



PUBLIC BUILDING COMMISSION

Public Building Commission of Chicago
BUILDINGChicago / Greening the Heartland 2014
Creating Extraordinary Results Through Integrative Design



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October 1, 2014

Acknowledgements/Credits

Chicago Public Schools

Principal Marti

Public Building Commission of
Chicago

Additional members of the team:

Jacobs/Ryan – landscape architect

Terra Engineering – civil engineer

F.H.Paschen/S.N.Nielsen -
contractor



Introduction

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- **Sachin Anand,**
PE, LEED AP BD+C, Principal,
dbHMS



- **Deeta Bernstein,**
LEED AP BD+C, Sustainability Manager,
Public Building Commission of Chicago



- **Jennifer Costanzo,**
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- **Helen J. Kessler,**
FAIA, LEED Fellow, President,
HJKessler Associates





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Course Objectives

- Encourage collaborative thinking beyond expectations. Develop new mindset.
- Leverage integrated design to reduce first cost while improving ongoing efficiency.
- Implement an integrative design process in context of a prototype based design process
- Show how synergies between architectural, mechanical, lighting and site design can improve environmental performance



Course Agenda

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1. Integrative Design Process
2. Public Building Commission Program
3. Audience mini-charrette
4. Sarah E. Goode STEM Academy
5. Comparison with similar building
6. Conclusions
7. Audience discussion



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Preliminary Questions

- *How many of you are Architects? Engineers? Landscape Architects? Owners?*
- *How many of you have experience with integrative design process? Yes/No*
- *How many have felt that integrative design process led to better outcomes?*
- *How many felt it was easy? Hard?*
- *Paired share on experiences, or what you hope to learn in this session*



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Characteristics of an Integrative Design Process

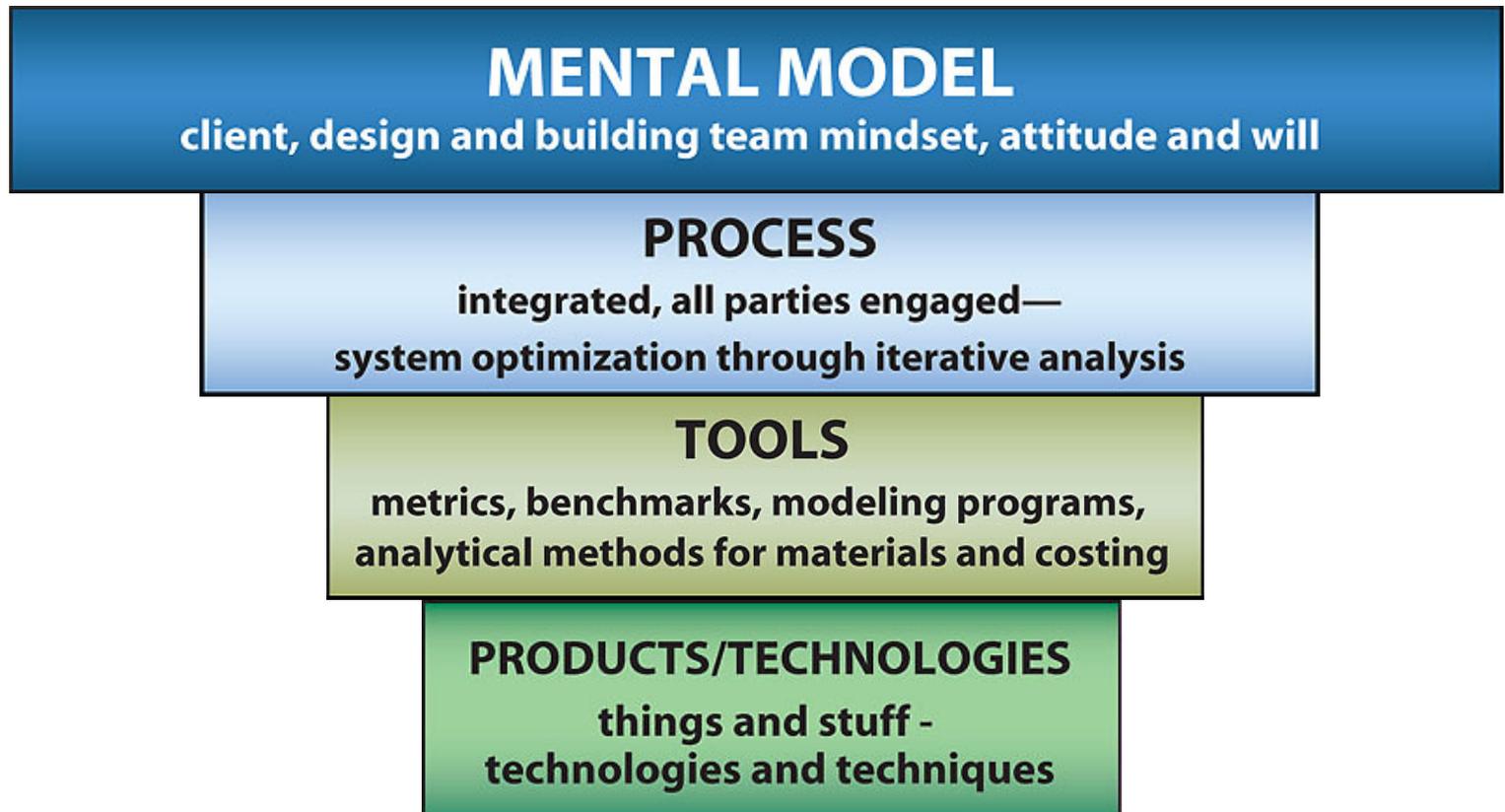
Everybody Engaging Every Issue Early

- Intentional process
- Discover interrelationships and synergies
- More and earlier analysis than typical practice
- Question conventional assumptions
- Iterative analysis
- Everyone working together



Stepping Stones to Integrative Design

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Shifting the Way We Think

From a linear process to



an interactive process to



an interdisciplinary process to



**a whole systems
process**

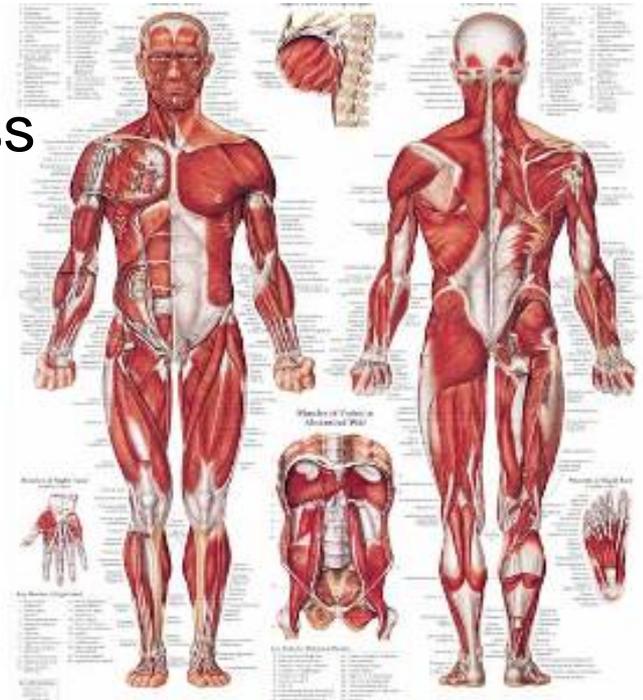


Building as an Organism

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Systems Integration:

- Understand relationships among systems
- Not a set of component parts
(Optimization in isolation)
- Holistic, non-linear process
- Downsize or eliminate
systems





A Whole Systems Integrative Process

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Tunneling through the cost barriers -
Optimize the system, not the parts

How?

- Take advantage of systems interactions
- Eliminate silos
- Use modeling/analysis tools

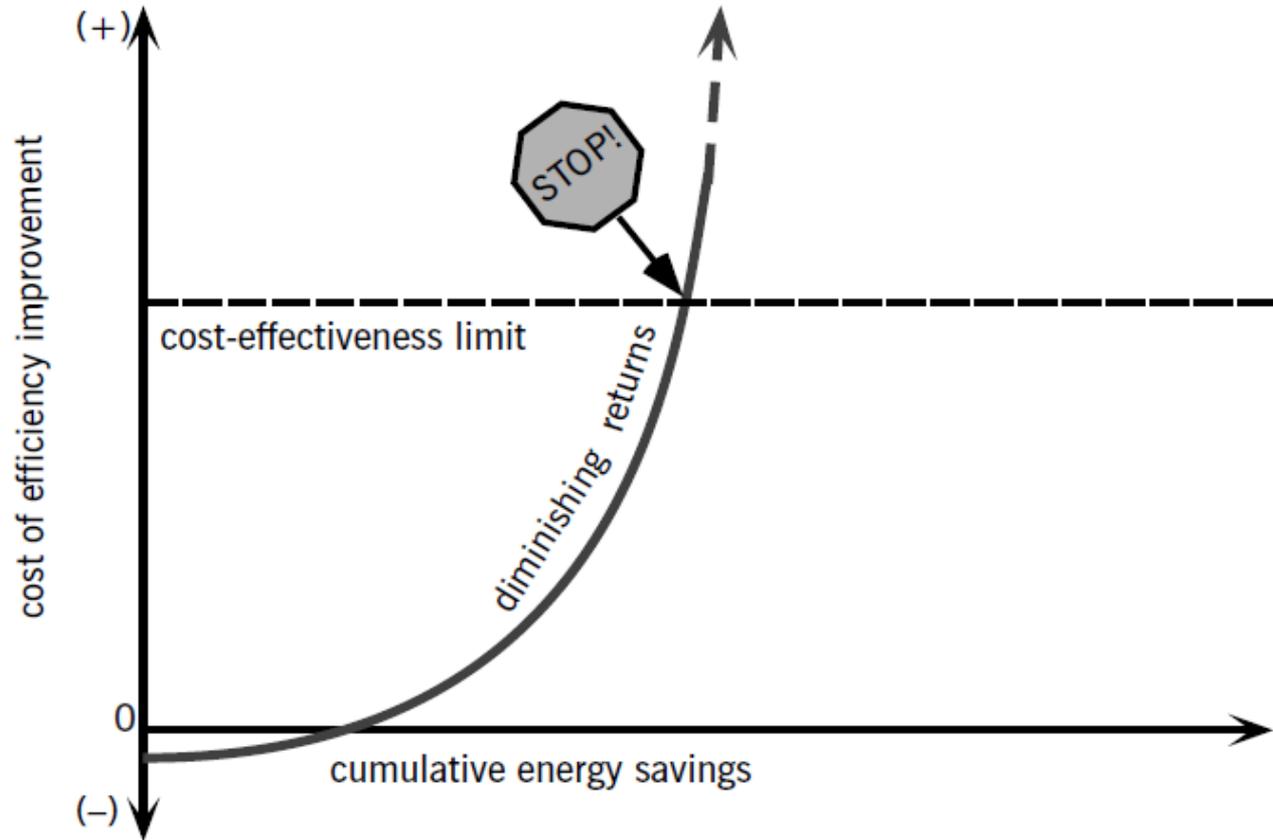
Goal –

Improve performance at lower first cost



Diminishing Returns

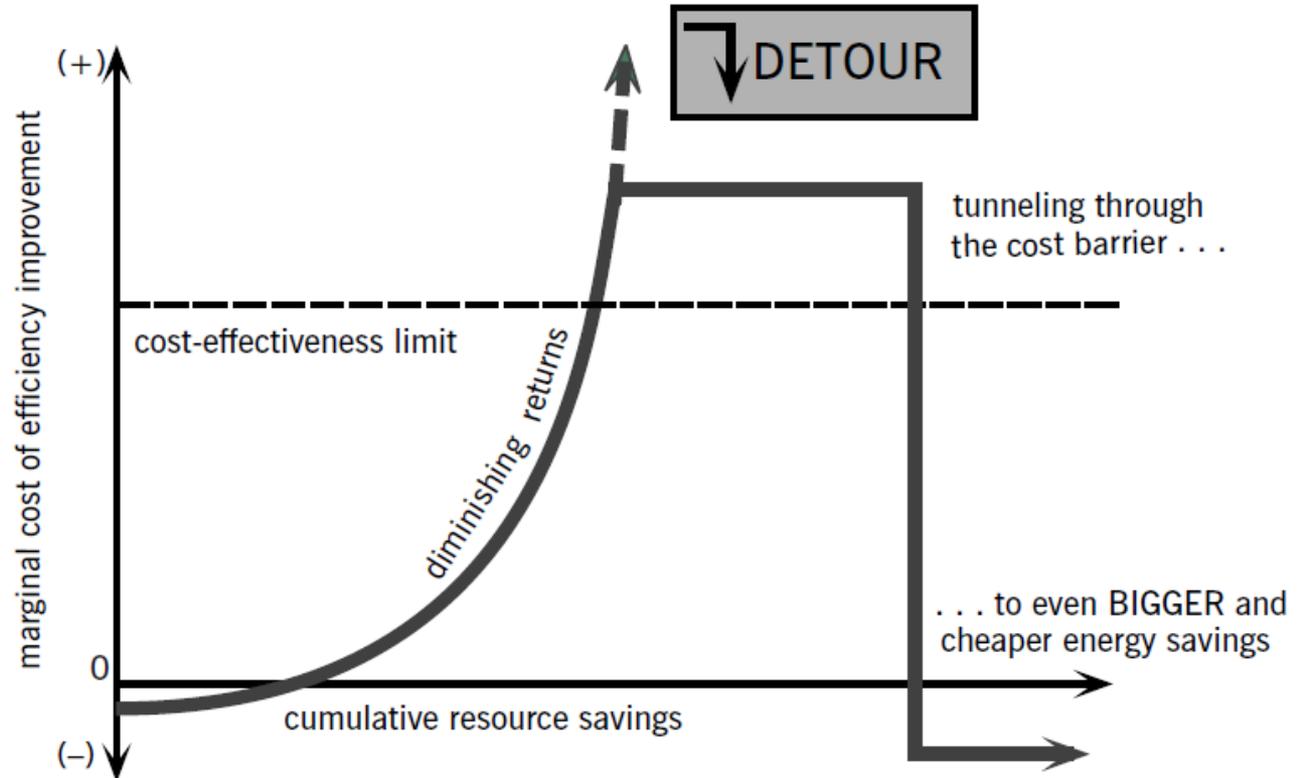
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Tunneling Through the Cost Barrier

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Integrative Design Process

- Start with an Initial Charrette, but don't stop there
- Ongoing Team Meetings, Discussions, Research throughout design process
 - Iterative, makes use of tools, such as energy and lighting models
 - Interdisciplinary
 - Considers Whole systems – the project and systems within larger context



The Program

The Public Building Commission of Chicago

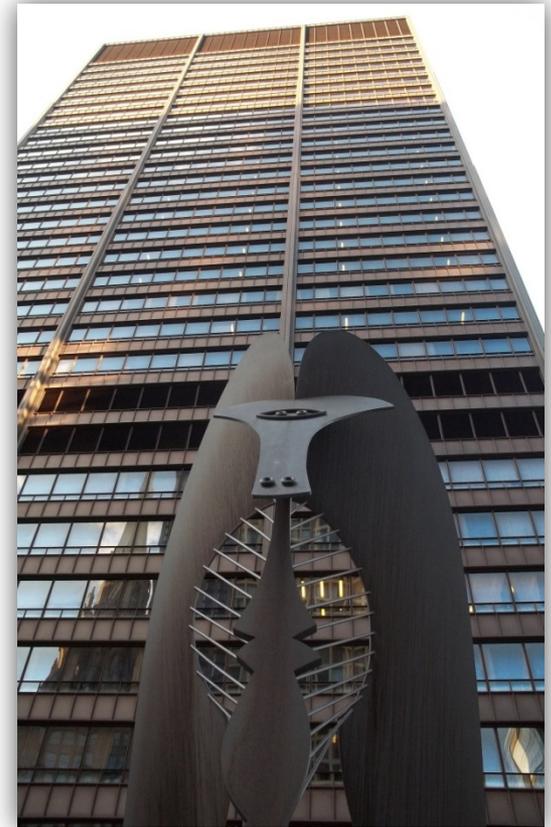
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Mission

The Public Building Commission of Chicago (PBC) is committed to client service and strong stewardship of public resources. The PBC plans, designs and builds facilities that reflect the highest standards of environmental and economic sustainability.

Vision

A built environment in which function, beauty and sustainability are inherent to every community; where physical surroundings inspire and support achievement of the individual goals of those who live, work and visit Chicago and Cook County; and, where people gather to share the common values that truly build our communities.



Daley Center, PBC Offices



The Program

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PBC manages a multi-year capital program -
Over \$2.6B in development authority

>4 Million SF of development

Over 100+ total projects

84 LEED-eligible (66 Certified to date):

- Public Schools
- Municipal – Firehouses/Police Stations/
Libraries
- Parks/Field Houses/Harbors
- Other Projects

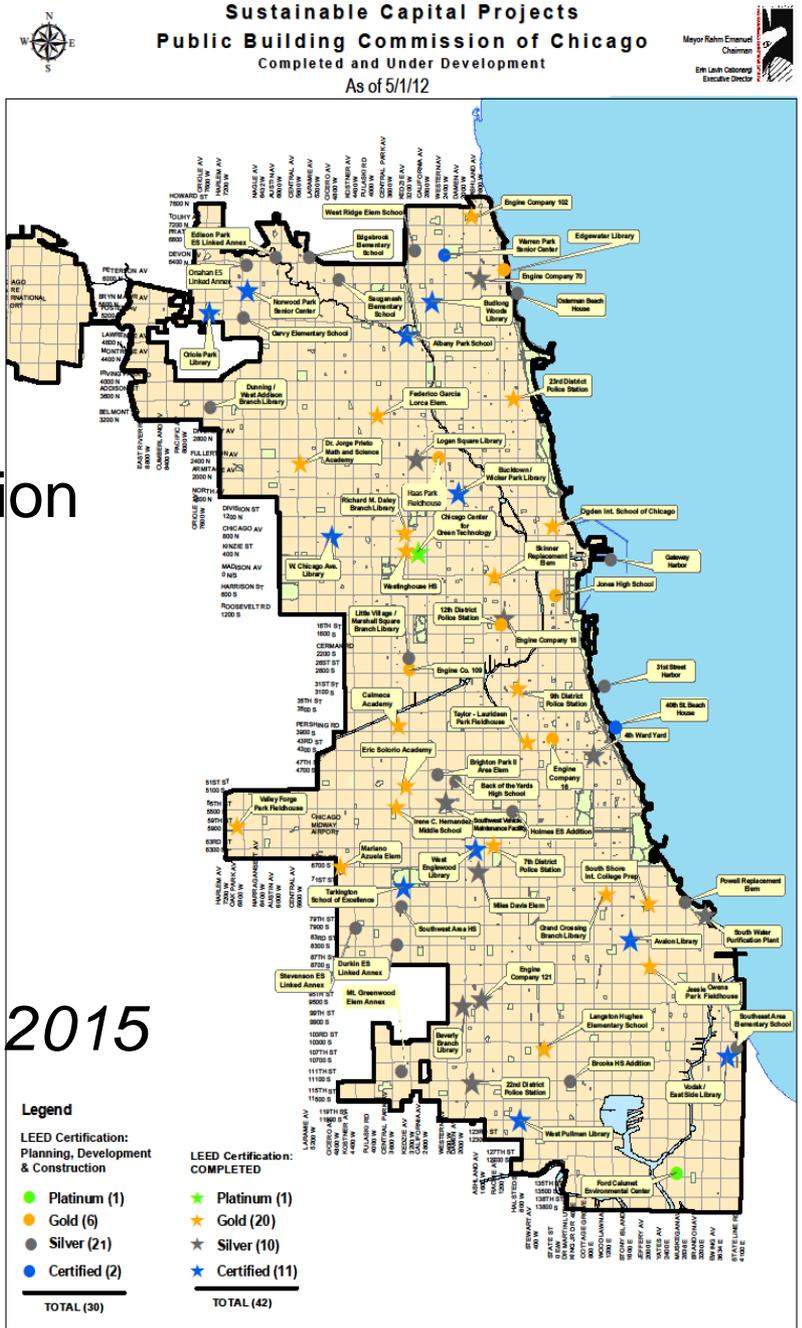


Context

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Public Building Commission
of Chicago
Chicago Public Schools
City of Chicago

- ✓ Aligned Goals
- ✓ Shared Commitment
- ✓ *Sustainable Chicago 2015*





Aligned Goals

From Green Medians to Sustainable Chicago 2015

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-- 2000

-- 2002



-- 2004

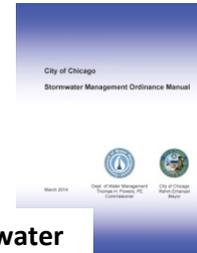


-- 2006



Green Alley Program

-- 2008



Stormwater Ordinance

-- 2010

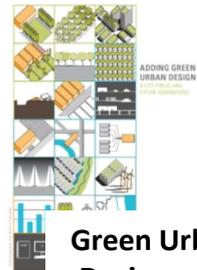
-- 2012



-- 2014



Chicago Standard



Green Urban Design (2008)



2013

Retrofit Chicago





Aligned Goals

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Program-wide: Make “green” routine
Excellent student experience / learning
environment

Use LEED to help meet goals





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The Evolving Prototype

- Chicago Public Schools Urban Model High School program – prototype design
- Minimum LEED Silver certification (LEED for Schools)
- Constraints – Design Standards



The Evolving Prototype

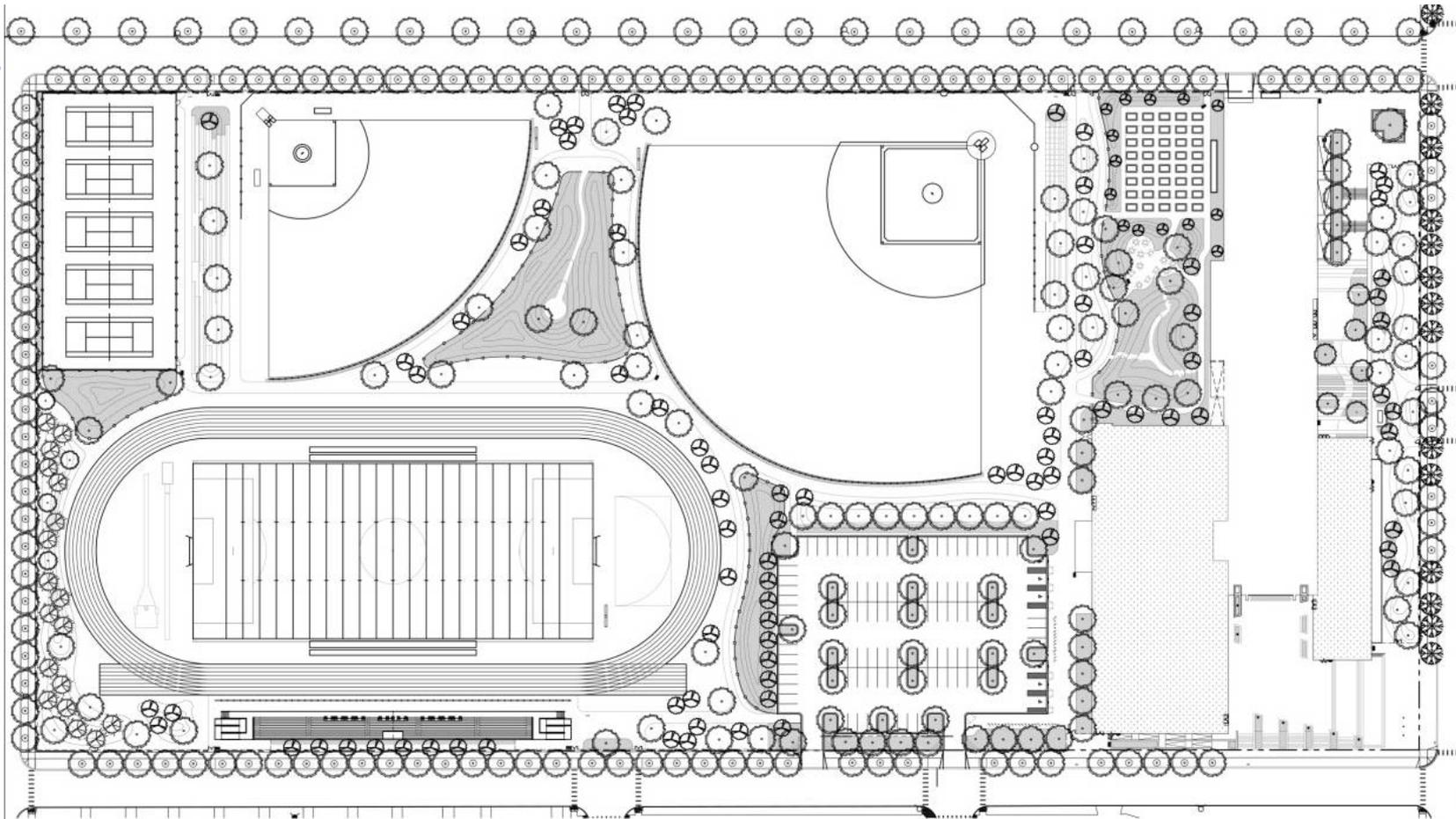
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Concept Transfer Package

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Concept Transfer Package

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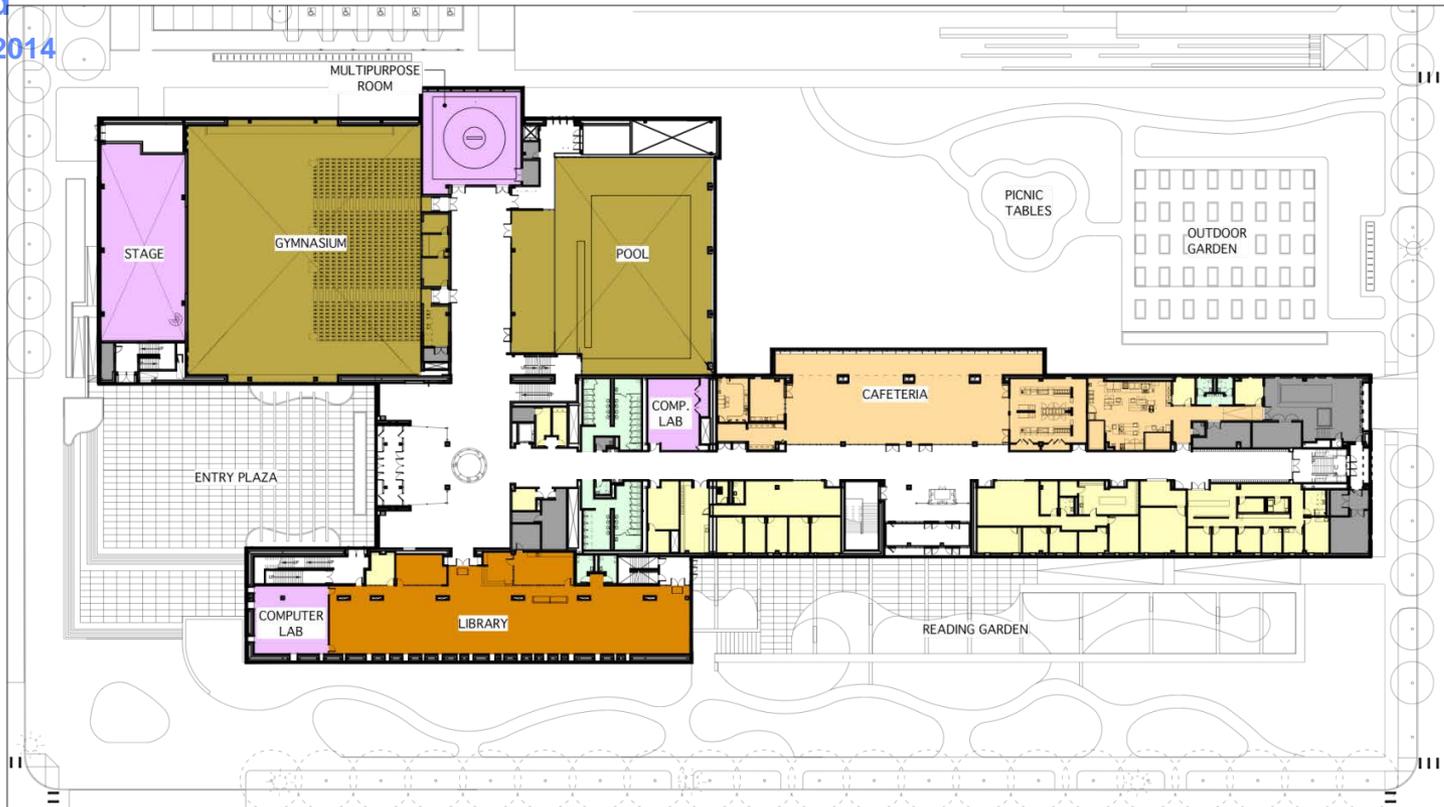


Lower Level Plan 



Concept Transfer Package

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- Core Academic ■
- Library ■
- Specialty/Arts ■
- STEM Laboratories ■
- Admin/Student Services ■
- Food Service ■
- Physical Education ■
- Building Services ■
- Toilets/Lockerrooms ■
- Green Roof ■

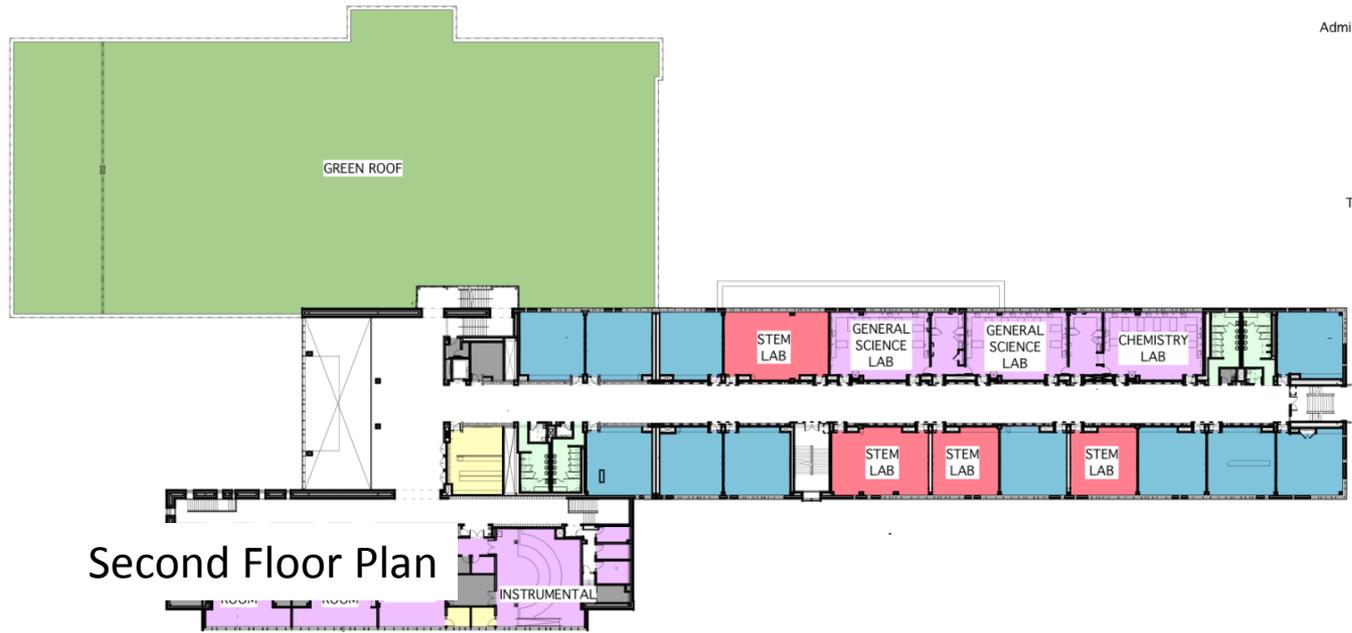
Main Level Plan N
50'



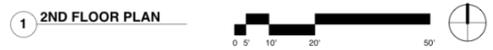
Concept Transfer Package

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- Core Academic
- Library
- Specialty/Arts
- STEM Laboratories
- Admin/Student Services
- Food Service
- Physical Education
- Building Services
- Toilets/Lockerrooms
- Green Roof



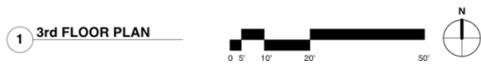
Second Floor Plan





Concept Transfer Package

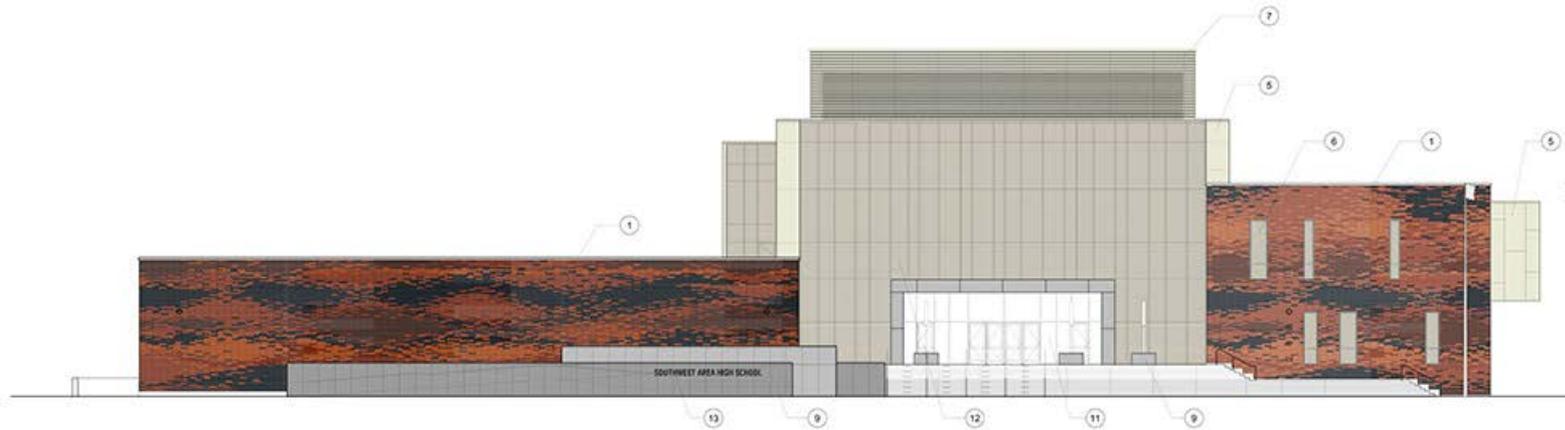
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West Elevation



East Elevation



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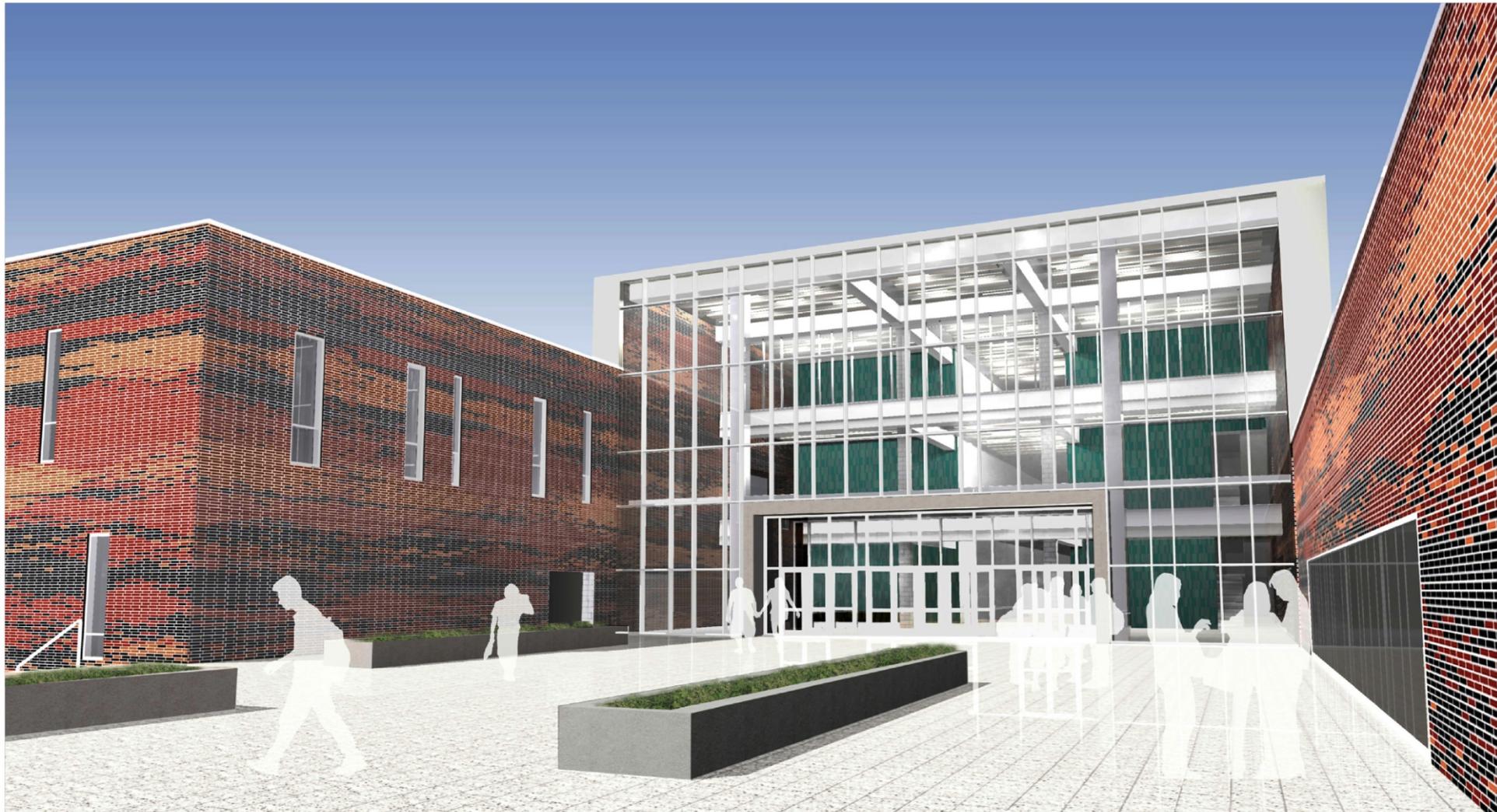
North Elevation



South Elevation



Concept Transfer Package





Sustainable Design / LEED Charrette

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Purpose of Initial Sustainable Design/LEED Charrette

- Understand what Sustainability means to stakeholders.
- Explore sustainable design goals, opportunities, interacting relationships.
- Identify further research.
- Develop LEED Checklist – Target points (Don't start here!!)



Charrette – Initial Discussion Points

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What would have you be able to say the project is sustainable?

What would make the project a success?



Charrette Notes

10

is site fenced fr/ community?
 filter 100% of stormwater
 make sure handicap parking is exposed to sun in winter
 introduce turtles + frogs to site
 playground area that slices water - illustrates water mgmt/control
 Create bird habitat @ green roof
 heads water
 make sure outdoor recreation facilities used year round
 Create ice skating rink, skate board park
 truth room - temperature sensors to show stratification, mechanical room visible
 materials visible - show where they come from - signage
 reduce amount of site lighting
 individual sport fields have own on/off switches
 trellises + plants @ parking lot
 PV parking lot canopies
 PV site lighting - to avoid electrical
 PV/wind site lighting
 solar trash compactor
 Use water from roof for water sculpture - physics demo

3

Reduce noise in duct system

find best fit for all three

Choose mat'ls that enhance healthy environment + that are durable
 a place that inspires students to make a difference in the world - in a good way
 Students take pride in the environment
 enhances interconnectivity -
 Community, students
 environment / community / learning
 improves ability of students to learn + changes their lives with respect to the community, the environment + themselves
 focus on passive solar heating/cooling/structures
 1st - well not change long term, therefore should be designed for efficiency
 easily maintained + sustained equipment
 reduce burden on landfill
 building continues to be used/useful for at least 100 years

6

provide just the illumination levels that are required
 lamps - high CRI, good color temp.
 CPS guidelines - water cooled chiller
 Use CO₂ sensors in gym, other large multi-tenant spaces, not classrooms
 occupancy sensor tied to HVAC system
 Design so that systems fail, measure that energy efficiency is maintained
 Explore micro-turbines - demand for waste heat??
 Capture NW winds w/ evergreens?
 Create layer of plants behind facade + bldg?
 Clean interior w/ plants?
 Small windows good for reducing interior noise levels
 window shading
 stack effect ventilation thru atrium - see Little Village issues
 envelope - insulation a bit beyond code
 increase roof insul beyond code
 Consider envelope for heating + cooling season
 intakes should be on north side

Good(e) Charrette Goals:

- Simplify Construction
- Increase Daylight
- Reduce Cost
- Implement Ground Source Heat Pump System
- Engage Community

Reduce noise in duct system

3

Comfort
Energy
Learning

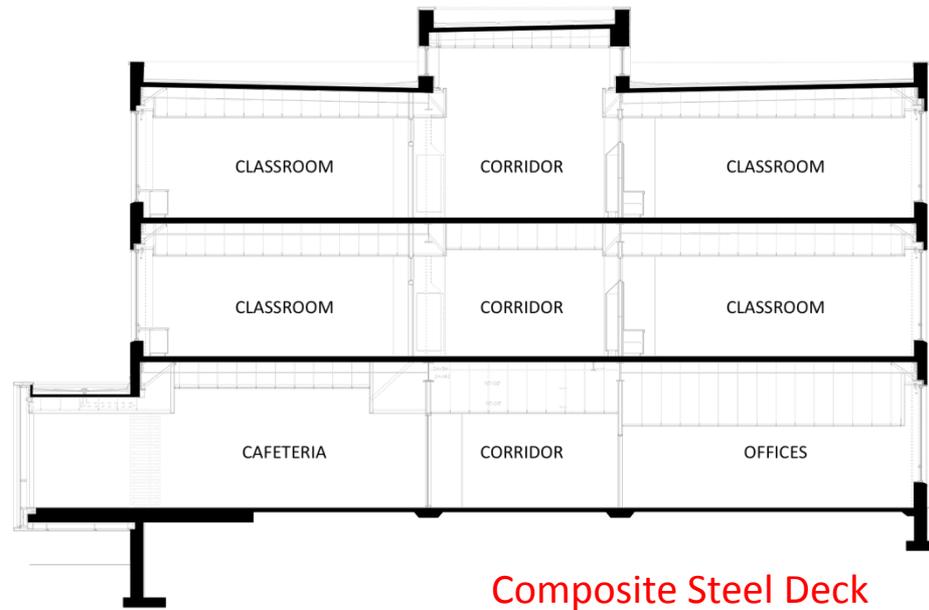
change materials that enhance healthy
a place that inspires students to make a
difference in the world - in a good way
improves ability of students to learn & engages
focus on passive solar heating/cooling/structure
1st - well not change long term, therefore
reduce burden on landfill
building continues to be used/useful for at least
100 years

enhances interconnectivity -
Community, students
improves ability of students to learn & engages
focus on passive solar heating/cooling/structure
1st - well not change long term, therefore
reduce burden on landfill
building continues to be used/useful for at least
100 years

provide for the utilization of solar
natural resources
Analysis - high CPT, encourage energy
CPS objectives water cooled radiant
CPS objectives in your other range
that present themselves and understand
CPS learning services that to H2O, liquid
Demand so that, systems to improve that
energy efficiency is maintained
Explore more turbines - demand for
heat heat
Create layer of insulation better facade & building?
Solar retention w/plants?
Small windows good for reducing interior or noise
levels
Window shading
stack effect ventilation thru atrium - see little
envelope - insulation a bit beyond code
increase roof insul beyond code
Consider envelope for heating + cooling season
intakes should be on north side

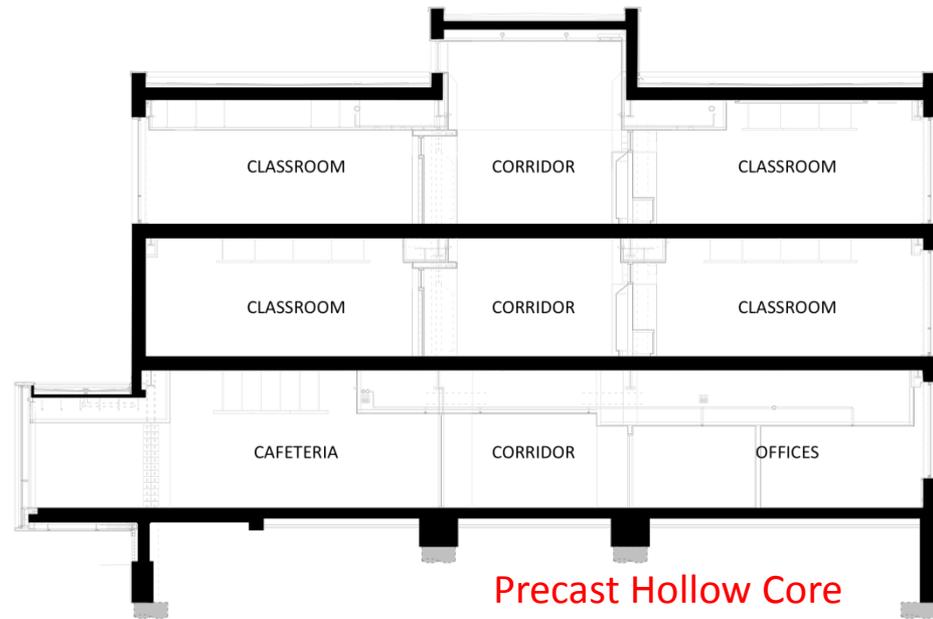
15 side panel
filters 100% of stormwater
introduce turtles + frogs to site
playground area that
Create bird habitat & green roof
fresh room - temperature sensors to show
Stratification, mechanics of room
materials used - show area that come
from sewage
reduce amount of site lighting
Individual sport fields have canopy/off
trellises + plants @ parking on
PV parking lot canopies
PV site lighting - to avoid electrical
PV/wind site lighting
Solar on fresh compactor
Use water from roof for water sculpture -
Physics demo

Structural System



Composite Steel Deck
w/ Concrete Topping

Sarah E. Goode Building Section



Precast Hollow Core
Concrete Planks

Prototype Building Section

Increase Daylight



**OPTION 2:
INTERIOR VIEW IN TYPICAL CLASSROOM**

41% Glazing Area



**BASE CONCEPT DESIGN:
INTERIOR VIEW IN TYPICAL CLASSROOM** 28% Glazing Area



**OPTION 1:
INTERIOR VIEW IN TYPICAL CLASSROOM** 35% Glazing Area

Study: Glazing Properties

Simulation Option	Glazing Area (% of Total Wall Area)	Electrical Energy		Gas Energy		Total Energy	
		Usage (kWh)	Cost (\$)	Usage (Therms)	Cost (\$)	Usage (10 ⁶ Btu)	Cost (\$)
Option 1 ^a	28%	941,500	30,214	62.04	1,220	3,833	31,434
Option 2 ^a	41%	918,377	29,471	72.86	1,433	3,862	30,904
Option 2 ^b - Scenario 1	41%	946,073	30,360	68.71	1,352	3,915	31,711
Option 2 ^b - Scenario 2	41%	944,431	30,307	69.06	1,358	3,913	31,666
Option 2 ^b - Scenario 3	41%	934,379	29,985	67.10	1,320	3,859	31,305

Prototype



Sarah E. Goode



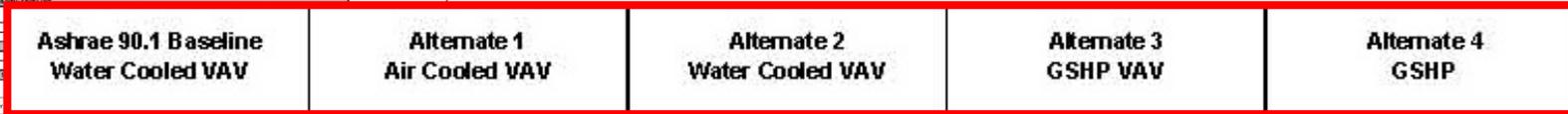




HVAC System: Life-Cycle Cost Analysis

HVAC SYSTEM COMPARISON FOR SOUTH WEST AREA HIGH SCHOOL

Equipment	Ashrae 90.1 Baseline Water Cooled VAV	Alternate 1 Air Cooled VAV	Alternate 2 Water Cooled VAV	Alternate 3 GSHP VAV	Alternate 4 GSHP	Responsibilities/Comments	
1							
2	Roof/Insulation	0.03					
3	Wall/Insulation	0.04					
4	Glaze on Green Floor Insulation	0.73					
5	Glaze	0.52					
7	Shading Coefficient	0.45					
8							
9	Heating Plant	Gas Boiler					
10	Cooling Plant	Water Cooled Chiller					
11	Energy Recovery						
12							
13	Conditioned Area	160,700	160,700	160,700	160,700		
14	Supply Unit - Supply Air Flow(CFM)	16,000	16,000	16,000	16,000		
15	Heating Load (kBtu/h)	150	150	150	150		
16	Cooling Load (Tons)	45	45	45	45		
17	Supply Unit - Supply Air Flow(CFM)	15,000	15,000	15,000	15,000		
18	Heating Load (kBtu/h)	1,310	1,310	1,310	1,310		
19	Cooling Load (Tons)	390	390	390	390		
20	Roof Unit - Supply Air Flow(CFM)	15,000	15,000	15,000	15,000		
21	Heating Load (kBtu/h)	200	200	200	200		
22	Cooling Load (Tons)	20	20	20	20		
23	1st Floor Unit - Supply Air Flow(CFM)	80,000	80,000	80,000	80,000		
24	Heating Load (kBtu/h)	600	600	600	600		
25	Cooling Load (Tons)	70	70	70	70		
26	2nd Floor Unit - Supply Air Flow(CFM)	80,000	80,000	80,000	80,000		
27	Heating Load (kBtu/h)	1,300	1,300	1,300	1,300		
28	Cooling Load (Tons)	190	190	190	190		
29	Water Supply Air Flow(CFM)	147,000	147,000	147,000	147,000		
30	Heating Load (kBtu/h)	4,500	3,700	3,700	4,000		
31	Cooling Load (Tons)	480	390	390	480		
32	Outside Air Flow(CFM)	48,200	48,200	48,200	48,200		
33	Cooling Capacity (Tons)	490	390	390	480		
34	Heating Capacity (kW - Btu/hr)	6,300	3,700	3,700	2,500		
35							
36	Water Air Handling Unit	\$1,200,000	\$1,200,000	\$600,000	\$600,000		
37	Roof Air Handling Unit	\$1,200,000	\$1,200,000	\$200,000	\$200,000		
38	1st Floor Air Handling Unit	\$400,000	\$400,000	\$200,000	\$200,000		
39	2nd Floor Air Handling Unit	\$400,000	\$400,000	\$200,000	\$200,000		
40	Water Unit with Outdoor Air Intake	\$200,000	\$200,000	\$100,000	\$100,000		
41	Water to Air Heat Exchanger (1st Floor, 2nd Floor, 1st Load only)	NA	NA	NA	\$100,000		
42	Water to Air Heat Exchanger (2nd Floor, 1st Load only)						
43	Water to Air Heat Exchanger (1st Floor, 2nd Floor, 2nd Load only)						
44	Water						
45	Controls			\$240,000	\$240,000	\$240,000	NA
46	Control System			\$150,000	\$150,000	\$150,000	\$150,000
47	Water Treatment						
48	Water to Water Heat Exchanger						
49	Water to Water Heat Exchanger						
50	Water to Water Heat Exchanger						
51	Water to Water Heat Exchanger						
52	Water to Water Heat Exchanger						
53	Water to Water Heat Exchanger						
54	Water to Water Heat Exchanger						
55	Water to Water Heat Exchanger						
56	Water to Water Heat Exchanger						
57	Total Equipment Cost			\$2,598,000	\$2,553,000	\$2,180,000	\$1,980,000
58	Total Installed Cost			\$7,794,000	\$7,659,000	\$6,540,000	\$5,940,000
59	Geo-Exchange Wells			N/A	N/A	\$2,000,000	\$1,700,000
60	Capital Cost (Note 2)			\$7,794,000	\$7,659,000	\$6,540,000	\$7,640,000
61	Federal Tax Credit (10% for Geothermal)			\$0	\$0	-\$854,000	-\$764,000
62	Total Cost of System to Owner			\$7,794,000	\$7,659,000	\$7,686,000	\$6,876,000
63	\$/sq ft			\$46.20	\$45.40	\$45.56	\$40.76
64							
65	Electric Consumption (kWh) - (Note 3)	1,007,516		1,000,746	971,117	885,189	735,811
66	Gas Consumption (THERMS) - (Note 3)	34,506		7,313	7,313	3,272	3,807
67	Annual Energy Cost	\$93,261		\$70,580	\$68,582	\$59,488	\$50,247
68	Performance Improvement	0.0%		24.3%	26.5%	36.2%	46.1%
69	LEED For Schools Points			4	5	8	10
70							
71	\$/Sq.ft Energy Cost	\$0.55		\$0.42	\$0.41	\$0.35	\$0.30
72	Cooling (\$/ton)	375		482	482	475	359
73							



COST SUMMARY							
53	VAV Boxes (80 boxes)			\$240,000	\$240,000	\$240,000	NA
54	Controls			\$150,000	\$150,000	\$150,000	\$150,000
55	Water Treatment						
56							
COST SUMMARY							
57	Total Equipment Cost			\$2,598,000	\$2,553,000	\$2,180,000	\$1,980,000
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ENERGY SUMMARY							
65	Electric Consumption (kWh) - (Note 3)	1,007,516		1,000,746	971,117	885,189	735,811
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68	Performance Improvement	0.0%		24.3%	26.5%	36.2%	46.1%
69	LEED For Schools Points			4	5	8	10
70							
METRICS							
71	\$/Sq.ft Energy Cost	\$0.55		\$0.42	\$0.41	\$0.35	\$0.30
72	Cooling (\$/ton)	375		482	482	475	359

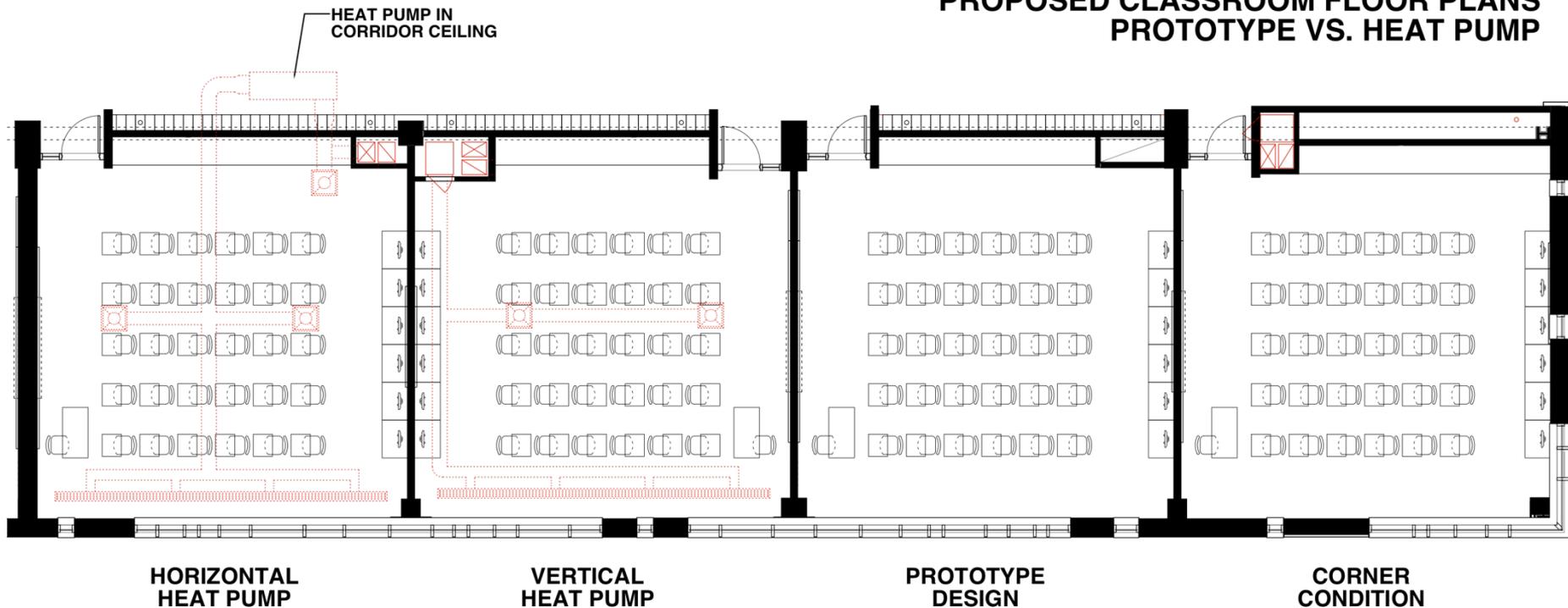
Notes:
 1. Energy Costs are for electric, heating and refrigeration loads only. Domestic hot water energy costs are not included in this analysis.
 2. Alternative Descriptions:
 Alternate 1: Separate variable volume air distribution systems with radiant ceiling systems. A constant volume system with air distribution serves the space. All-in-one package heating.
 Prime: LEED v4.0 Building for Schools.
 Cost: Low first cost without tax savings, may require some modification to architecture.
 Alternate 2: The systems in Alternate 1 are utilized. A water cooled-chiller plant. Prime: LEED v4.0 Building for Schools. Alternate 1, meets LEED v4.0 Building for Schools. Cost: Greater maintenance than Alternate 1.
 3. The systems are sized as in Alternate 1 and utilize package gas-fired boilers to serve heat pumps providing heating in the space. Prime: High energy savings, higher LEED v4.0 rating, lowest cost after tax credits, cost. High first cost without tax savings, may require some modification to architecture.
 4. Individual geothermal heat pumps provide heating and cooling to all conditioned spaces. A geothermal heat pump with air distribution serves the space. Fresh air is distributed from dedicated wells or used to each heat pump for conditioning and distribution in the space. Each heat pump is connected to the ground loop for heat rejection and a high efficiency supplemental boiler provides additional heating.
 Prime: High energy savings, higher LEED v4.0 rating, lowest cost after tax credits, overall will require the least space.
 Cost: High first cost without tax savings, may require some modification to architecture.

Ground Source Heatpump System



Ground Source Heatpump System

PROPOSED CLASSROOM FLOOR PLANS
PROTOTYPE VS. HEAT PUMP



Ground Source Heatpump System



**Drilling wells for
geo-exchange system**

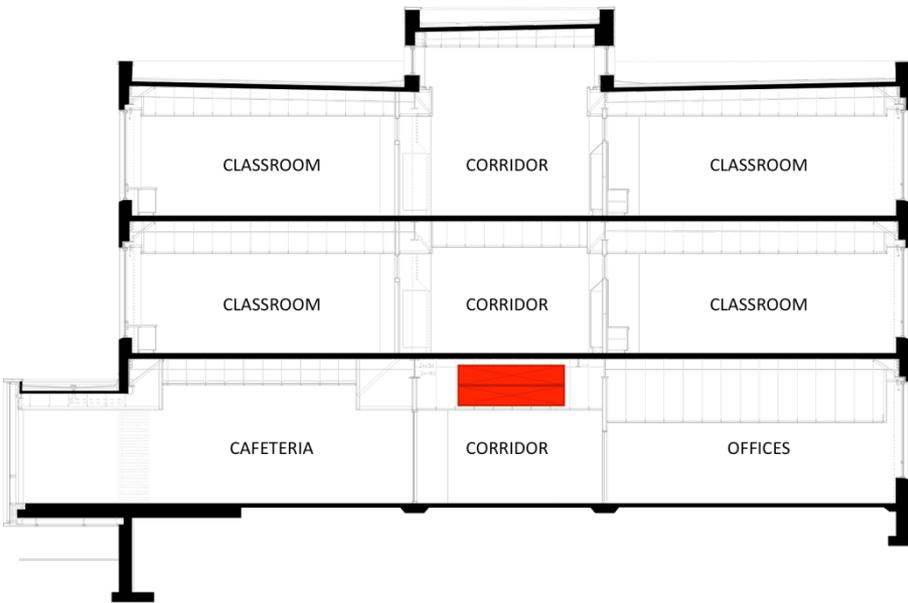
**Heatpump Closet
located in classroom**



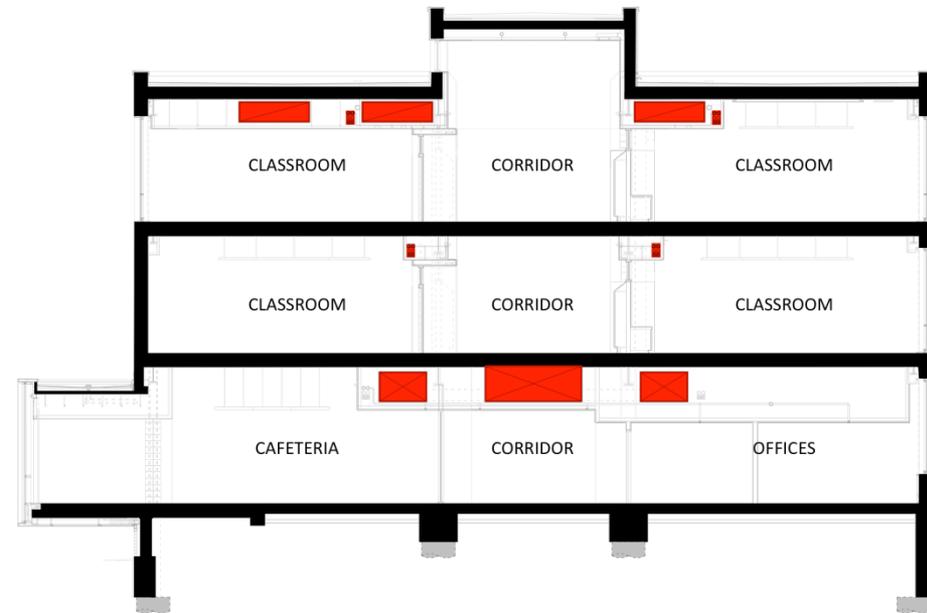
Ground Source Heatpump System

Areas of Intense Mechanical Coordination

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Sarah E. Goode Building Section



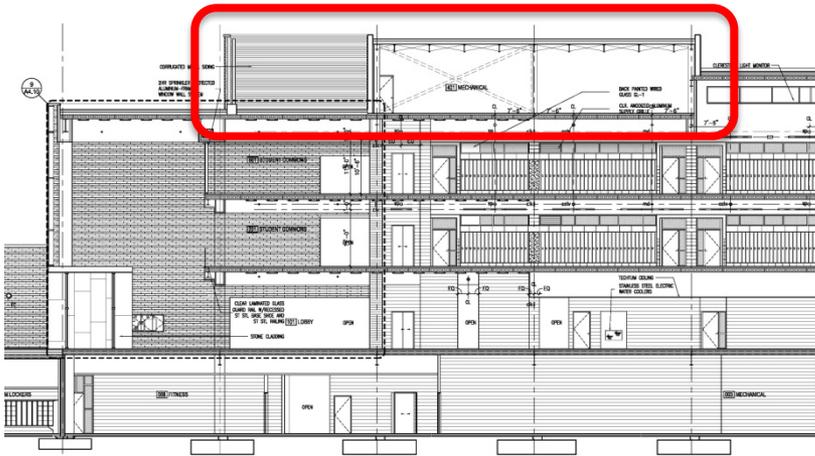
Prototype Building Section



Ground Source Heatpump System

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**Penthouse Eliminated
At Sarah E Goode**



Prototype Building Section

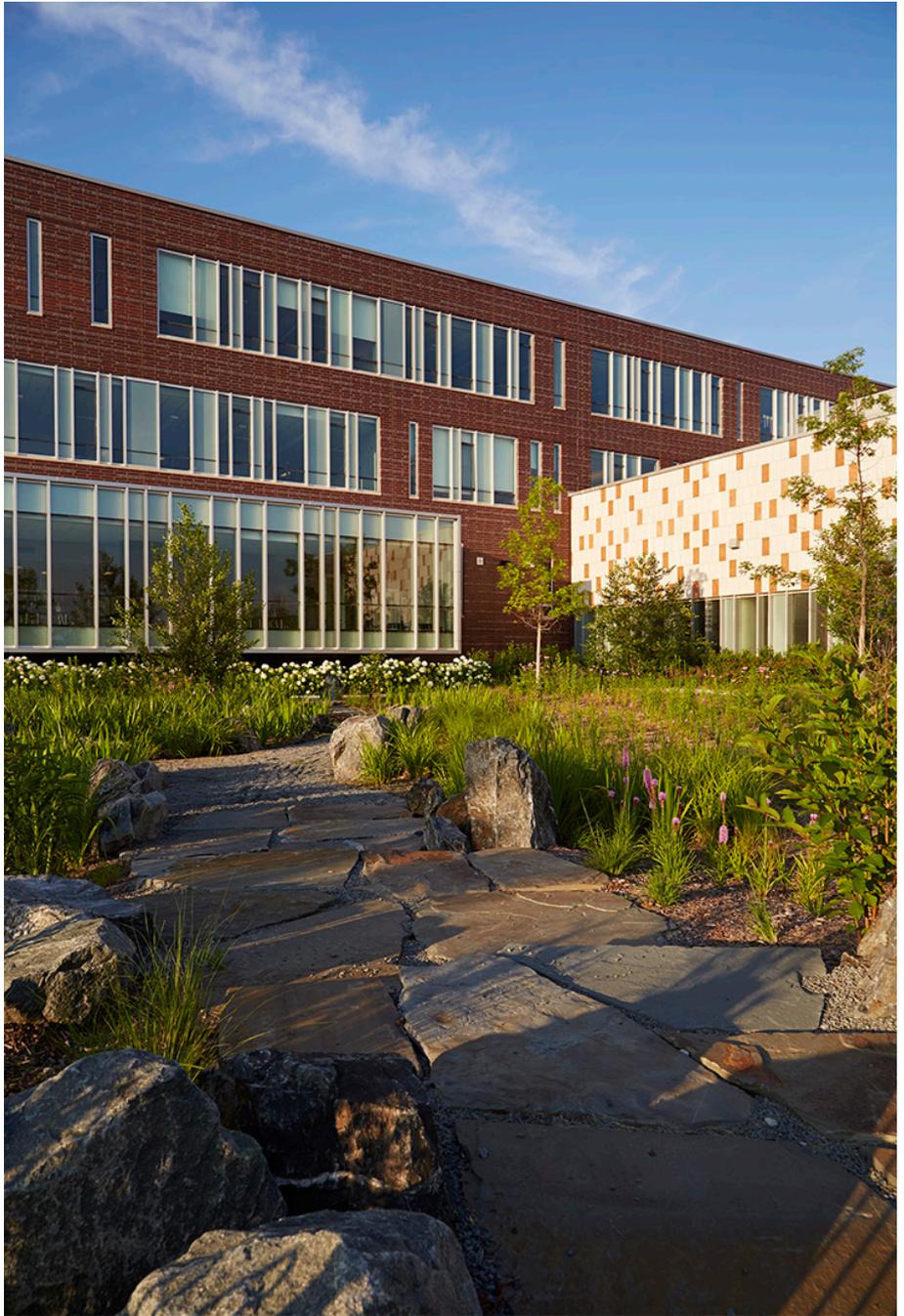


Sarah E Goode Solar Panels



Engage Community















Solar Water Heating



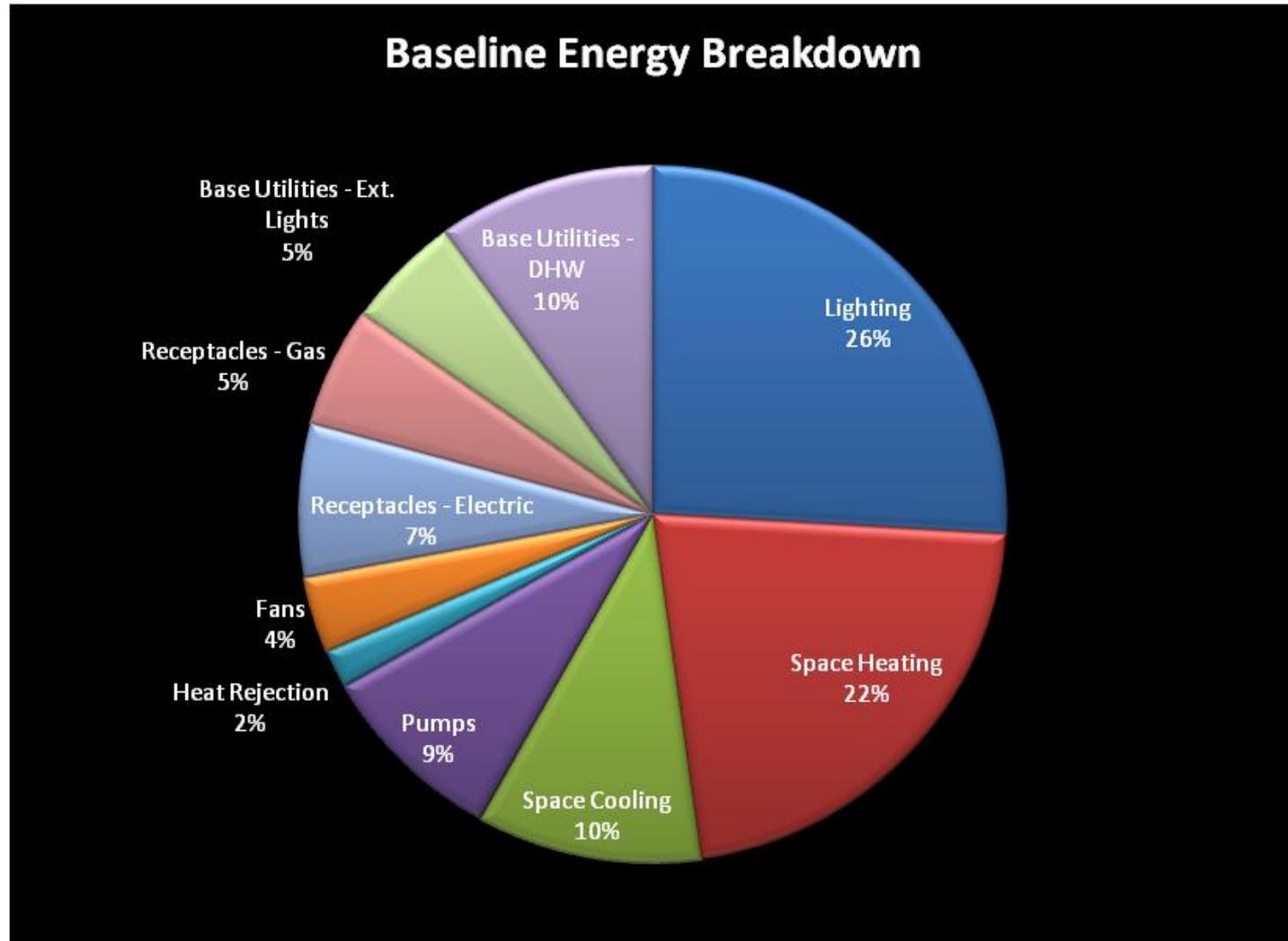
Natatorium





Energy Baseline

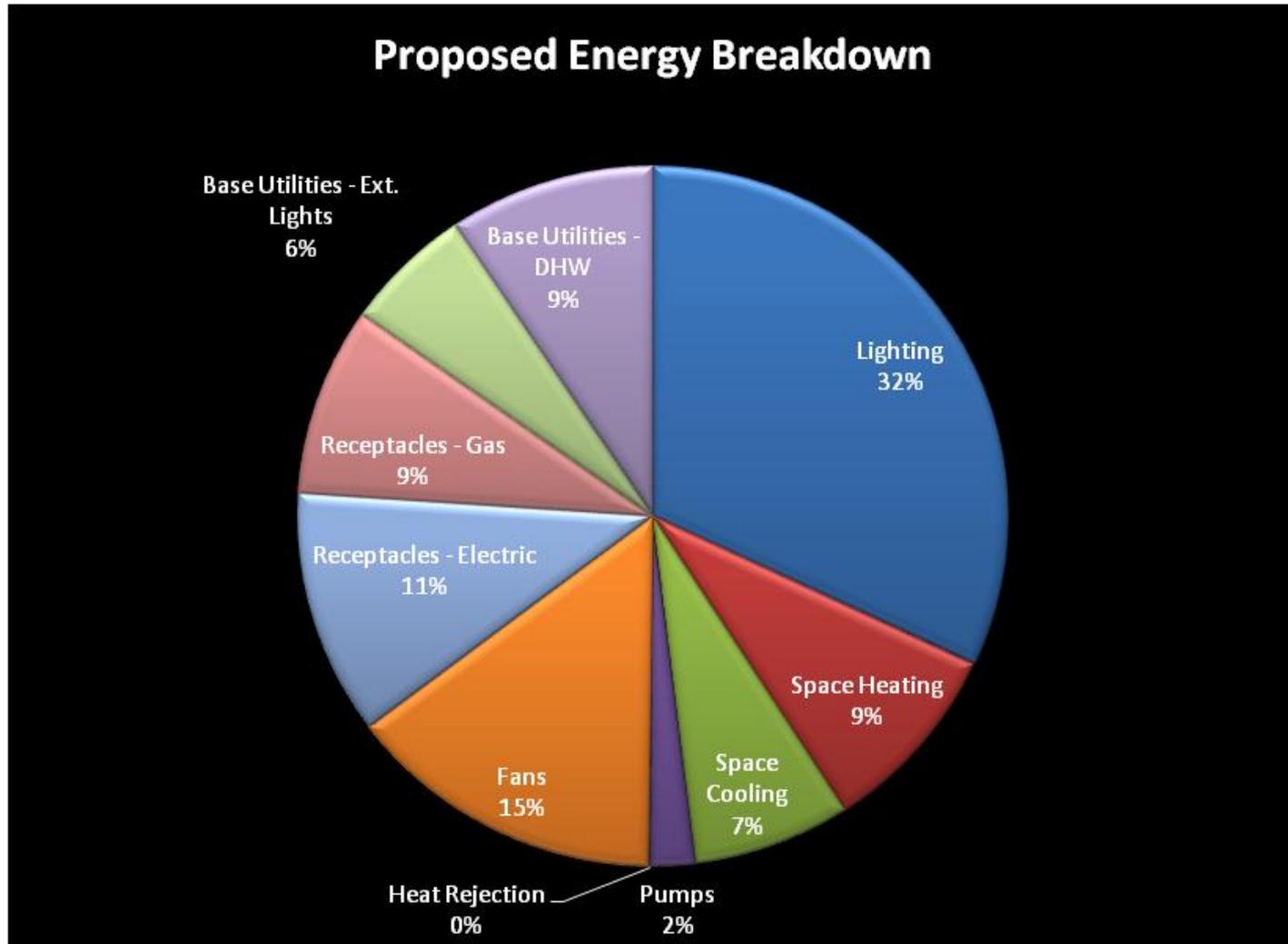
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Energy Proposed

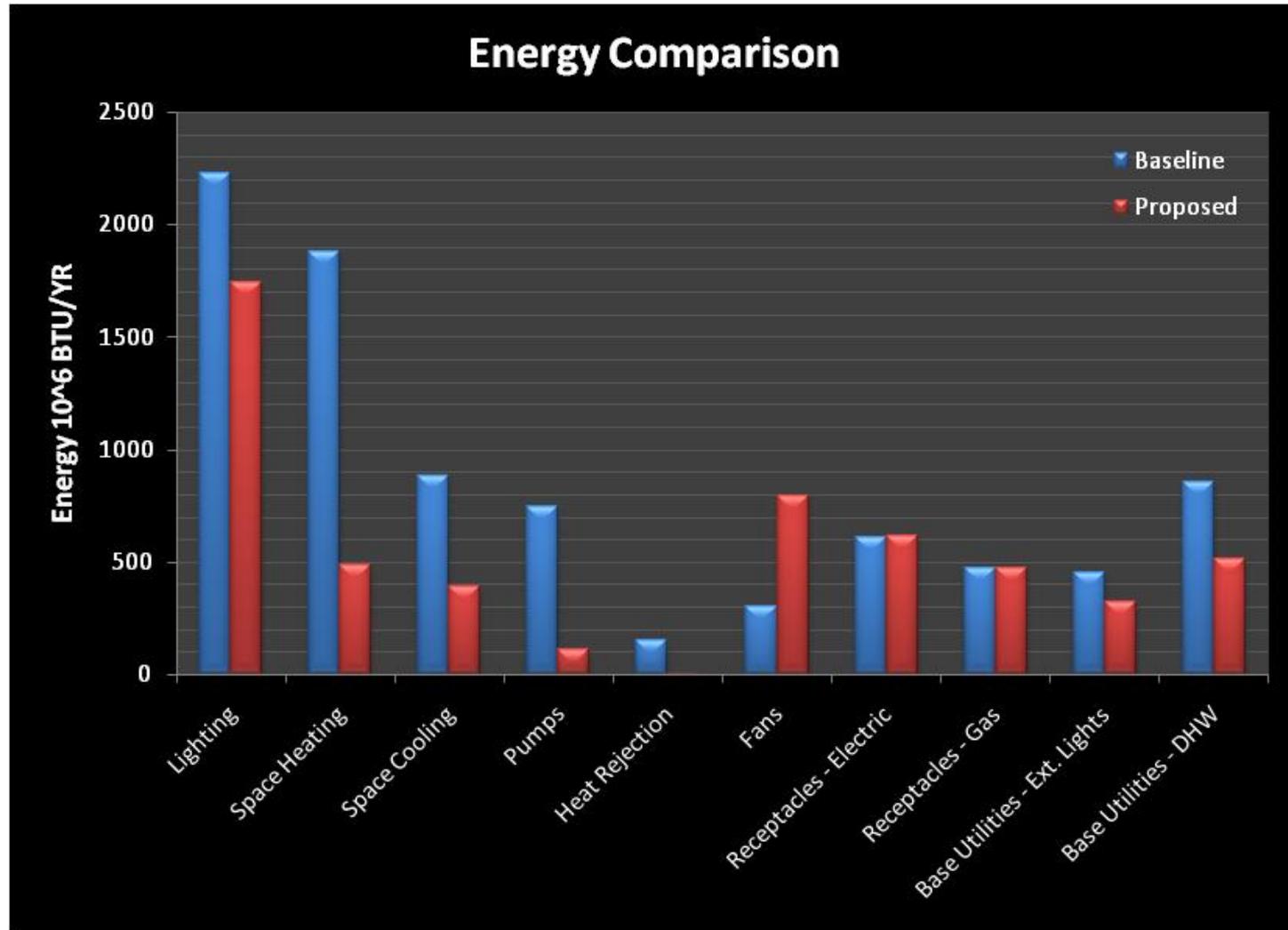
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Energy Comparison

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Sarah E. Goode vs. Evolving Prototype

A Side-By-Side Comparison: Cost

Goode	\$	62,452,000	
BOTY	\$	63,822,440	
	\$	(1,370,440)	@ \$7/SF difference

Significant Scope Differences:

Masonry	Brick pattern regularized; Less quantity than prototype due to increase in windows and shorter building due to HVAC changes.
Steel / Miscellaneous Metals	Goode changed from concrete deck to steel deck with concrete top. Shorter building due to smaller HVAC ductwork. Eliminated Penthouse. BOTY stayed with precast plank. Penthouse required with standard HVAC
Spray Fireproofing and Insulation	Less Steel; less fireproofing.
HVAC	Smaller ductwork – VAV versus distributed heat pumps with dedicated outside air; Added acoustic insulation at classroom heat pump closets;
Geothermal wells	Boilers reduced from (3) 3,000 mbh to (2) 1,500 mbh; (1) 450 ton Chiller versus distributed heat pumps and geothermal pool dehumidification unit. Added geothermal wells – 170 wells at 450 feet deep each.

Sarah E. Goode vs. Evolving Prototype

A Side-By-Side Comparison: LEED

LEED Categories	GOODE	BOTYHS
Sustainable Sites	14	10
Water Efficiency	5	5
Energy and Atmosphere	12	8
Materials and Resources	7	7
Indoor Environmental Quality	16	10
Innovation	5	5
TOTAL	59	45
	Platinum	Gold

A word cloud featuring various terms related to business, innovation, and collaboration. The words are arranged in a dense, overlapping manner. The largest words are 'collaborative', 'integrative', and 'synergies'. Other prominent words include 'efficiency', 'design', 'cost', 'performance', 'innovation', and 'process'. The words are in various colors including red, brown, green, purple, and black.

effort
research holistic green
efficiency focused support
collaborative high leverage
believer durable
optimize creative
broadminded
welcoming
cognitive leadership risk challenging
integrative value receptive extraordinary
cost ongoing synergies persistence
unstoppable design performance thoughtful
interrelationships communication first modeling process
champion out committed open innovative continuous
sustainable taking proved mindset engage
team belief quality



Questions





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