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Designing a Resilient Building in the Coastal Zone

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Clark Nexsen

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Clark Nexsen

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RESILIENCE IN COASTAL BUILDING

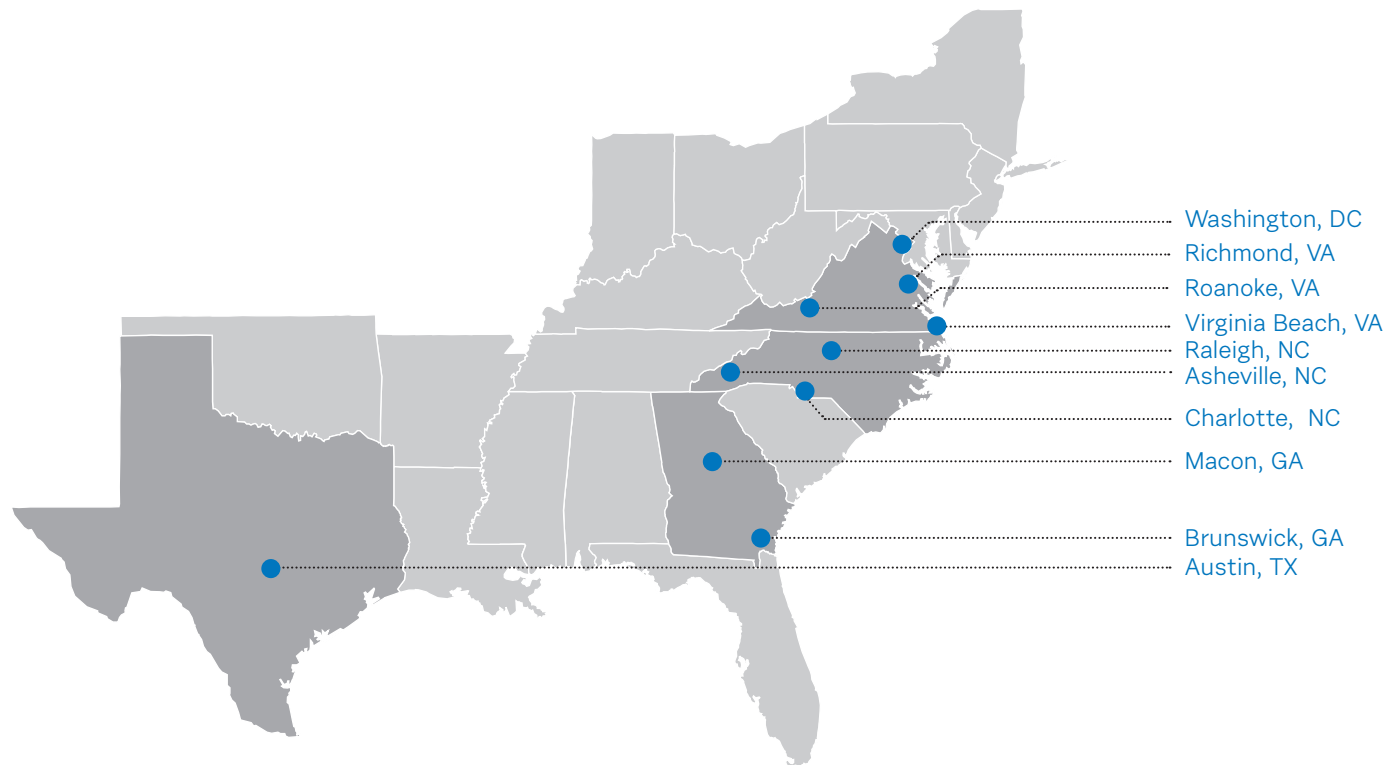
THROUGH ARCHITECTURE AND ENGINEERING

DESIGN PROCESS OF THE UNC COASTAL STUDIES INSTITUTE (CSI)

Don Kranbuehl, AIA, LEED BD+C Senior Architect Clark Nexsen Lead Design Architect for CSI

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



PARTNER. DISCOVER.TRANSFORM.

‘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 Archeology
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



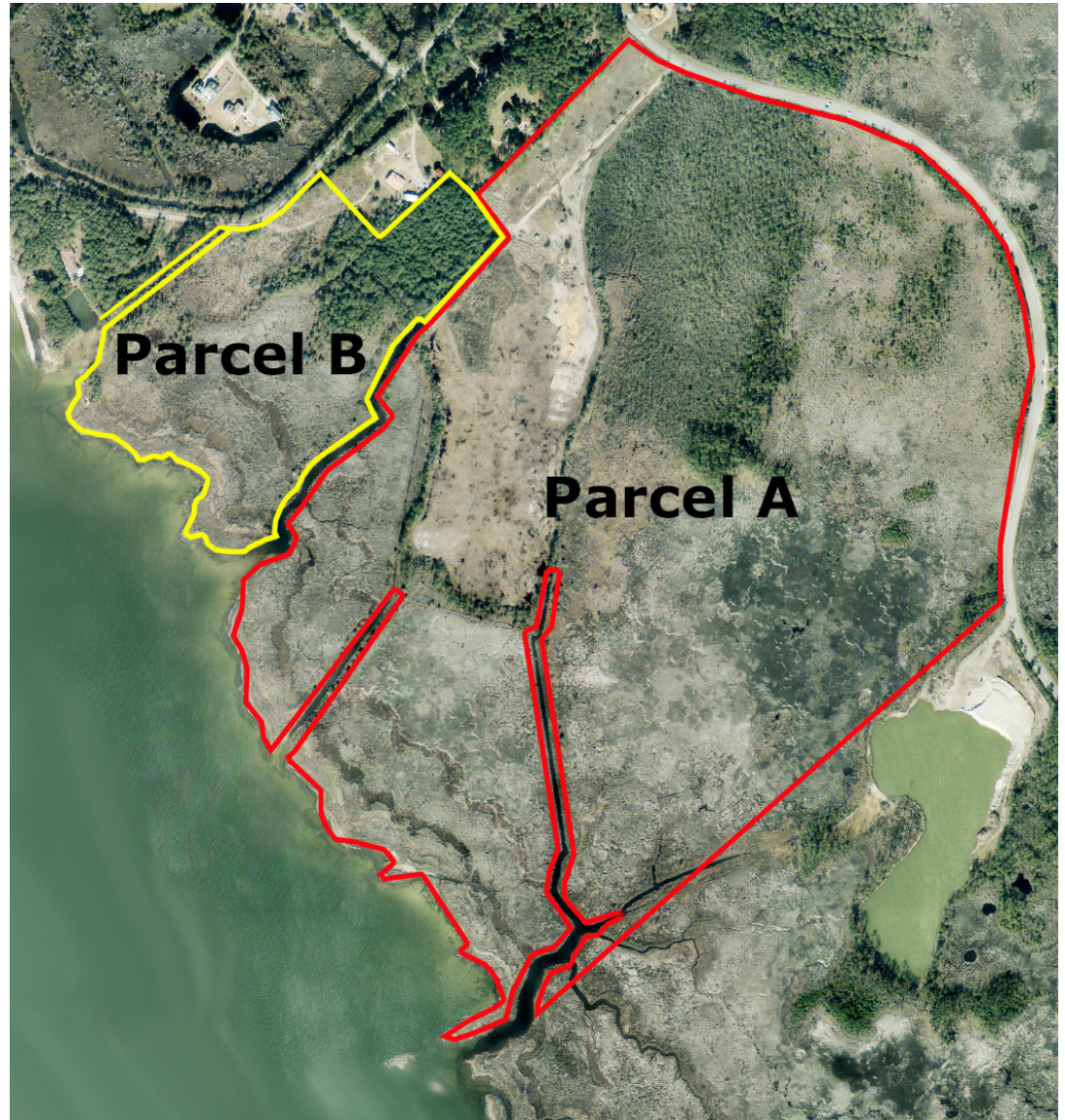
SITE

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

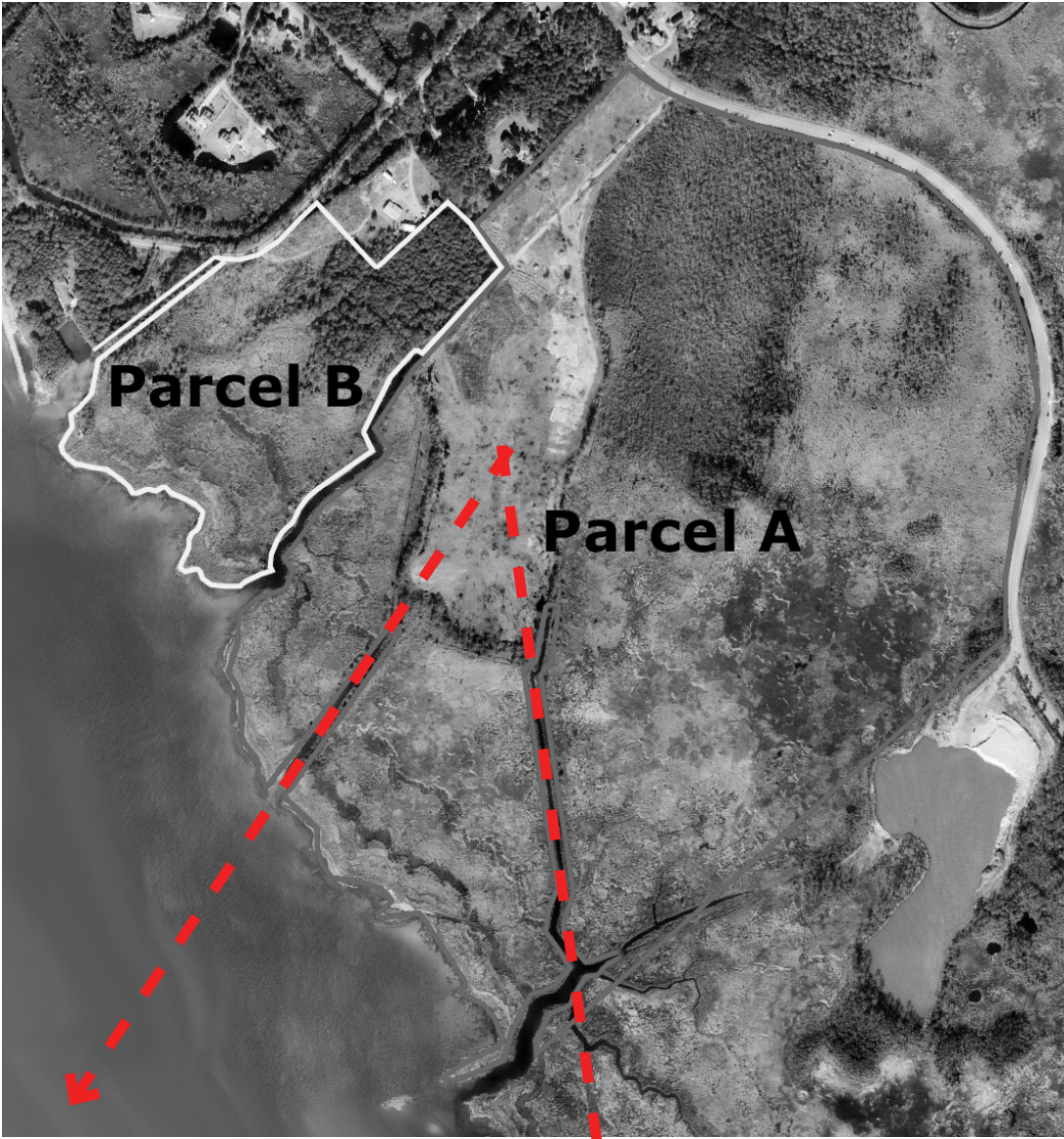


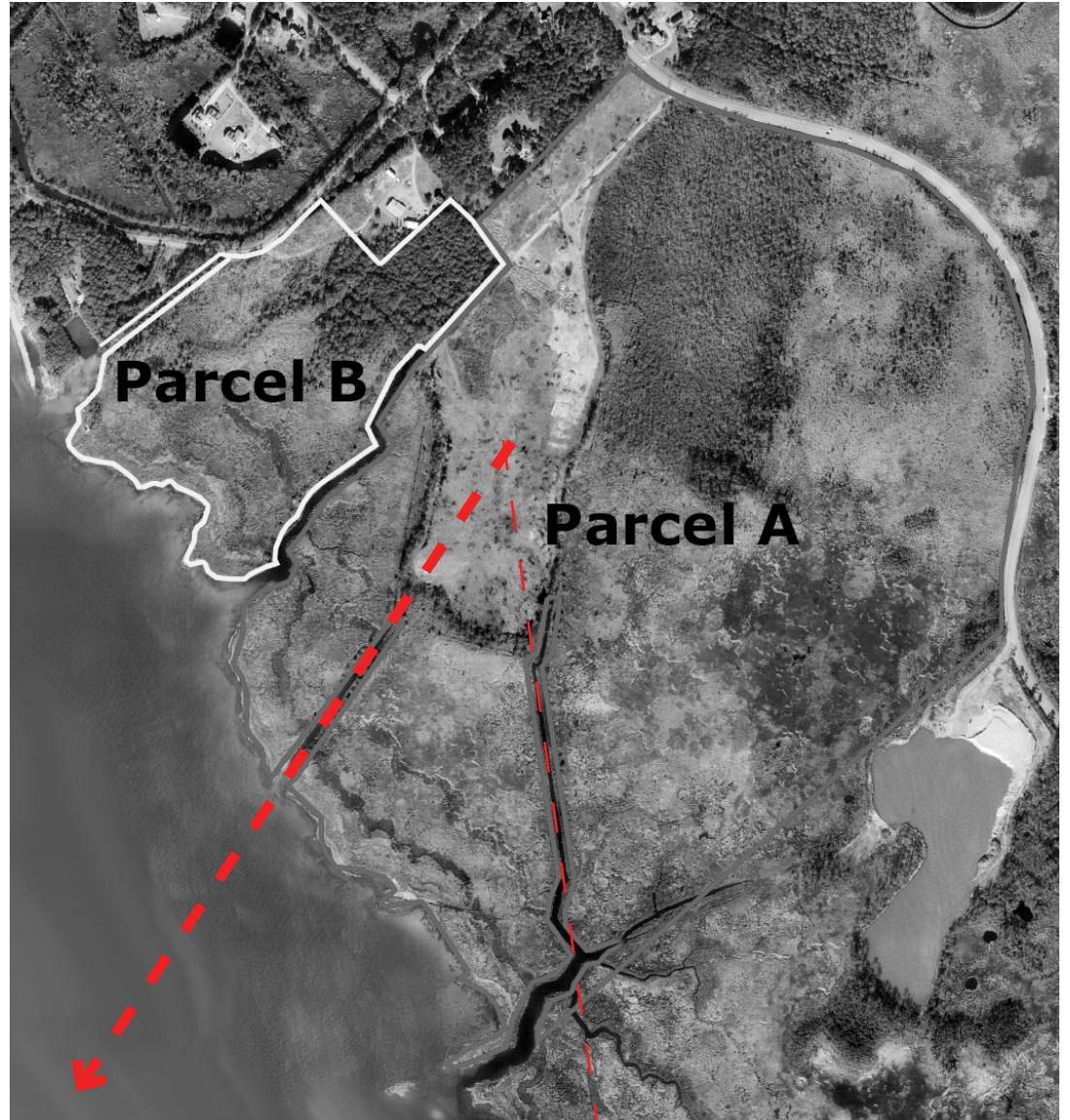
SITE

23 ACRE BUILDABLE SITE
BUILT FROM DREDGED CANALS
CANALS FOR WATER ACCESS AND VIEWS
NARROW SOUTHERN EXPOSURE



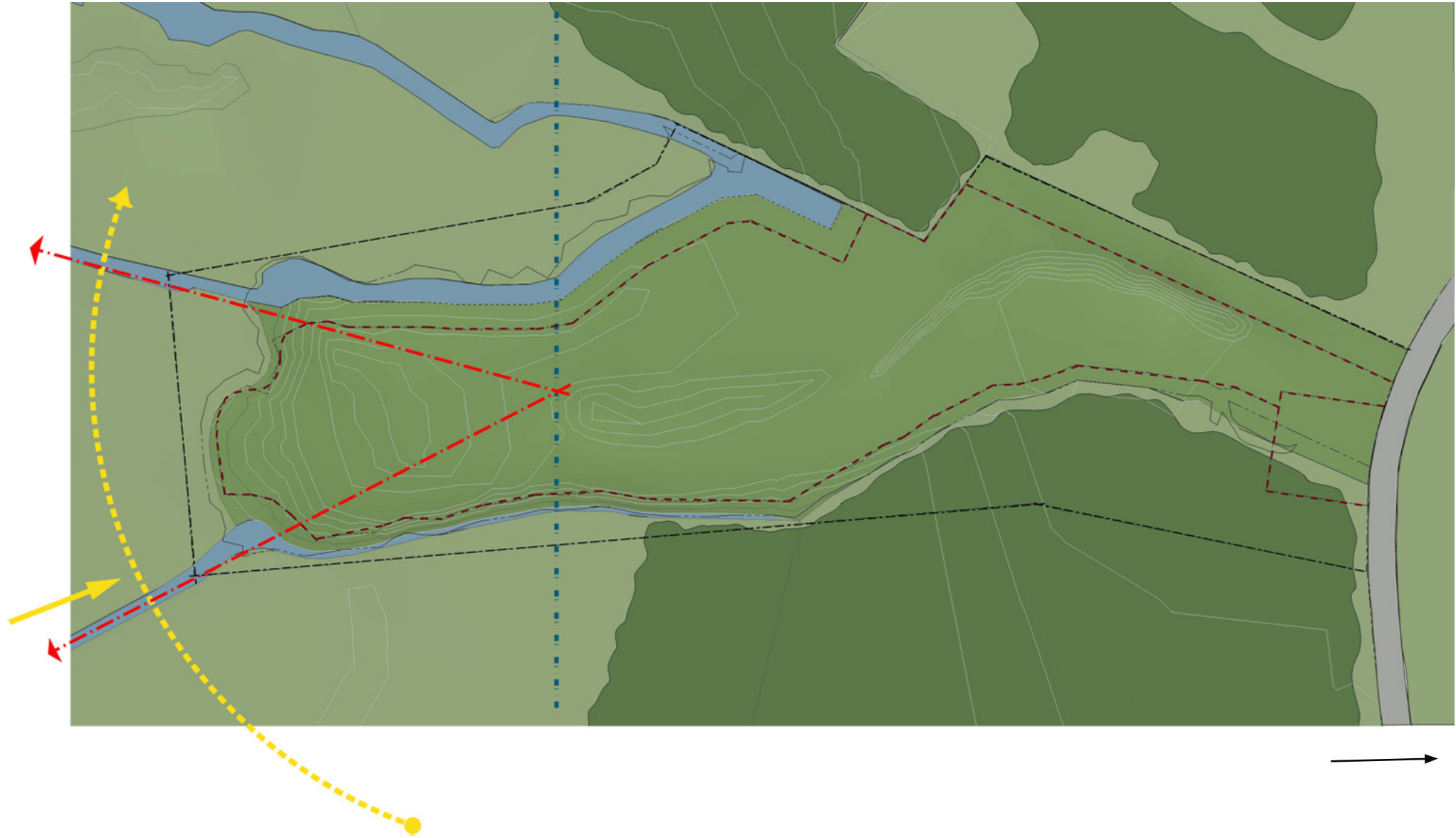
CANALS + VIEWS





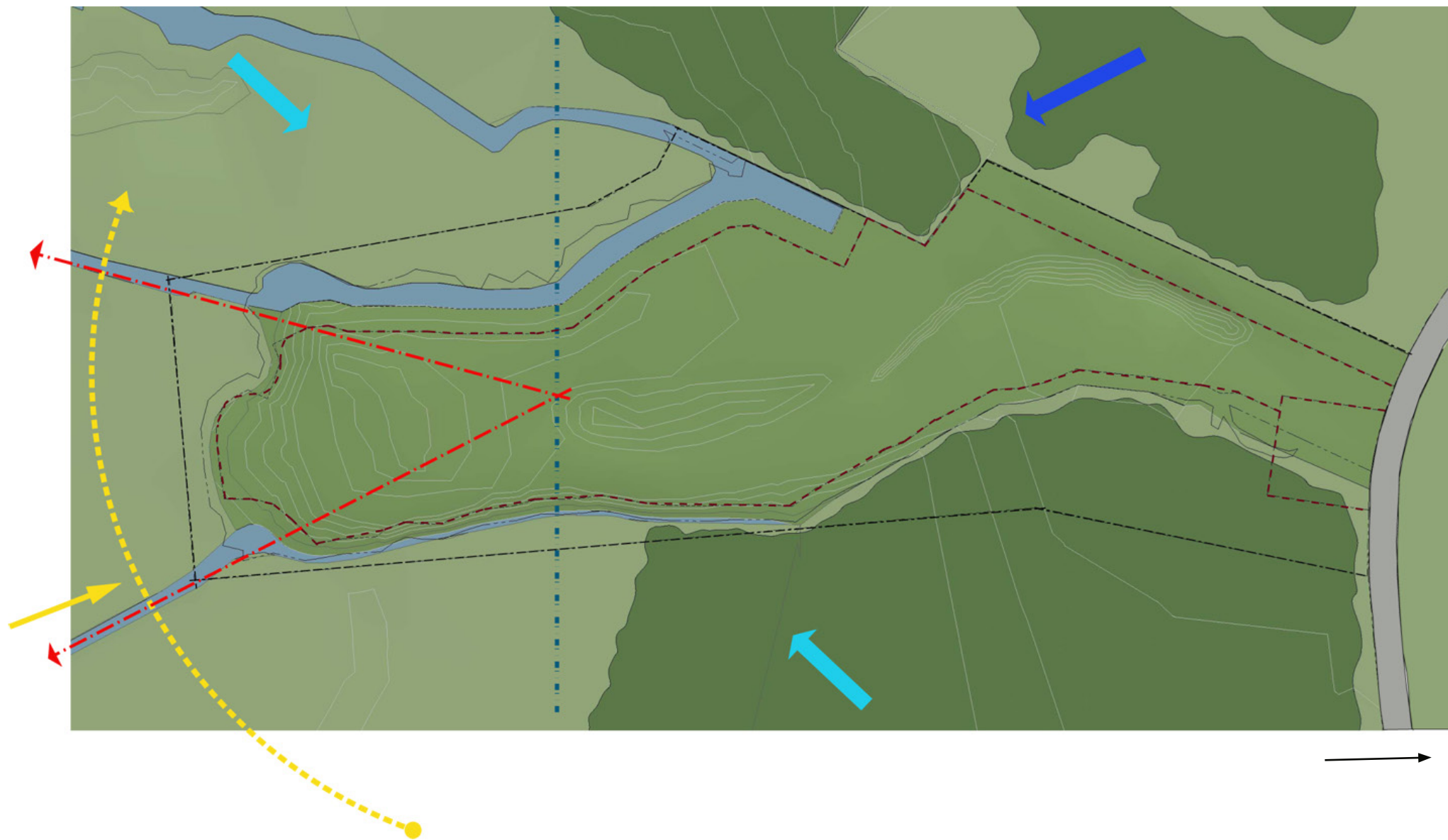
SITE ANALYSIS

SOLAR PATH and NATURAL AXIS AND THRESHOLD

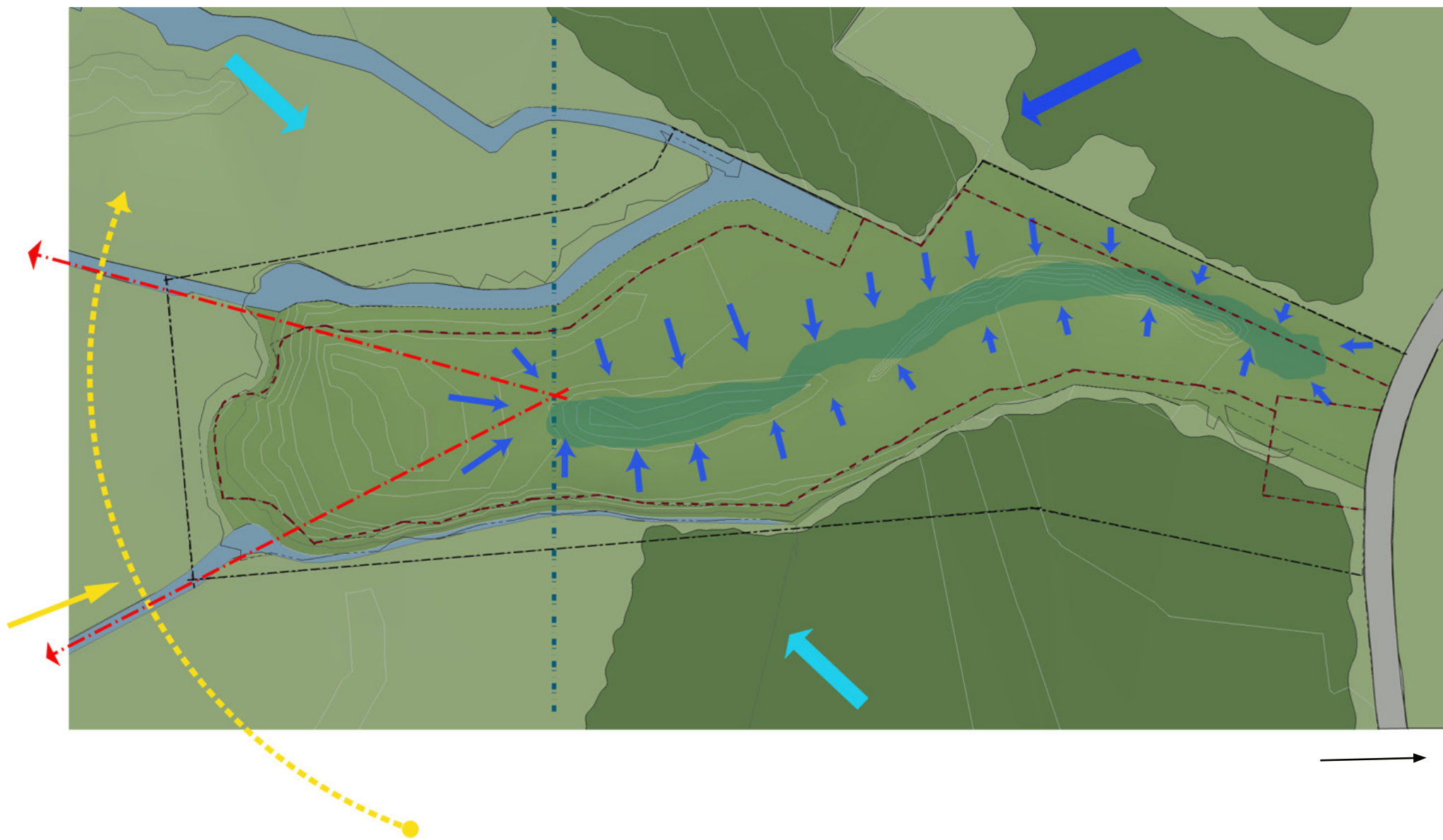


SITE ANALYSIS

SUMMER AND WINTER WINDS

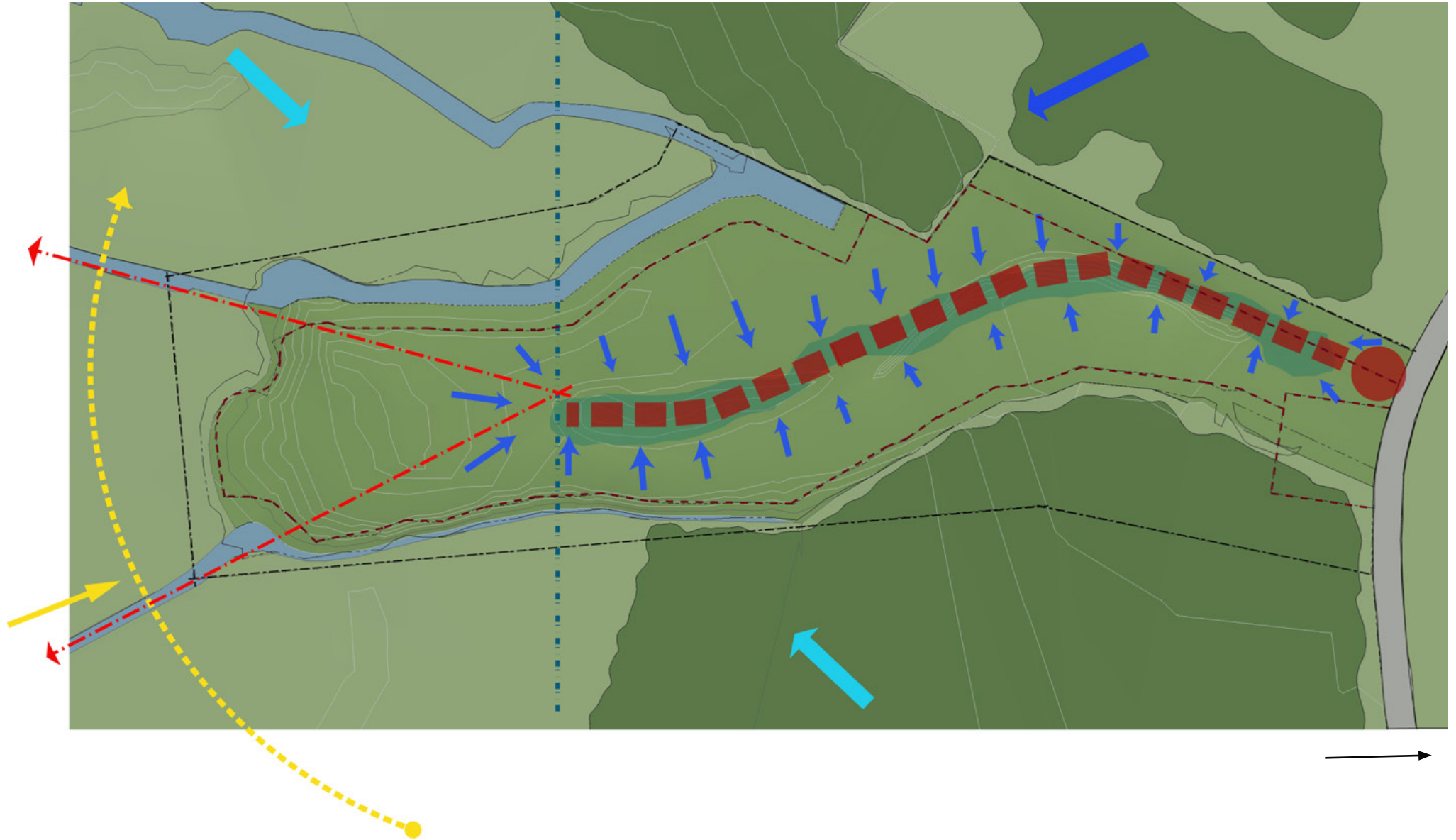


SITE ANALYSIS
STORMWATER COLLECTION DIAGRAM

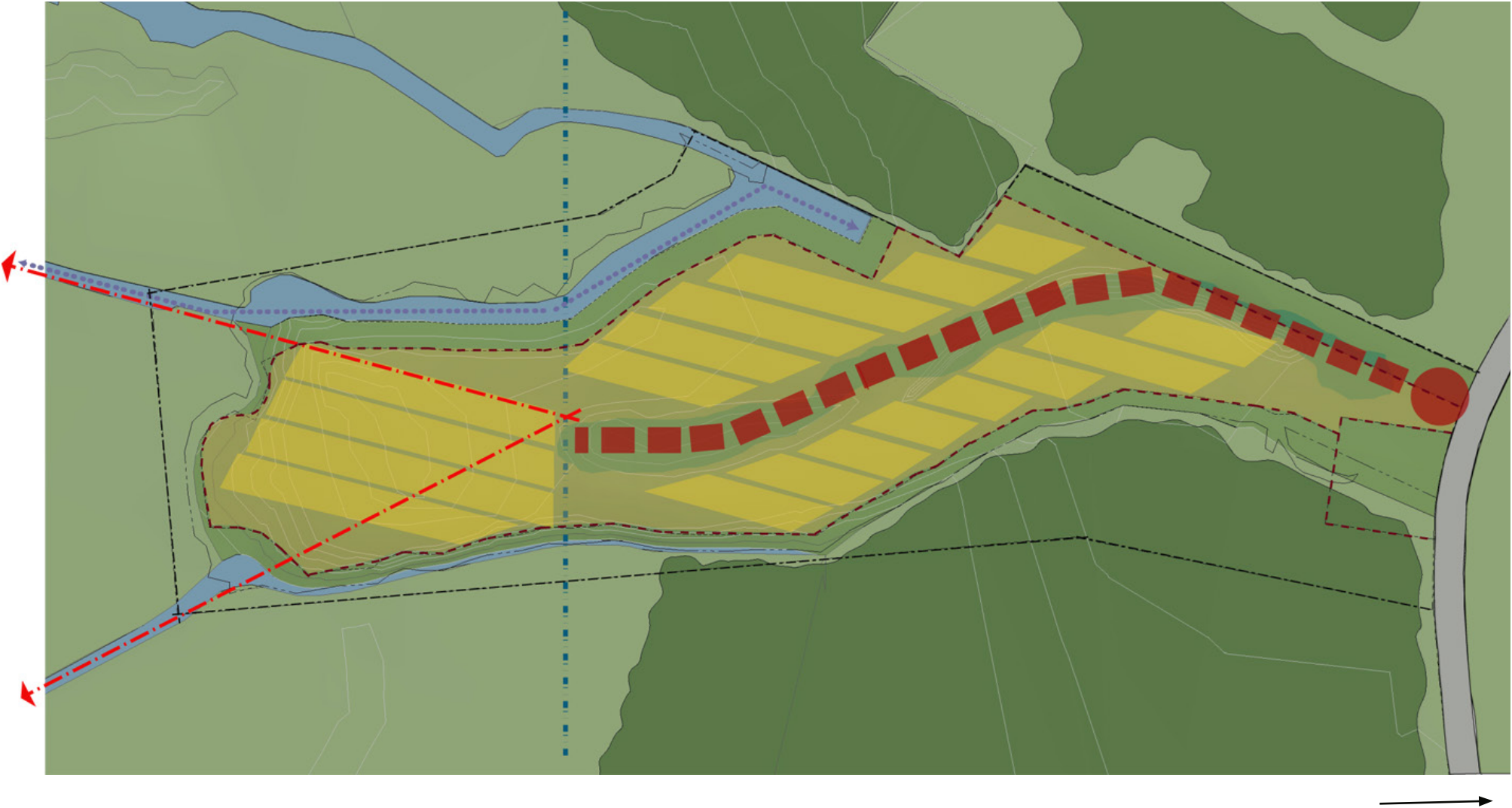


SITE ANALYSIS

PUBLIC SPACE CONNECTOR - A SPINE OF CREATED WETLANDS



SITE ANALYSIS
BUILDING ZONES



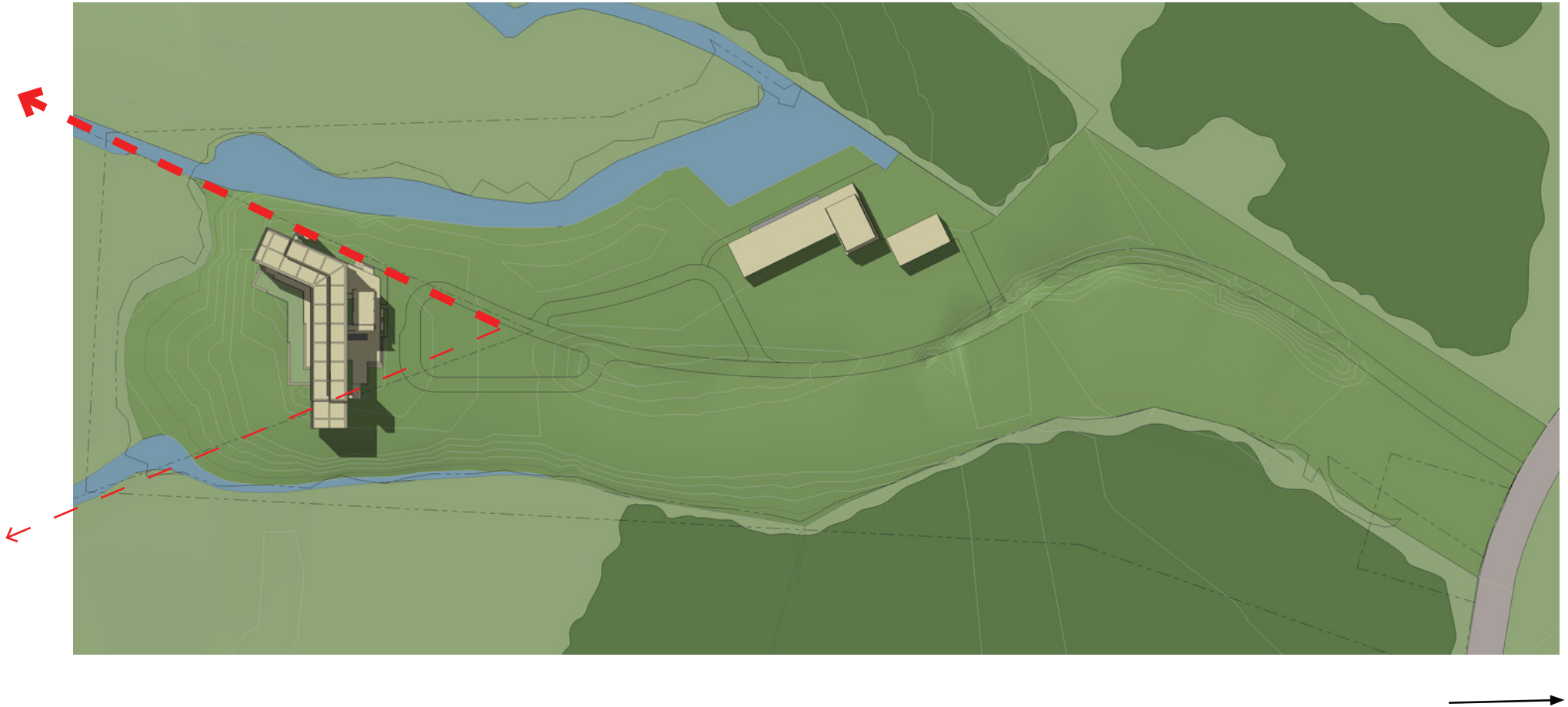
BUILDING SITING

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



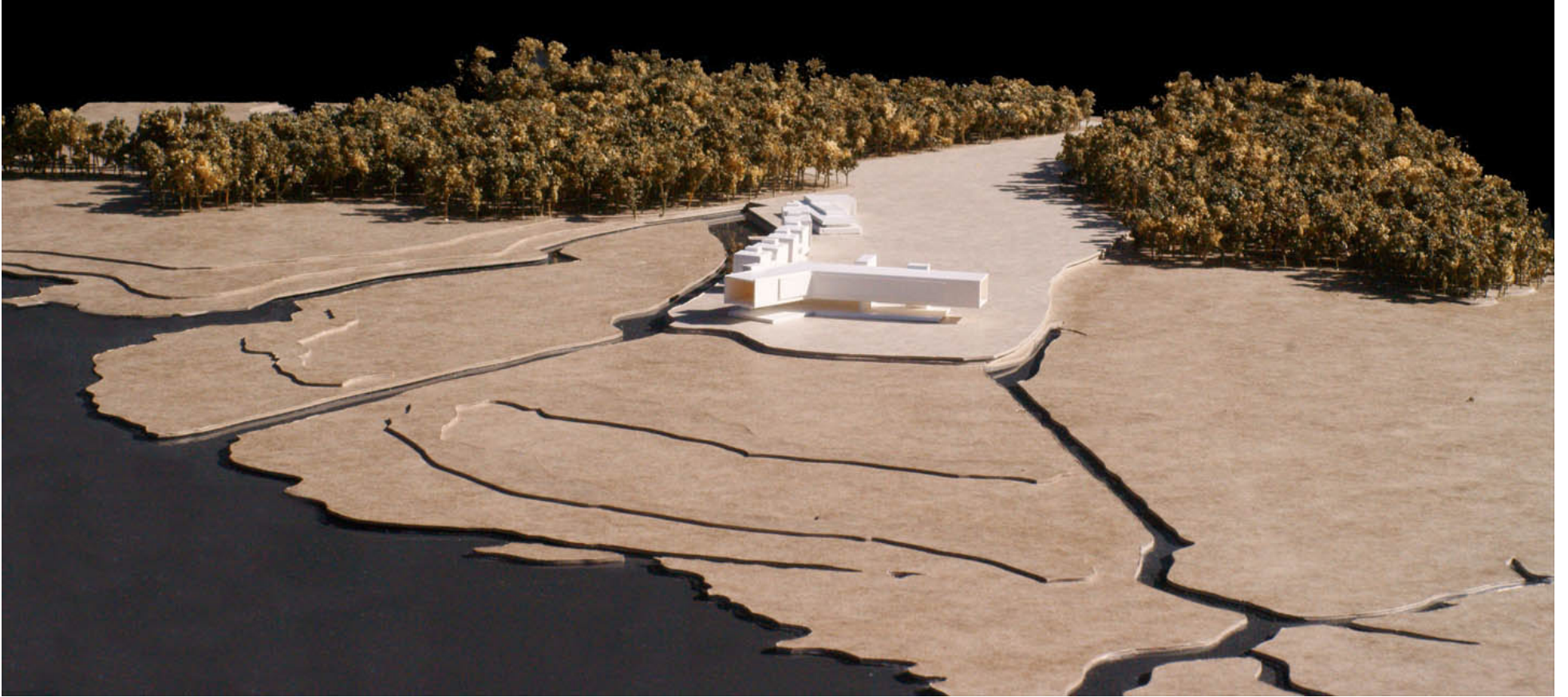
INTERACTION WITH SITE

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



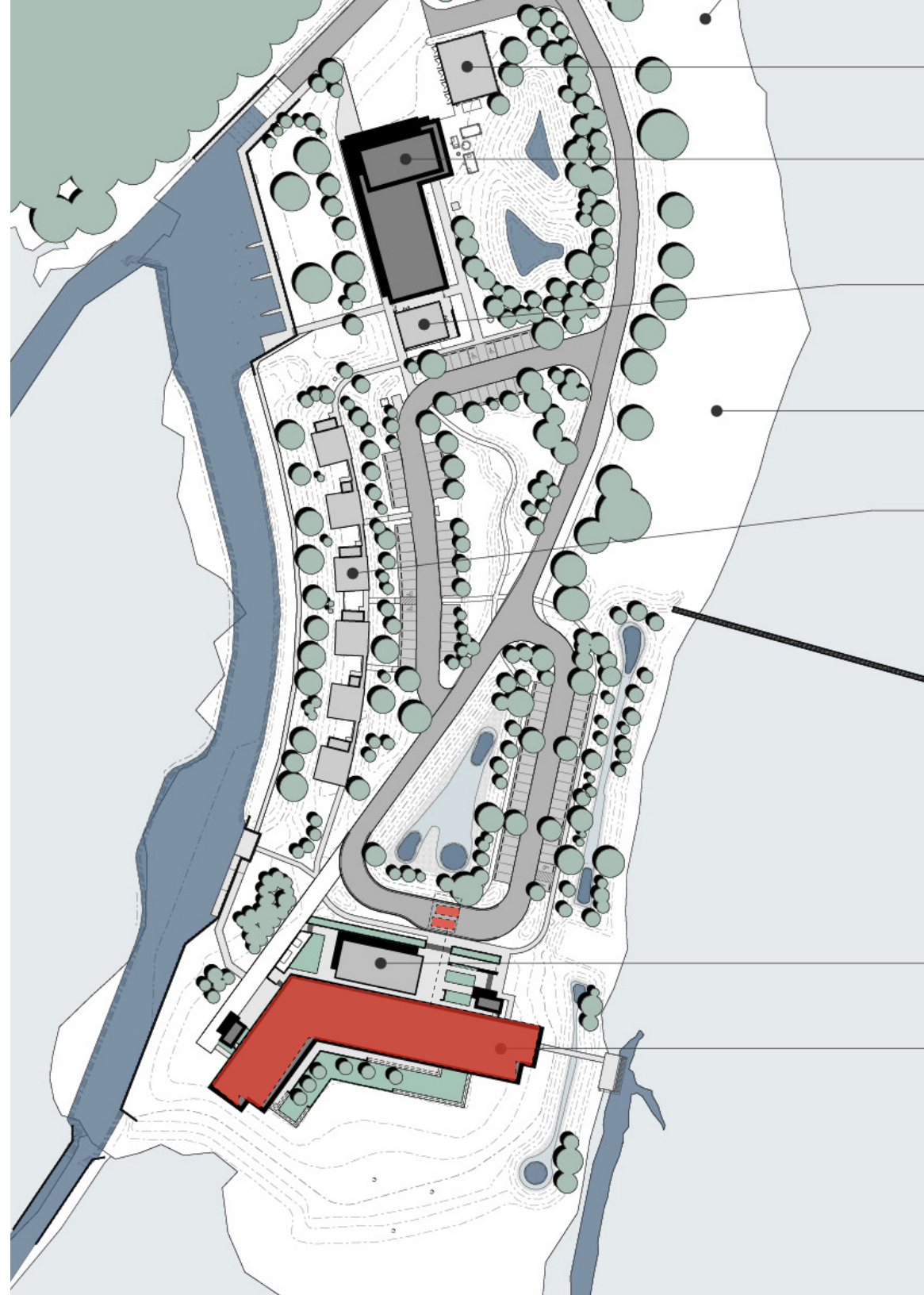
preservation of **natural resources**

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**

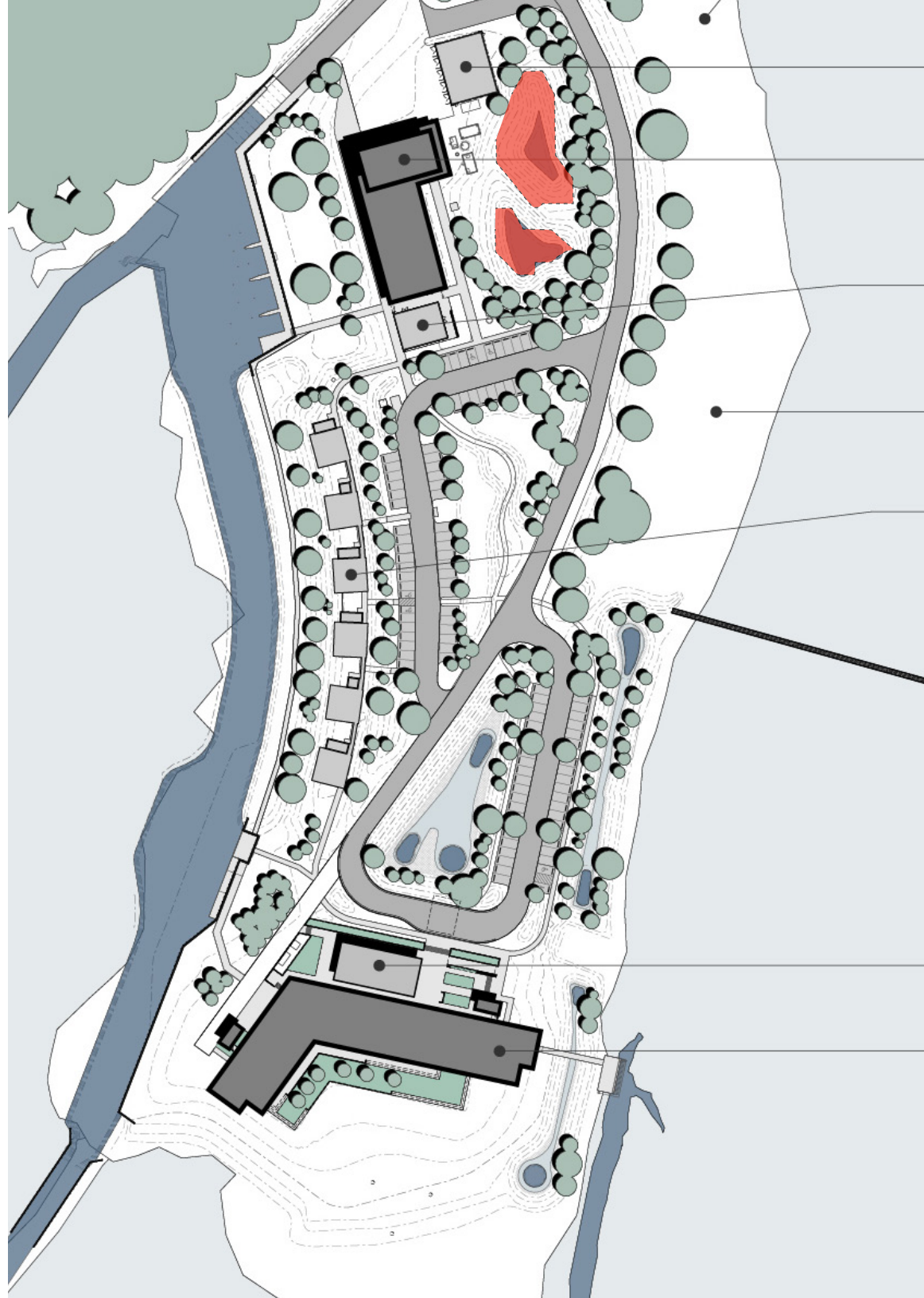
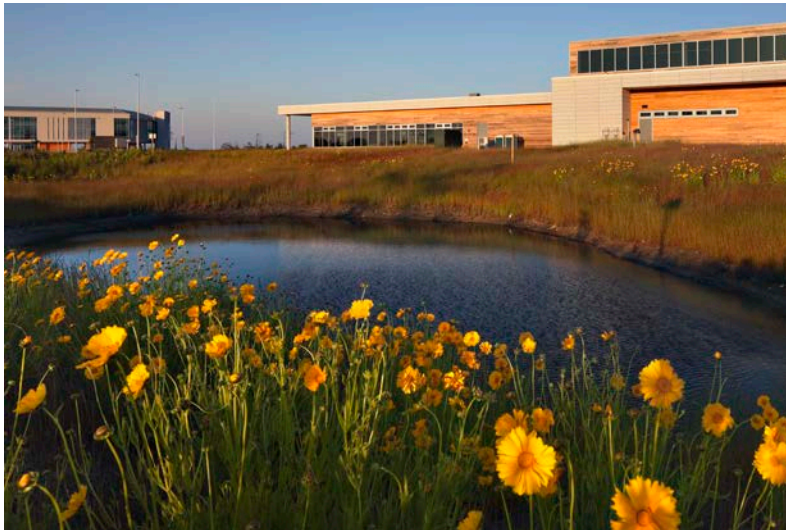
BALANCE CUT AND FILL

MINIMIZE FOOTPRINT AND IMPERVIOUS

HARVEST RAINWATER

TREAT ALL STORMWATER ON SITE

TREAT ALL WASTEWATER ON SITE



preservation of **natural resources**

BALANCE CUT AND FILL

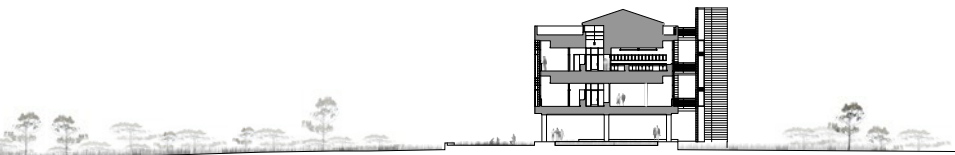
MINIMIZE FOOTPRINT AND IMPERVIOUS

HARVEST RAINWATER

TREAT ALL STORMWATER ON SITE

TREAT ALL WASTEWATER ON SITE

USE OF **"BORROWED WATER"** GEOTHERMAL



LOWER PRINCIPAL FRESH WATER AQUIFER

YORKTOWN SALTWATER AQUIFER



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

from **Resilient Design Institute**

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





view from south lawn



BUILDING SYSTEMS

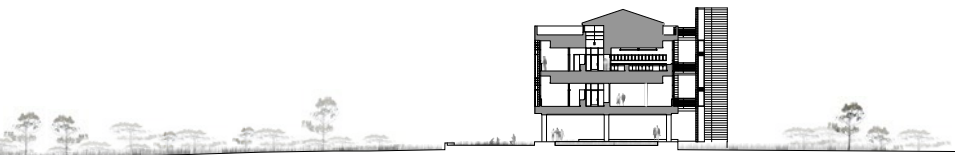
RAINWATER SYSTEM

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



GEOHERMAL HVAC SYSTEM

ORGINIAL 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



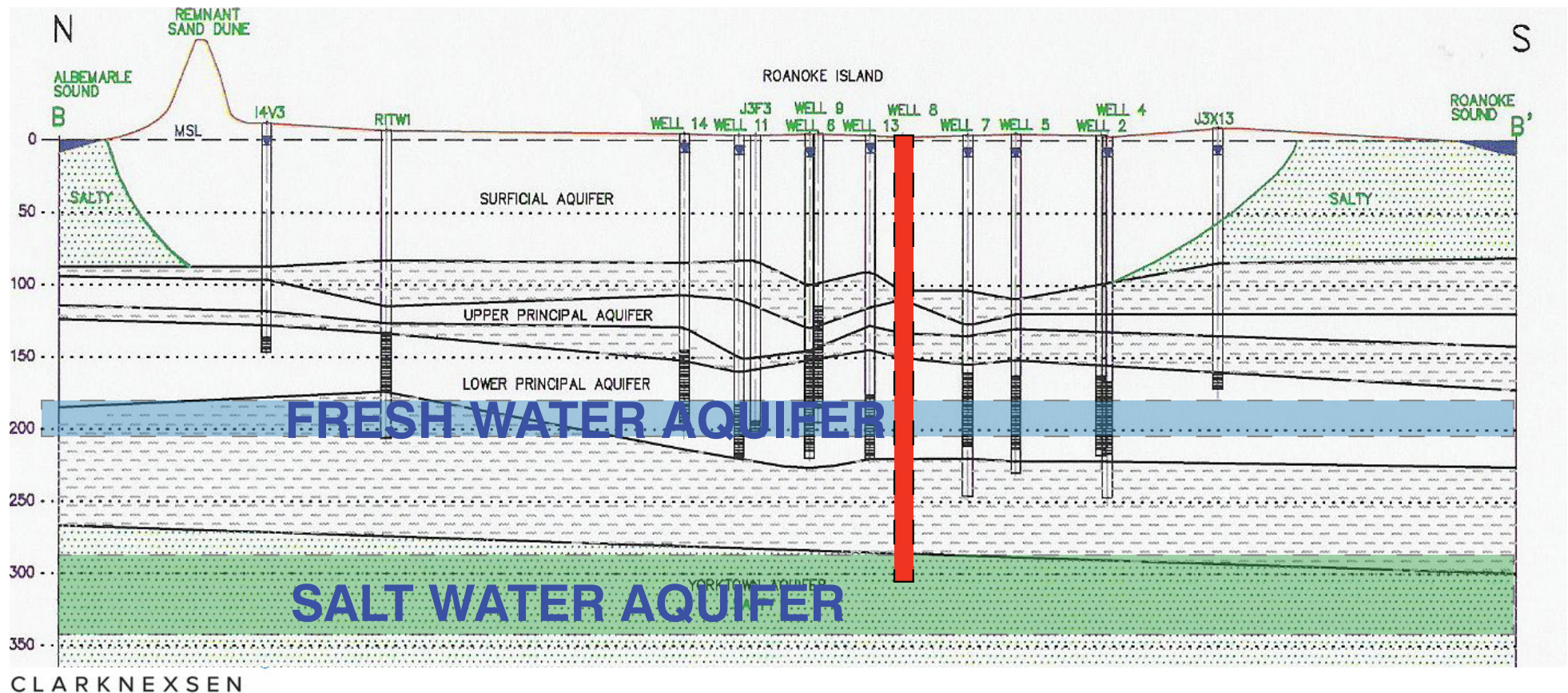
ORIGINAL DESIGN CONCERNS

Wells Penetrated three acquifers

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

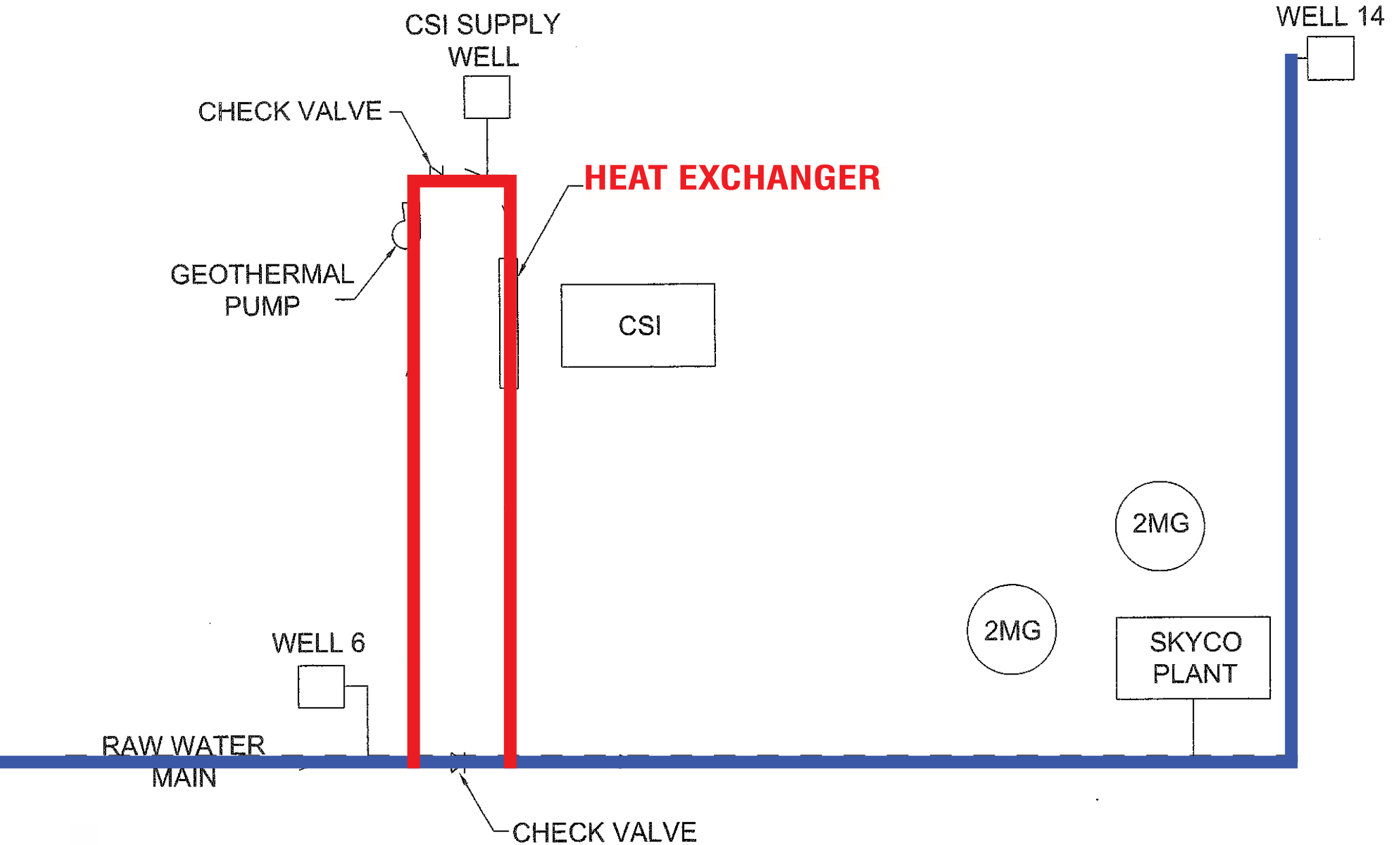
Most energy saving option

Public Public partnership

Required Memorandum of Understanding



OPEN LOOP "BORROWED WATER" GEOTHERMAL DESIGN



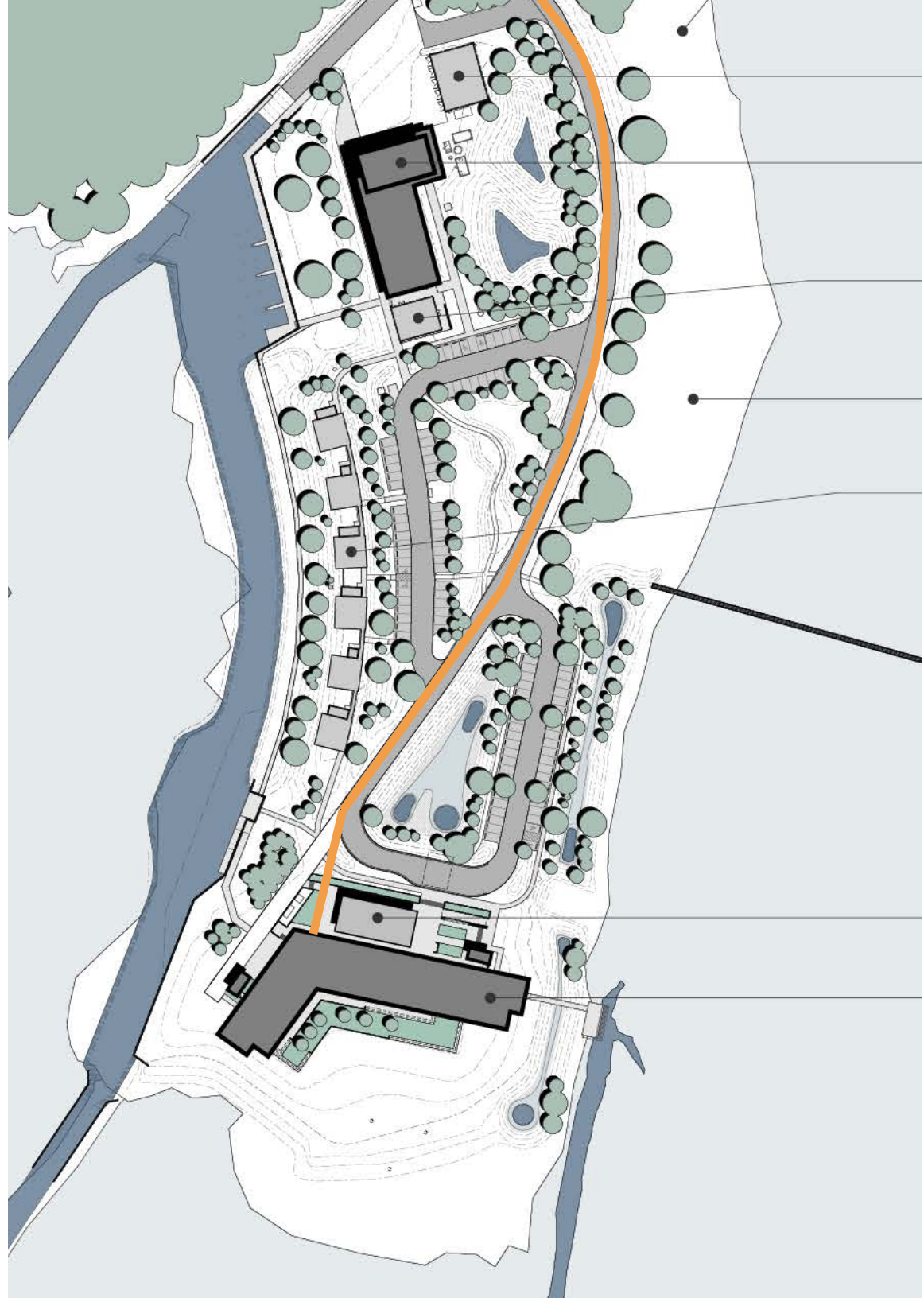
FINAL GEOTHERMAL HVAC SYSTEM

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



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Resilient systems provide basic human needs

Diverse and Redundant Systems

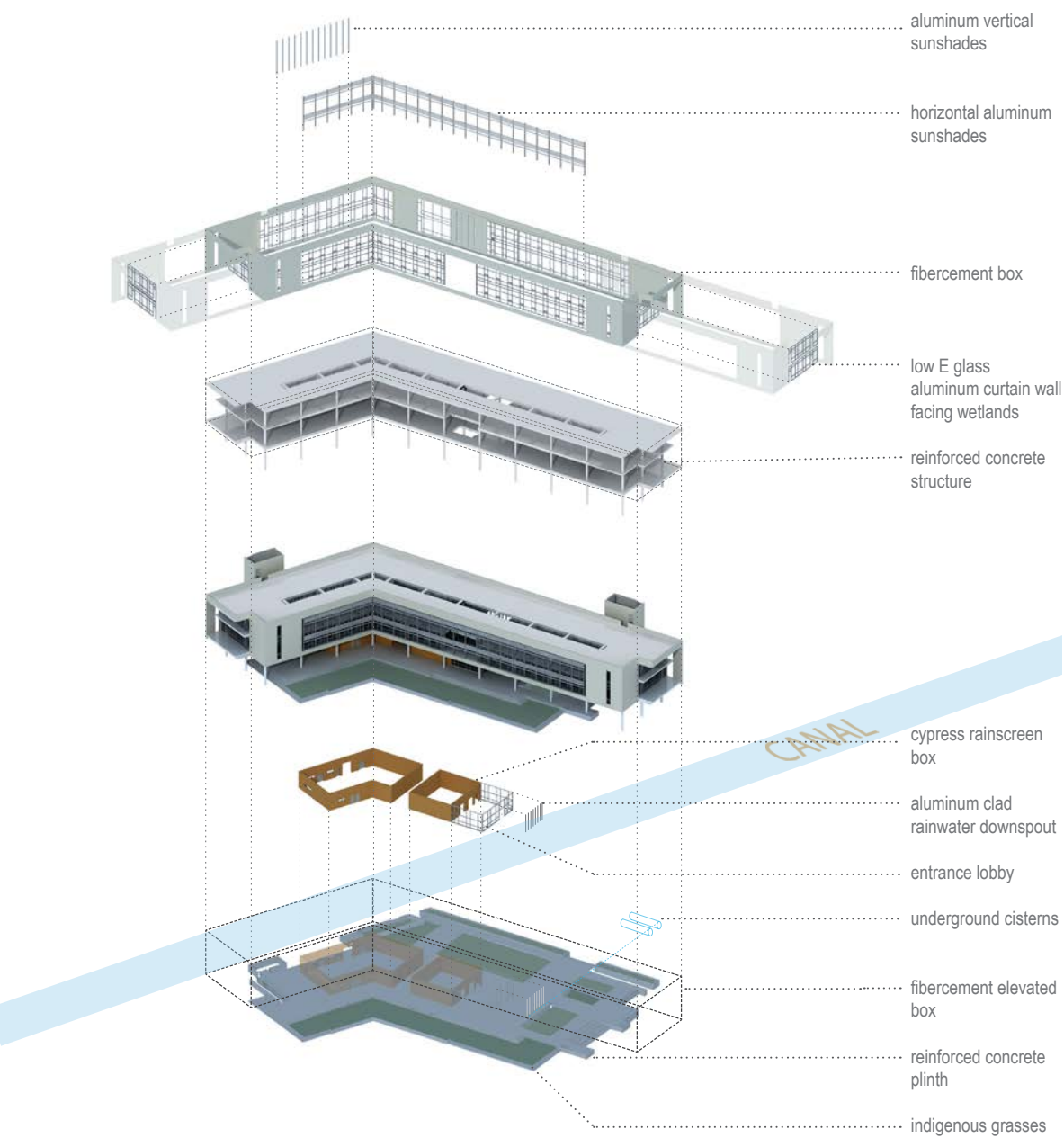
Simple Passive and Flexible

Durable Materials

Locally Available, Renewable Resources



MATERIALS



canal view

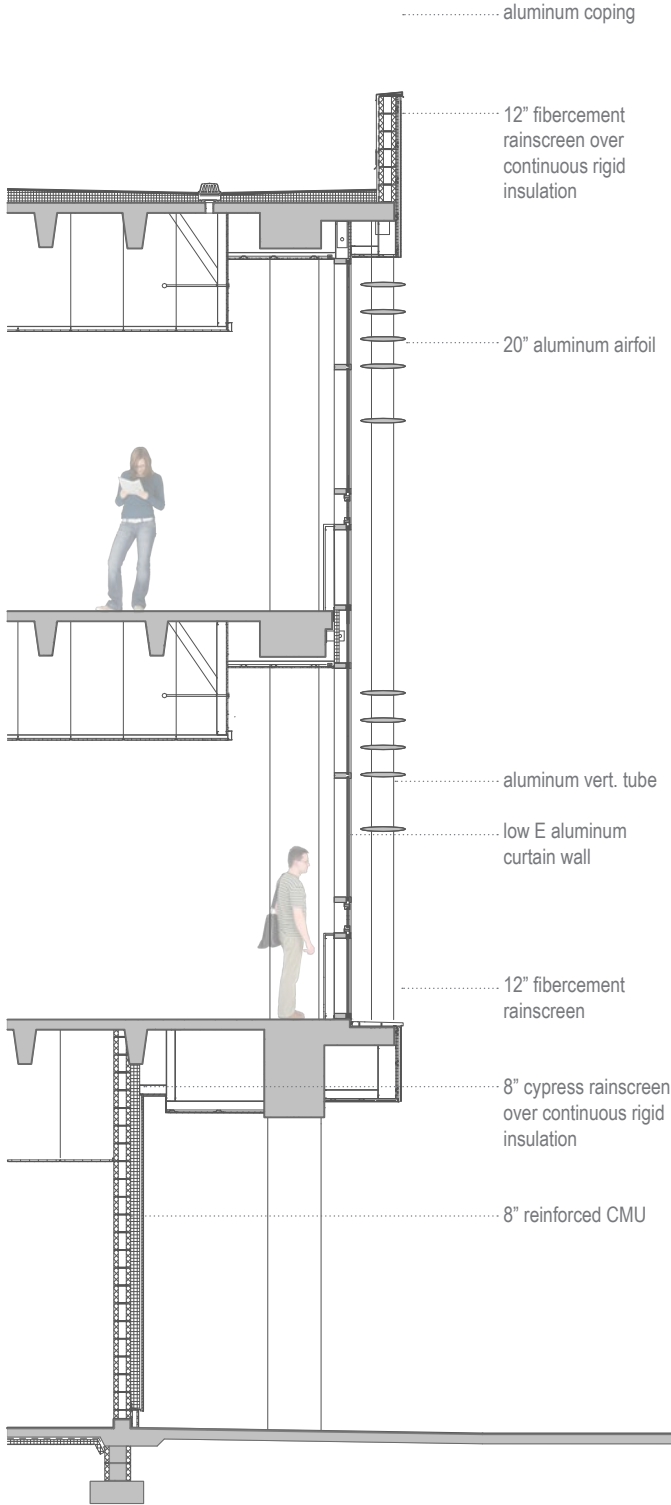


view from south lawn

MATERIALS



south elevation

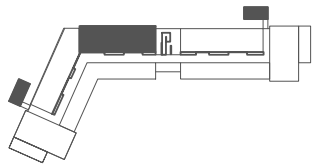




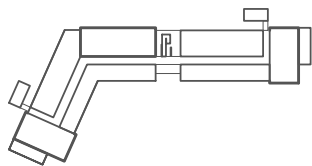
solid/void



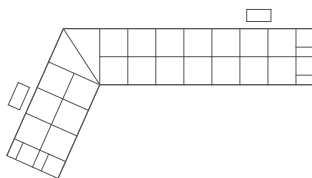
structure



objects

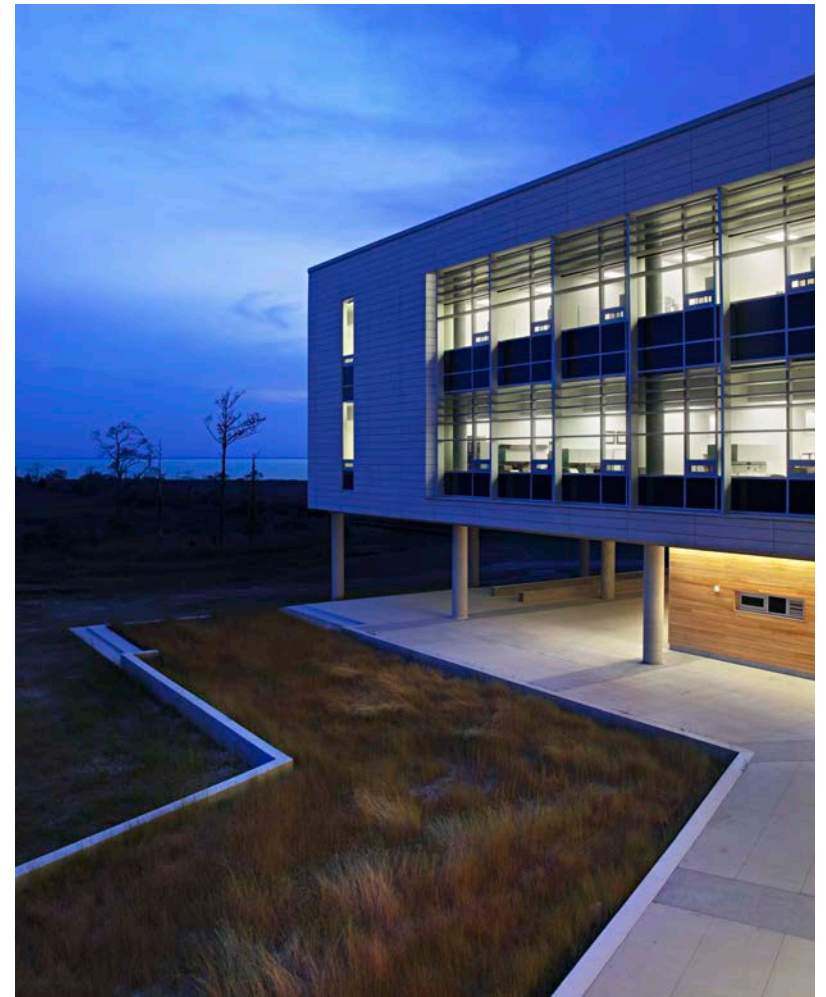
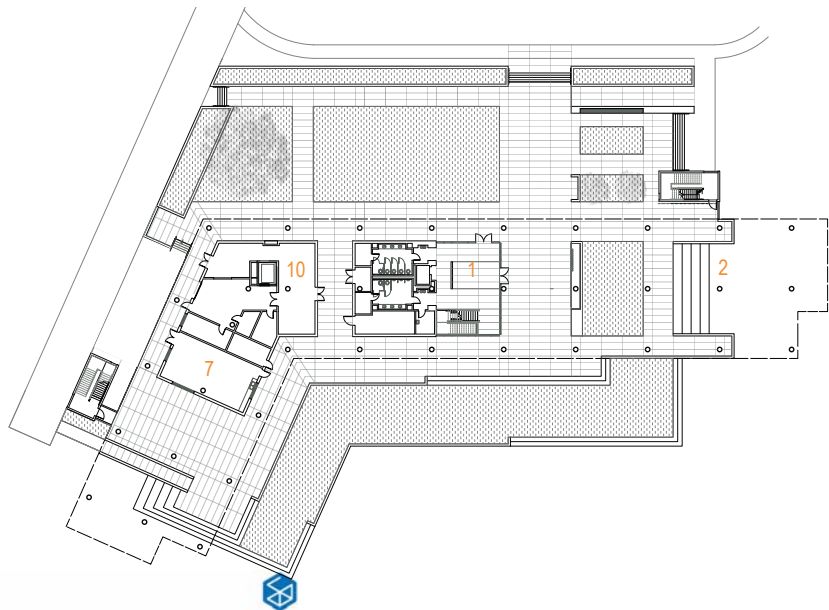
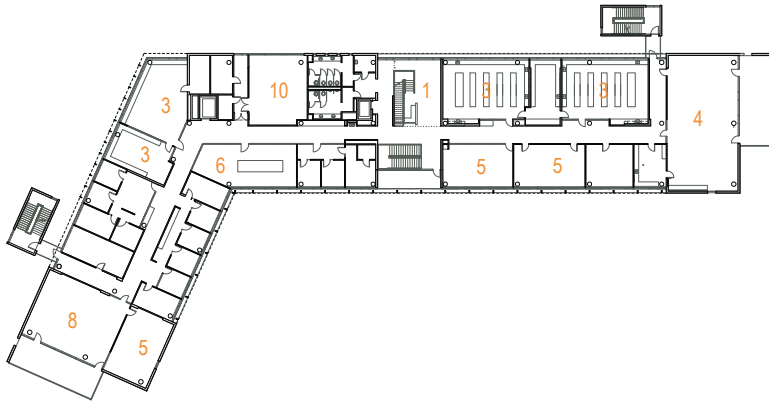
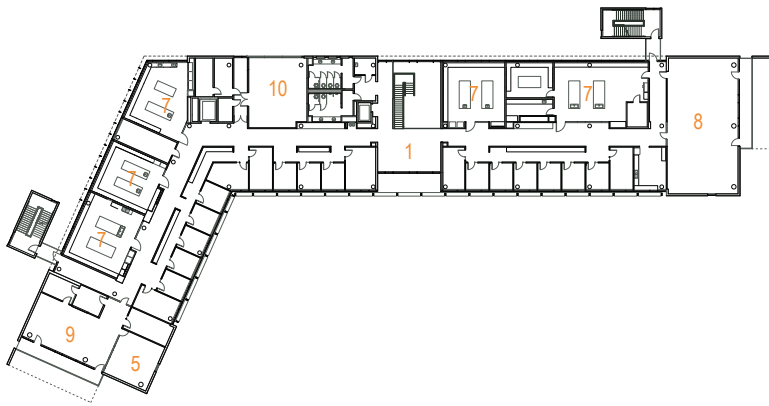


use



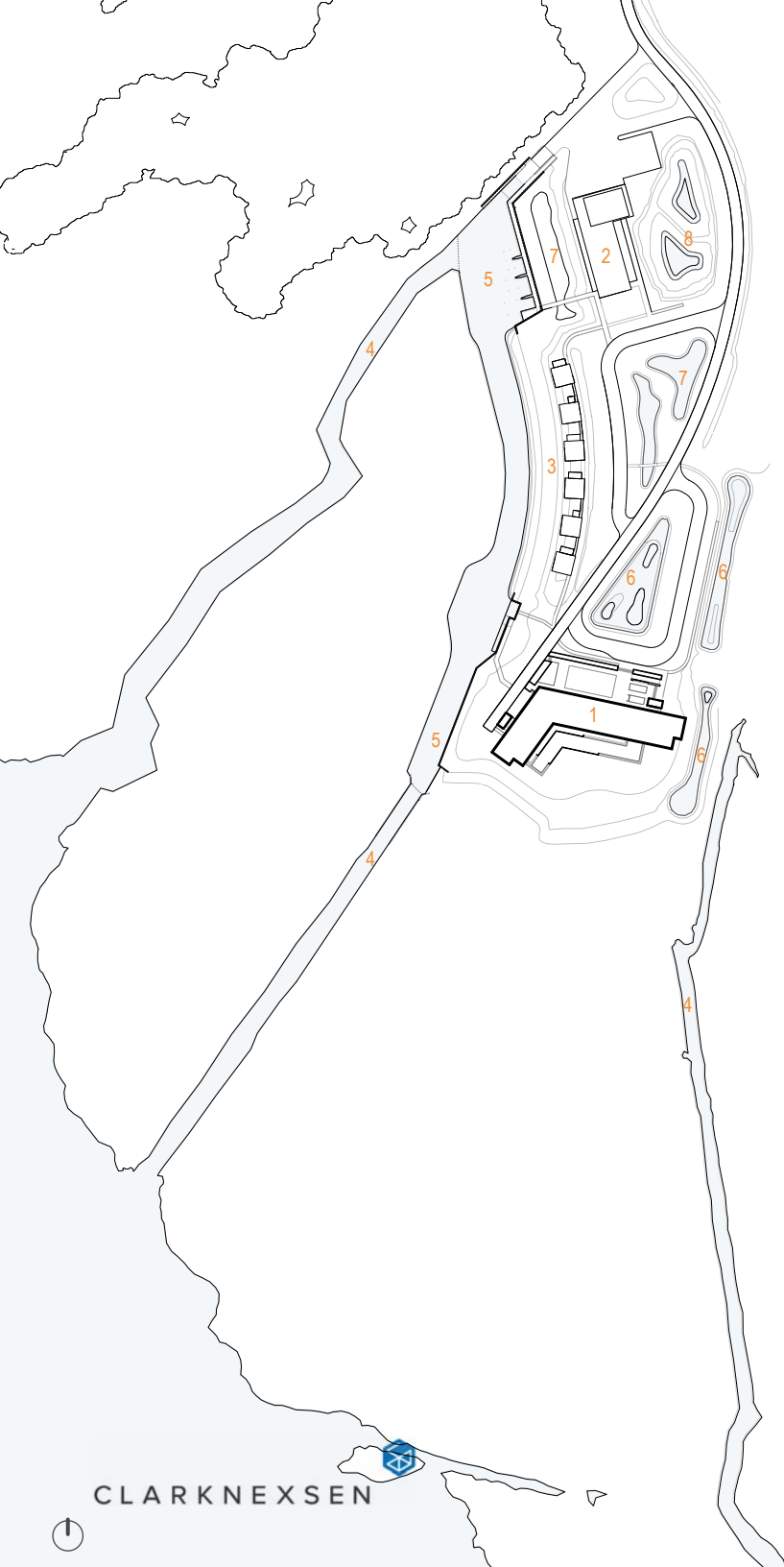
geometry





view of southwest wing

- 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



view from northeast wetland



view from new connecting canal

- 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







level two lobby view to north



level three east corridor



level two flex classroom













