# Lake Saint Clair Metropark Ecological Center







### 79&Park



**POROSITY** Three public passages activate the courtyard as a shared, central space.



**796PARK** The site is interpreted as an extension of the surrounding park, all within an urban block.





vegetated surface systems for increased insulation and decreased air Infiltration main circulation northern end to

reduce heat loss mech/storage/vestibule entry spaces fronting strongest wind angles

Ν

- breeze pathways

- openings along SW/NE plane for Anatural cross-ventilation

F

large surface areas & glazing oriented to south to capture passive solar energy for heat, can utilize twin face system

W

S

creation of pocket spaces open to sun but sheltered from wind; elongates use of outdoor space during colder months

> smaller building size to minimize HVAC/energy waste

overhangs on southern end to control – glare/overheating in summer, can utilize PV panels as shading louvers

elongation of plan along E/W plane -

small, fightly sealed skylights can reduce daytime energy needs

# Climate Analysis

\*Diagrams Courtesy of Kayleigh Walker

















#### Figural Organization







# **Program** Iterations



# Program Svnthesis



The Ecological Center will not take away from the natural aspect of the metropark. The Center will embody an idea of porosity in order to make the structure an extension of the park's greenscape.

### Concept



# Circulation





# Views





#### Sustainability:

- Green roofs
- PV panel roofs
- Pervious hardscape surfaces
- Wetlands/wildlife habitat
- East-west spanning plan
- Large southern exposure
- Solid wall windstops
- Light well areas



### **North Views**



## South Views



# **Upper Plan**





### **Upper Level**



### Lower Plan

 $\bigcirc$ 





### Lower Level



# **Section A**



### Section B



# **Section C**



### Section D



# North Elev.



### South Elev.



### Materiality



### **Cross Section Axos**

## **Section Axo**







## Earess



# Structure - 11





# Structure - 12





# Structure - Roof







# GabionWall

#		Material	λ [W/mK]	R [m²K/W]	Temp min	o. [°C] max	sd-value [m]	Condensate [kg/m²] [%]		Weight [kg/m²]	Heat capacity [J/(kg*K)]
		Thermal contact resistance		0,130 (0,250)	19,5	20,0					
1	50 cm	Ytong Energy+	0,067	7,463	2,4	19,5	2,50	0,23	0,2	120,0	1000
2	0,05 cm	Vapor barrier sd=100m	0,220	0,002	2,4	3,8	100,00	0,23	179	0,1	1700
3	18 cm	Biofib Ouate	0,040	4,500	-4,9	3,8	0,36	<u>.</u>		7,5	1800
	18 cm	spruce (7,7%)	0,130	1,385	-4,8	2,6	9,00	÷		6,2	1600
		Thermal contact resistance		0,130 (0,040)	-5,0	-4,8					
4	4.5 cm	Rear ventilated level (outside air)			-5	,0				0,0	
5	50 cm	Ytong Energy+		-5,(						120,0	
	122,55 cm	Whole component		11,650		103,26	0,23		253,8		

#### U-value: 0,086 W/m<sup>2</sup>K

Temperature of inside surface: 19,5 °C Temperature of outside surface: -4,9 °C

# **Gabion Wall**





500

180 45

500

0%-

# Gabion





Inside:	Reduced air circulation 🔻	20 °C 50 % Humidity Rsi				Outside		
	From inside to outside: reverse	e Thickness Width Distance •		T20	7-7-7-	(5)		
⊞ 1	HASIT 110 Haftputz	10 mm	≡ 💉 👎 🕛	45	000 000	0 4 000 000	6	
∷ 2	Vapor barrier sd=100m	0,5 mm	≡ 💉 👎 🕛		$\gamma \gamma $	$\gamma \gamma $		
⊞ 3	Biofib Ouate 🔹	180 mm	≡ 💉 🕂 🕛	222'2	$\Lambda \wedge \Lambda$	$\Lambda_{A} \Lambda \Lambda \Lambda \Lambda$		
	Fichte 🔹	180 mm 50 mm 600 mm	≡ 〃 な 心		$/ \setminus / \setminus / \setminus$			
∷ 4	Rear ventilated level (outside air)	45 mm	≡ 〃 〒 🕚		t XXXX			
⊞ 5	Pine v	20 mm )+	≡ 🖋 👎 🕛		$\overline{\sqrt{2}}$			
∷ 6	<b>v</b>	mm	Ī			Inside	ubakus.de	
Outside	Direct contact to outside air	-5 °C 80 % Humidity Rse		50		600		
U-v	alue: 0,240 w/m²κ 🖄	Condensate: 0 kg/m <sup>2</sup>		sd-value: 101 m Thickn	ness: 25,55 cm	temp. amplitude dampi	ng (1/TAV): 6,3	
-				We	eight: 36 kg/m²			
		moisture content of wood:	+0,0 %	Interior surface: 17,5°C (5	8%)	phase shift: 7,9 h		
EnE∖	Bestand: $U \le 0.24^*$							
Contr	ibution to the greenhouse effect:	Drying time: -		Drying reserve: 10016 g/m	n²a	Heat storage capacity:	23 kJ/m²K	
excell	ent insufficier	ent excellent	insufficient	insufficient	excellent	insufficient	excellent	

# Metal Wall

#		Material	λ [W/mK]	R [m²K/W]	Temp min	o. [°C] max	sd-value [m]	Condensate [kg/m²] [%]	Weight [kg/m²]	Heat capacity [J/(kg*K)]
		Thermal contact resistance		0,130 (0,250)	17,5	20,0				
1	1 cm	HASIT 110 Haftputz	0,330	0,030	17,1	18,7	0,05	11.TC	12,0	1000
2	0,05 cm	Vapor barrier sd=100m	0,220	0,002	17,1	18,5	100,00	1470.	0,1	1700
3	18 cm	Biofib Ouate	0,040	4,500	-4,8	18,5	0,36	ien.	7,5	1800
	18 cm	spruce (7,7%)	0,130	1,385	-4,4	17,4	9,00	-	6,2	1600
		Thermal contact resistance		0,130 (0,040)	-5,0	-4,4				
4	4.5 cm	Rear ventilated level (outside air)			-5	,0			0,0	
5	2 cm	Pine			-5	,0			10,4	
	25,55 cm	Whole component		4,170			100,81	12	36,2	

#### U-value: 0,240 W/m<sup>2</sup>K

Temperature of the inside surface (min/average/max): 17,5 / 18,5 / 18,7 °C Temperature of the outside surface (min/average/max): -4,80 / -4,80 / -4,40 °C

# Metal Wall





Metal









# Mod<sub>-</sub> 4



Mod 3







or chilled wat

Hot



Cooling air volume: approx. 70,000cfm Main supply/return ducts: 30sf Branch supply/return ducts: 60sf Fan room area: 1000sf Fresh air louvers area: 100sf Exhaust air louvers: 90sf

# **HVAC Sizind**







Mech. rooms Artificial lighting: Sprinklers: Glazing above --use a structural grid to give way to -locate sprinklers in Also open to below a symmetrical artificial lighting plan standard grid pattern that -provide more lighting in spaces follows general structural towards the north end of the grid while meeting code of building (not adjacent to curtain having every room Ν walls) sprinkled



Water: collect, filter, and harvest water from green roofs to use for gray water and sprinklering Shading: devices to prevent solar glare Heat island reduction: flat roofs with vegetation Energy: D integrated BIPV n south sloping a roofs

Daylighting: northern clerestory at sloped roofs Daylighting: channel glass clerestory

Environmental impact: save existing boardwalk

Transportation: electric vehicle charging stations

> Heat island reduction: grasscrete pervious surface with bioswales

Environmental impact: leave shoreline untouched Environmental impact: incorporate natural wetlands for ecosystem and flooding benefits Materials: natural gabion wall

Thermal comfort: radiant floor heating Thermal comfort: two-pipe active chilled beam system

Sustainability



# Site Section

#### **PSYCHROMETRIC CHART**

#### ASHRAE Standard 55-2004 using PMV

#### LOCATION: Mount Clemens Selfridge Fld, MI, USA

Latitude/Longitude:

42.62° North, 82.83° West, Time Zone from Greenwich -5

Data Source: TMY3 725377 WMO Station Number, Elevation 580 ft





**Psychrometric** 

**Surface area:** make building form compact with simple facades in order to reduce surface area exposure, resulting in more efficient systems

**Building form:** spanning east to west will create a larger south facing facade that will take advantage of collecting solar gains

**Green roof:** act as thermal insulation and helps to prevent runoff

**Sun wells:** allows sunlight to penetrate into the building by creating pockets, also shield from southern winds to avoid heat loss

**Mechanicals:** centrally locate building services in order to increase efficiency and keep HVAC duct sizes compact

**Breezeways:** incorporate passageways to let wind flow through building for natural ventilation

**Shoreline:** position building far away from shoreline to not disturb natural habitats/prevent erosion



# Orientation



Water catchment areas

Roof area: 9000sf Runoff coef: .9 Ave. daily demand: 75ppl\*2gal/day=150gal/day Monthly demand: 4,562gal (583gal) Yearly demand: 150\*365=54,750gal

# **Rain Harvesting**

june-september september-june

\*Kayleigh Walker

Thick gabion walls with insulation act as a thermal pass that helps resist wind and regulates building temperature. Solid south-facing walls to act as a wind stop and thermally insulate interior of building during cold months from the strong south wind.

#### SS Credit Site Development - Protect or Restore Habitat

**Intent:** To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

#### Requirements: On-Site Restoration (2 points)

Using native or adapted vegetation, restore 30% (including the building footprint) of all portions of the site identified as previously disturbed. Projects that achieve a density of 1.5 floor-area ratio may include vegetated roof surfaces in this calculation if the plants are native or adapted, provide habitat, and promote biodiversity.

#### Solution:

In order to re-establish natural ecosystem after lakeshore boardwalk is built, provide a wetlands area at the south end of the site along the lakeshore. Populate with native flora such as cattails.



#### SS Credit Site Development - Heat Island Reduction

**Intent:** To minimize effects on microclimates and human and wildlife habitats by reducing heat islands.

#### Requirements: Non-roof and Roof (2 points)

- Provide shade with vegetated structures.
- Use an open-grid pavement system (at least 50% unbound).

#### Solution:

In order to reduce the human impact on the surrounding microclimate the building will incorporate a series of vegetated green roofs, thus reducing the amount of reflective roof materials. Additionally, to avoid a heat island effect, a grasscrete paving system will be used for the parking areas instead of a cement/asphalt parking lot.







#### WE Credit - Indoor Water Use Reduction

Intent: To reduce indoor water consumption.

Requirements: Non-roof and Roof (1-6 points-based off reduction %)

 Further reduce fixture and fitting water use from the calculated baseline in WE Prerequisite Indoor Water Use Reduction.
 Additional potable water savings can be earned above the prerequisite level using alternative water sources.

#### Solution:

In order to reduce water use, the building will also use pervious pavement material to harvest rainwater and store it in collection tanks for use as gray water in the building's toilets. Additionally, low-flow plumbing fixtures and appropriate metering will be utilized.



#### IEQ - Daylighting

**Intent:** To connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space.

#### Requirements: Non-roof and Roof (1-3 points)

- Provide manual or automatic (with manual override) glare-control devices for all regularly occupied spaces.

#### Solution:

In order to maximize natural daylighting throughout the building, the south facing facades will be mostly glazings. Clerestory windows will be incorporated also at sloped roofs facing north. The use of awnings and shading devices will ensure there is limited solar glare or overheating.



#### WE Credit - Thermal Comfort

**Intent:** To promote occupants' productivity, comfort, and well-being by providing quality thermal comfort.

#### Requirements: Non-roof and Roof (1 points)

- Meet the requirements for both thermal comfort design and thermal comfort control.

#### Solution:

In order to achieve thermal comfort of occupants, the building will utilize an air-water HVAC system. The water component uses radiant floor heating in the concrete floor topper to provide heat throughout the space. The air portion utilizes a two-pipe active chilled beam system to provide active cooling to the building.





#### LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Y	?	N		
			Gredit	Integrative Process

Project Name: LAKE ST. CLAIR METROPARK ECOLOGICAL CENTER Date: MAY 7TH, 2020

2	0 0	Locat	ion and Transportation	16	13	0	0	Materia	als and Resources	13
		Crede	LEED for Neighborhood Development Location	16	Y	-		Prereq	Storage and Collection of Recyclables	Required
1	-	Credit	Sensitive Land Protection (NATURE PARK)	1	Y	1		Preseq	Construction and Demolition Waste Management Planning	Required
		Credit	High Priority Site	2	5			Credit	Building Life-Cycle Impact Reduction (ECO-FRIENDLY MATERIALS SELECTION)	5
		Credit	Surrounding Density and Diverse Uses	5	2			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
	0	Credit	Access to Quality Transit	5	2		-	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials (GABION WALL)	2
		Credit	Bicycle Facilities	1	2		-	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
		Credit	Reduced Parking Footprint	1	2		1	Credit	Construction and Demolition Waste Management (CAREFUL CONSTRUCTION-PERSERVE SHORELINE ECOSYSTEM)	2
1		Credit	Green Vehicles (PROVIDE ELECTRIC VEHICLE CHARGING UNITS)	1	-					
					13	0	0	Indoor	Environmental Quality	16
7	0 0	Susta	inable Sites	10	Y		Ŧ	Prereq	Minimum Indoor Air Quality Performance	Required
Y	10.1	Preseq	Construction Activity Pollution Prevention	Required	Y	1	. 1	Prereg	Environmental Tobacco Smoke Control	Required
		Credit	Site Assessment	1	3		1	Credit	Enhanced Indoor Air Quality Strategies (AIR AND WATER SYSTEM)	2
2		Gredit	Site Development - Protect or Restore Habitat (RESTORE WETLANDS)	2			-	Credit	Low-Emitting Materials	3
		Credit	Open Space	1	1		1	Credit	Construction Indoor Air Quality Management Plan	1
3	1	Credit	Rainwater Management (GREEN ROOF WATER FILTRATION)	3	2			Credit	Indoor Air Quality Assessment	2
2	1	Credit	Heat Island Reduction (GRASSCRETE PARKING LOT WITH BIOSWALES)	2	1			Credit	Thermal Comfort (AIR AND WATER SYSTEM)	1
		Credit	Light Pollution Reduction	1	2			Credit	Interior Lighting (MOTION SENSORED, LED)	2
		10030000			3		1	Credit	Daylight (SOUTH GLAZING, NORTH CLERESTORY, LIGHT WELLS)	3
9	0 0	Water	Efficiency	11	1			Credit	Quality Views (FACING LAKE ST. CLAIR)	1
Y	-	Ptereg	Outdoor Water Use Reduction	Required			_	Gredit	Acoustic Performance	1
γ		Prereq	Indoor Water Use Reduction	Required	-					
γ		Proteq	Building-Level Water Metering	Required	0	0	0	Innova	tion	6
2	1	Credit	Outdoor Water Use Reduction (RUNOFF USED FOR SITE SPRINKLERING)	2				Greidit	Innovation	5
6		Credit	Indoor Water Use Reduction (GRAY WATER USED FOR TOILETS)	6				Credit	LEED Accredited Professional	1
		Credit	Cooling Tower Water Use	2	-		_			
1		Credit	Water Metering	1	0	0	0	Region	nal Priority	4
								Credit	Regional Priority: Specific Credit	1
20	0 0	Energ	and Atmosphere	33				Credit	Regional Priority: Specific Credit	1
Y	100	Prereq	Fundamental Commissioning and Verification	Required			1	Eredit	Regional Priority: Specific Credit	1
γ		Prereq	Minimum Energy Performance	Required				Gredit	Regional Priority: Specific Credit	1
Y		Prereg	Building-Level Energy Metering	Required		151 161				
Y		Prereg	Fundamental Refrigerant Management	Required	64	0	0	TOTAL	S Possible Point	nts: 110
		Credit	Enhanced Commissioning	6	-				Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110	Later and the
18		Credit	Optimize Energy Performance (ACTIVE 2-PIPE CHILLED BEAM W/RADIANT FLOOR)	18						
1		Credit	Advanced Energy Metering	1						
		Credit	Demand Response	2						
		Credit	Renewable Energy Production	3						
	1	Credit	Enhanced Refrigerant Management	1						
		Candit	Green Power and Carbon Offsets (INTEGRATED BIPV AT SLOPED ROOFS)	2						

1

### **Building Code Analysis**

#### **Project Information**

Site Description:	5 acres of land along L'anse Creuse Bay
	at Lake St. Clair Metropark
Address:	31300 Metro Parkway
	Harrison Charter Township, MI 48045

#### **Programming Requirements**

### Projected gross area: 25,000 square feet Main programs:

- Multi-purpose hall/education center
- Exhibit area/science center
- Indoor animal habitats
- Aquarium tanks
- Water research & conservation
- Souvenir shop
- Administration area

#### **Occupancy Classification**

- Assembly: A-3
- Mercantile: M

#### 303.4 Assembly Group A-3

Includes assembly uses intended for worship, recreation or amusement and other assembly use not classified elsewhere in Group A including, but not limited to:

- Exhibition halls
- Lecture halls
- Museums

#### 309.1 Mercantile Group M

Includes the use of a building or a portion thereof for the display and sale of merchandise, and involves stock of good to such purposes and accessible to the public. Mercantile occupancies shall include, but not be limited to, the following:

- Markets
- Retail stores

### Building Code Analysis | Construction Type - Steel

	TYF	TYP	EII	TYPE III		TYPE IV	TYPE V		
BUILDING ELEMENT	А	в	A	в	Α	в	нт	A	в
Primary structural frame <sup>†</sup> (see Section 202)	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls Exterior <sup>a, r</sup> Interior	3 3ª	2 2ª	1	0 0	2 1	2	2 1/HT	1	0
Nonbearing walls and partitions Exterior					See	Table	602		
Nonbearing walls and partitions Interior <sup>d</sup>	o	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	11/20	1 <sup>b. c</sup>	1 <sup>b, c</sup>	0 <sup>c</sup>	1 <sup>b, c</sup>	0	HT	1 <sup>b, c</sup>	0

TABLE 601 FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

For 51:1 foot = 304.8 mm

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and 5-1 occupancies, fire protection of structural members shall not be required, including protection of root framing and decking where every part of the root construction is 20 feet or more above any fisor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.

#### 602.2 Types I and II

Types I and II construction are those types of construction in which the building elements listed in Table 601 are of noncombustible materials

#### A is protected construction

B is unprotected construction

#### 602.3 Types III

Types III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted

https://codes.iccsafe.org/content/IBC2015/chapter-6-types-of-construction

https://dps.mn.gov/divisions/sfm/programs-services/Documents/Sprinkler%20Applications/ConstructionTypeDefinitions.pdf

### Building Code Analysis | Building Heights & Area

	TYPE OF CONSTRUCTION											
OCCUPANCY CLASSIFICATION		TYPE I		EI TYF		TYP	PE III	TYPE IV	TYP	PE V		
	SEE FOOTNOTES	A	В	A	В	Α	В	нт	Α	В		
	NS <sup>b</sup>	UL	160	65	55	65	55	65	50	40		
A, B, E, F, M, S, U	S	UL	180	85	75	85	75	85	70	60		
	NS <sup>c, d</sup>	0.02	160			05		65	50	10		
H-1, H-2, H-3, H-0	S	UL		60	00	65	00		50	40		
	NS <sup>c, d</sup>	UL	160	65	55	65	55	65	50	40		
H-4	S	UL	180	85	75	85	75	85	70	60		
14 Condition 4.1.2	NS <sup>d, e</sup>	UL	160	65	55	65	55	65	50	40		
I-1 Contation 1, 1-3	S	UL	180	85	75	85	75	85	70	60		
	NS <sup>d, f, e</sup>	UL	160	65	65 85		55			40		
I-1 Condition 2, I-2	s	UL	180	85				65	50	40		
	NS <sup>d, g</sup>	UL	160	65	55	65	55	65	50	40		
1-4	S	UL	180	85	75	85	75	85	70	60		
	NS <sup>d, h</sup>	UL	160	65	55	65	55	65	50	40		
R	S13R	60	60	60	60	60	60	60	60	60		
	S	UL	180	85	75	85	75	85	70	60		

TABLE 504.3<sup>a</sup> ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

For SI: 1 foot = 304.8 mm.

Note: UL = Unlimited; NS = Buildings not equipped throughout with an automatic sprinkler system; S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1; S13R = Buildings equipped throughout w

a. See Chapters 4 and 5 for specific exceptions to the allowable height in this chapter.

b. See Section 903.2 for the minimum thresholds for protection by an automatic sprinkler system for specific occupancies.

c. New Group H occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.5.

d. The N5 value is only for use in evaluation of existing building height in accordance with the International Existing Building Code.

e. New Group 1-1 and 1-3 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6. For new Group 1-1 occupancies Condition 1, see Exception 1 of Section 903.2.6.

f. New and existing Group I-2 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6 and Section 1103.5 of the International Fire Code.

g. For new Group I-4 occupancies, see Exceptions 2 and 3 of Section 903.2.6.

h. New Group R occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.8.