards. – The Department may adopt rules to implement this Article. The Department may adopt architectural or engineering standards as needed to implement this Article.

"§ 143-135.40. Monitor construction standards and sustainable building standards.

(a) The Department shall monitor the development of construction standards and sustainable building standards to determine whether there is any standard that the Department determines would better fulfill the intent of the Sustainable Energy- Efficient Buildings Program to achieve sustainable, energy-efficient public buildings than the standards under G.S. 143-135.37, and, if so, whether this Article should be amended to provide for the use of any different standards or the use of any additional standards to address additional aspects of sustainable, energy-efficient buildings. Additional standards monitored shall address consideration of site development, material and resource selection, and indoor environmental quality to enhance the health or productivity of building occupants. Also, the Department shall monitor the development of improved energy-efficiency standards developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the ASHRAE standards, shall monitor whether the State Building Code Council adopts any other energy-efficiency standards for inclusion in the State Building Code that result in greater energy efficiency and increased energy savings in major facility construction and renovation projects under this Article, and shall monitor other standards for sustainable, energy-efficient buildings that are based upon recognized, consensus standards based on science and demonstrated performance.

(b) Each year, the Department shall report the results of its monitoring under this section, including any recommendations for administrative or legislative proposals."

SECTION 2. G.S. 115D-20 is amended by adding a new subdivision to read:

"(14) To comply with the design and construction requirements regarding energy efficiency and water use in the Sustainable Energy-Efficient Buildings Program under Article 8C of Chapter 143 of the General Statutes."

SECTION 3. Article 6 of Chapter 146 of the General Statutes is amended by adding a new section to read:

"§ 146-23.2. Purchase of buildings constructed or renovated to a certain energy-efficiency standard.

(a) A State agency shall not acquire by purchase any building unless the building was designed and constructed to at least the same standards for energy efficiency and water use that the design and construction of a comparable State building was required to meet at the time the building under consideration for purchase was constructed. Further, a State agency shall not acquire by purchase any building that had a major renovation unless the major renovation of the building was designed and constructed to at least the same standards for energy efficiency and water use that the design and construction of a major renovation of a comparable State building was required to meet at the time the building under consideration for purchase was renovated.

(b) This section does not apply to the purchase of a building having historic, architectural, or cultural significance under Part 4 of Article 2 of Chapter 143B of the General Statutes. This section does not apply to buildings that are acquired by devise or gift."

SECTION 4. The initial report under G.S. 143-135.37(e), the initial report under G.S. 143-135.39(f), and the initial report under G.S. 143-135.40 are due no later than August 1, 2009. The initial consolidated report required under G.S. 143-135.39(g) is due no later than October 1, 2009.

SECTION 5. Section 1 of S.L. 2007-546 is repealed.

SECTION 6. Section 2.1(a)(1) of S.L. 2007-546 reads as rewritten:

"(1) Lighting Systems. – The installation of exit signs that employ light-emitting diode (LED) technology or photo luminescent technology; the replacement of incandescent light bulbs with compact fluorescent light bulbs; and where appropriate, as determined by the Department of Administration, the installation of occupancy sensors or optical sensors."

SECTION 7. This act is effective when it becomes law. Section 1 and Section 2 of this act apply to every major facility construction project, as defined in G.S. 143-135.36 as enacted in Section 1 of this act, and every major facility renovation project, as defined in G.S. 143-135.36 as enacted in Section 1 of this act, of a public agency, as defined in G.S. 143-135.36 as enacted in Section 1 of this act, that has not entered the schematic design phase prior to the effective date of this act.