Designing a Resilient Building in the Coastal Zone

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RESILIENCE IN COASTAL BUILDING
THROUGH ARCHITECTURE AND ENGINEERING

DESIGN PROCESS OF THE UNC COASTAL STUDIES INSTITUTE (CSI)

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David Pryor, PE  Director of Waterfront Engineering  Clark Nexsen
2030 CHALLENGE COMMITMENT

We are committed to a sustainable future. Clark Nexsen has formally adopted the “2030 Challenge” which states that all new buildings, developments, and major renovations will be carbon neutral by 2030. This starts today by designing buildings to meet an energy consumption performance standard of 70% below the regional or national average.
We are committed to a sustainable future. Clark Nexsen has formally adopted the “2030 Challenge” which states that all new buildings, developments, and major renovations will be carbon neutral by 2030. This starts today by designing buildings to meet an energy consumption performance standard of 70% below the regional or national average.

“Together we discover, inspire, and shape ideas that transform the world.”

We begin with partnership. Great ideas come from collaboration. Our approach crosses disciplines to inspire innovation. Our process advances communities through discovery and design. We believe ideas have the power to transform.
Waterfront Engineering Services

Services
- Marine Structural Design
- Coastal Engineering
- Marine Structural Inspections
- Dredging and Navigation
- Port and Shipyard Engineering

Client Sectors
- DoD & Federal
- State & Municipal
- Shipyards
- Public and Private Ports
- Private Developers
Waterfront Projects

Cape Henry Lighthouse
Colley Bay Living Shoreline
13th Street Boat Ramp
Santa Rosa Island Seawall
Lesner Bridge Coastal Modeling & Bulkhead
Fort Boykins Shoreline Restoration
Lake Lawson Recreation Development
re-sil-i-ence

noun

definition:
1. the capacity to recover quickly from difficulties; toughness

*oxford dictionary*
RESILIENT DESIGN PRINCIPLES

from Resilient Design Institute

Resilience Transcends Scales

Protects Natural Environment & Resources

Anticipates Interruptions and Adversity

Resilient systems provide for basic human needs

Diverse and Redundant Systems

Simple Passive and Flexible

Durable Materials

Locally Available, Renewable Resources
UNC COASTAL STUDIES INSTITUTE

NEW CAMPUS FOR UNC SYSTEM
200 acre site

MARINE SERVICES BUILDING - 12,000 SF

RESIDENTIAL BUILDINGS - 14,000 SF

RESEARCH LAB BUILDING - 52,000 SF
  Marine Archaeology
  Coastal Processes
  Engineering
  Teaching Classroom and Labs
  Administration and Offices

LEED Gold
USGBC Green School Award
2014 AIA Triangle Honor Award
2013 AIA North Carolina Honor Award
2014 Chicago Athenaeum International Award
DIVERSE LEADERSHIP TEAM

UNC Coastal Studies Institute Board and Staff
Senator Marc Basnight and State Legislature
Director Dr. Nancy White
East Carolina University
Citizens of Dare County
University of North Carolina
MULTIDISCIPLINARY DESIGN TEAM

CSI
Clark Nexsen
Cahoon and Kasten - Local Architect
RMF Engineering - MEP
Stewart Engineering - Structural
Albemarle & Associates - Civil
CLH Design - Landscape
Whiting Turner Construction
ECU
State Construction Office
CSI DESIGN OBJECTIVES

“TO EXEMPLIFY THE HIGHEST AND BEST PRACTICES OF COASTAL DESIGN THAT ARE SUSTAINABLE AND PRACTICAL”

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS SURFACES
HARVEST ALL RAINWATER
TREAT STORMWATER AND WASTEWATER ON SITE
DAYLIGHT MAXIMIZE SOUTHERN EXPOSURE
INTEGRATE RENEWABLE ENERGY
PRESERVE NATURAL RESOURCES
RESILIENT DESIGN PRINCIPLES

from Resilient Design Institute

Resilience Transcends Scales

Protect Natural Environment & Resources

Anticipates Interruptions and Adversity

Resilient systems provide for basic human needs

Diverse and Redundant Systems

Simple Passive and Flexible

Durable Materials

Locally Available, Renewable Resources
RESPOND TO REGIONAL CONTEXT

HISTORY
VERNACULAR ARCHITECTURE
INFRASTRUCTURE & BUILT ELEMENTS
SITE
SITE

200 ACRES
WETLANDS AND MARSH PRESERVES
UNOBSSTRUCTED VIEWS OF CROATAN SOUND
ABOVE FRESHWATER AQUIFER
SITE

23 ACRE BUILDABLE SITE
BUILT FROM DREDGED CANALS
CANALS FOR WATER ACESS AND VIEWS
NARROW SOUTHERN EXPOSURE
SITE ANALYSIS
SOLAR PATH and NATURAL AXIS AND THRESHOLD
SITE ANALYSIS
STORMWATER COLLECTION DIAGRAM
SITE ANALYSIS
PUBLIC SPACE CONNECTOR - A SPINE OF CREATED WETLANDS
BUILDING SITING
MARINE SERVICES BUILDING - SHELTERED AT INTERSECTION OF CANALS
BUILDING SITING
RESEARCH BUILDING - EW ORIENTATION, BENT FORM TO ALIGN WITH CANAL, MAXIMIZE DAYLIGHT
BUILDING SITING
RESIDENTIAL - CAMPUS PATH ALONG CANAL
INTERACTION WITH SITE
POUROUS BOUNDARY ALONG CANAL TO FRAME VIEWS OF SOUND AND WETLANDS
INTERACTION WITH SITE
ELEVATED TO RESPOND TO SEA LEVEL RISE, UTILIZATION OF SUN AND WIND, ALIGNED TO CANAL
Preserve Natural Resources
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
HARVEST RAINWATER
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
HARVEST RAINWATER
TREAT ALL STORMWATER ON SITE
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
HARVEST RAINWATER
TREAT ALL STORMWATER ON SITE
TREAT ALL WASTEWATER ON SITE
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
HARVEST RAINWATER
TREAT ALL STORMWATER ON SITE
TREAT ALL WASTEWATER ON SITE
USE OF “BORROWED WATER” GEOTHERMAL
preservation of natural resources

BALANCE CUT AND FILL
MINIMIZE FOOTPRINT AND IMPERVIOUS
HARVEST RAINWATER
TREAT ALL STORMWATER ON SITE
TREAT ALL WASTEWATER ON SITE
USE OF BORROWED WATER GEOTHERMAL
NO IRRIGATION - ALL INDIGENOUS PLANTS
RESILIENT DESIGN PRINCIPLES

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Resilience Transcends Scales

Protect Natural Environment & Resources

Anticipates Interruptions and Adversity

Resilient systems provide basic human needs

Diverse and Redundant Systems

Simple Passive and Flexible

Durable Materials

Locally Available, Renewable Resources
BUILDING SYSTEMS

RAINWATER SYSTEM
GRAYWATER SYSTEM
CONDENSATE WATER SYSTEM
ON-SITE WASTEWATER SYSTEM
USE OF “BORROWED WATER” GEOTHERMAL

LOWER PRINCIPAL FRESH WATER AQUIFER

YORKTOWN SALTWATER AQUIFER
GEOTHERMAL HVAC SYSTEM

ORIGINAL DESIGN APPROACH

CLOSED LOOP SYSTEM
230 WELLS
MODULAR HEAT PUMP
VAV AIR HANDLING UNITS
VAV AND CAV TERMINAL UNITS
GEOTHERMAL HVAC SYSTEM

ORIGINAL DESIGN APPROACH

CLOSED LOOP SYSTEM
230 WELLS
MODULAR HEAT PUMP
VAV AIR HANDLING UNITS
VAV AND CAV TERMINAL UNITS

FINAL DESIGN

OPEN LOOP SYSTEM
UTILIZES DARE COUNTY RAW WATER
MODULAR HEAT PUMP
VAV AIR HANDLING UNITS
VAV AND CAV TERMINAL UNITS
Wells Penetrated three aquifers

Possible Contamination from brakish waters

Possible Increase in Aquifer Temperature

Primary Water Supply could be compromised
OPEN LOOP DESIGN OPTIONS

3 Supply Wells and Dump into Sound
Cost Effective
Potentially Damaging to sound

3 Supply Wells and 4 Injection Wells
Costly
High Maintenance
Potential Contamination of fresh water aquifer

Borrowed Raw Water from Dare County
Most cost effective
Proposed by county as protection for aquifer
Most energy saving option
Public Public partnership
Required Memorandum of Understanding
OPEN LOOP “BORROWED WATER” GEOTHERMAL DESIGN

CSI SUPPLY WELL

CHECK VALVE

GEOTHERMAL PUMP

HEAT EXCHANGER

WELL 14

WELL 6

RAW WATER MAIN

CHECK VALVE

2MG

SKYCO PLANT

2MG

CSI
Borrowed Raw Water from Dare County
  Open Loop system
  Utilizes Dare County Raw Water
  Modular Heat Pump
  VAV Air Handling Units
  VAV & CAV Terminal Units

RESULTS
  Energy Modeling
  Compared to ASHRAE 90.1 2007
  34% Energy Savings
  27% Energy Cost Savings
  10 LEED Points
  Helped Achieve LEED Gold

FINAL GEOTHERMAL HVAC SYSTEM
RESILIENT DESIGN PRINCIPLES
from Resilient Design Institute

Resilience Transcends Scales

Protect Natural Environment & Resources

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Resilient systems provide basic human needs

Diverse and Redundant Systems

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Durable Materials

Locally Available, Renewable Resources
aluminum vertical sunshades
horizontal aluminum sunshades
fibercement box
low E glass aluminum curtain wall facing wetlands
reinforced concrete structure
canal view
cypress rainscreen box
aluminum clad rainwater downspout
entrance lobby
underground cisterns
fibercement elevated box
reinforced concrete plinth
indigenous grasses
view from south lawn
MATERIALS

- aluminum coping
- 12" fibercement rainscreen over continuous rigid insulation
- 20" aluminum airfoil
- aluminum vert. tube
- low E aluminum curtain wall
- 12" fibercement rainscreen
- 8" cypress rainscreen over continuous rigid insulation
- 8" reinforced CMU

south elevation
exterior bridges and stair tower

- solid/void
- structure
- objects
- use
- geometry
1 lobby
2 outdoor classroom
3 teaching lab
4 flex classroom
5 seminar room
6 mapping room
7 research lab
8 collaborative space
9 teaching studio
10 utilities
1 research building
2 marina building
3 future residential
4 existing canal
5 new connecting canal
6 created wetland
7 bioretention pond
8 waste water effluent pond

view from new connecting canal

view from northeast wetland