Enviro-Logic
Construction

Partnering with
SKANSKA

Written Response

Reduce negative environmental impacts.

Environment

To find work locally creating the most efficient project possible.

Economics

Constant communication with the owner, and the community creating a safe and ethical environment.

Engagement

Problem One LEED 2009 vs LEED v4

At Enviro-Logic Construction, we focus on fulfilling the Owner's needs at the lowest cost through the most efficient LEED certification process available. When analyzing the impacts of each rating system on particular credit requirements we recognize that **time, documentation, and product disclosure** play important roles in the certification process. Achieving new LEED v4 credits like **Building Product Disclosure and Optimizations and Building Life-Cycle Impact Reduction** often involve in-depth analyses and information tracking that may not be widely available at the start of pre-construction.

Part 1: Overall Project Review

Utilizing the LEED 2009 and LEED v4 Rating System Reference Guides, LEED checklists, available information within the Project Documents and our reasonable assumptions, we believe a **Gold Certification** can be achieved using both rating systems. Under the LEED 2009 Rating System, it is feasible for the project team to achieve a total of **72 points** compared to 67 under the LEED v4 Rating System. We believe the LEED 2009 Rating System will allow for an efficient execution, cost and time savings, and float within the checklist allowing for the modification of contingent credits. The following

Our Reasoning

The checklists below are completed by looking at the construction documents and assuming the transit center feasibility. The LEED 2009 rating system requires 20% water reduction to be LEED certified. We decided since we already have to get 20%, there would be **little to no extra cost** to get 2 points for water reduction by using low-flow fixtures, dual-flush toilets, and drought tolerant landscaping, giving us a **30% total water reduction**. In the Energy and Atmosphere category our project team fulfills beyond the prerequisites by looking to achieve **enhanced commissioning and optimize energy performance** without additional effort since the project already must meet specified standards in the prerequisite. We allotted 7 points for optimized energy performance because that is the maximum you can get at little to no extra cost by reducing the building's energy by 24%, according to past projects. We aimed to fulfill the low-emitting materials credit because we are aware of **Skanska's commitment to safety** for their employees and the community. We realize it is uncommon to achieve all the points anticipated, and with a 7 point float and room for innovation credits and energy optimization we believe this project is capable of securing a **LEED 2009 Gold Certification**.

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

Project Checklist

Project Name: Exposition Transit Project- Colorado Avenue/4th Street
Date: 02/05/2015

Y	?	N			
			Credit	Integrative Process	1

0	0	0	**Location and Transportation**		16
		✓	Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
		✓	Credit	High Priority Site	2
5			Credit	Surrounding Density and Diverse Uses	5
5			Credit	Access to Quality Transit	5
1			Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
1			Credit	Green Vehicles	1

0	0	0	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit	Site Assessment	1
2			Credit	Site Development - Protect or Restore Habitat	2
		✓	Credit	Open Space	1
2			Credit	Rainwater Management	3
		✓	Credit	Heat Island Reduction	2
1			Credit	Light Pollution Reduction	1

0	0	0	**Water Efficiency**		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
3			Credit	Indoor Water Use Reduction	6
		✓	Credit	Cooling Tower Water Use	2
1			Credit	Water Metering	1

0	0	0	**Energy and Atmosphere**		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
6			Credit	Enhanced Commissioning	6
7			Credit	Optimize Energy Performance	18
1			Credit	Advanced Energy Metering	1
2			Credit	Demand Response	2
3			Credit	Renewable Energy Production	3
		✓	Credit	Enhanced Refrigerant Management	1
		✓	Credit	Green Power and Carbon Offsets	2

0	0	0	**Materials and Resources**		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
		✓	Credit	Building Life-Cycle Impact Reduction	5
		✓	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		✓	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		✓	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2

0	0	0	**Indoor Environmental Quality**		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
2			Credit	Indoor Air Quality Assessment	2
		✓	Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
3			Credit	Daylight	3
1			Credit	Quality Views	1
		✓	Credit	Acoustic Performance	1

0	0	0	**Innovation**		6
1			Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

0	0	0	**Regional Priority**		4
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1
1			Credit	Regional Priority: Specific Credit	1

TOTALS Gold = 67 out of Possible Points: **110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

LEED-NC v3.0 Preliminary Project Checklist - Subject to Change

Exposition Transit Project
Colorado Avenue- 4th Street Station

2/5/15

Yes	?	No	RP	EP	POINTS			Owner	A/E	C
					22	**Sustainable Sites**	26 Points			
Y						Prereq 1	**Construction Activity Pollution Prevention**	Required		
Y					5	Credit 1	**Site Selection**	1	X	
Y					1	Credit 2	**Development Density & Community Connectivity**	5	X	
		N				Credit 3	**Brownfield Redevelopment**	1	X	
Y					6	Credit 4.1	**Alternative Transportation**, Public Transportation Access	6		X
Y					1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1		X
Y					3	Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	3		X
		N				Credit 4.4	**Alternative Transportation**, Parking Capacity	2		X
Y			RP		1	Credit 5.1	**Site Development,** Protect or Restore Habitat	1			X
		N	RP			Credit 5.2	**Site Development,** Maximize Open Space	1		X	
Y					1	Credit 6.1	**Stormwater Design,** Quantity Control	1		X	
Y					1	Credit 6.2	**Stormwater Design,** Quality Control	1		X	
		N			1	Credit 7.1	**Heat Island Effect,** Non-Roof	1		X	X
		N			1	Credit 7.2	**Heat Island Effect,** Roof	1		X	X
Y					1	Credit 8	**Light Pollution Reduction**	1		X	X
					9	**Water Efficiency**	10 Points			
Y						Prereq 1	**Water Use Reduction,** 20% Reduction	Required			
Y					3	Credit 1	**Water Efficient Landscaping**	2 to 4		X	X
Y			RP		2	Credit 2	**Innovative Wastewater Technologies**	2		X	X
Y			RP		2	Credit 3	**Water Use Reduction**	2 to 4		X	X
					19	**Energy & Atmosphere**	35 Points			
Y						Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required			
Y						Prereq 2	**Minimum Energy Performance**	Required			
Y						Prereq 3	**Fundamental Refrigerant Management**	Required			
Y					7	Credit 1	**Optimize Energy Performance**	1 to 19		X	
Y			RP	EP	7	Credit 2	**On-Site Renewable Energy**	1 to 7		X	
Y					2	Credit 3	**Enhanced Commissioning**	2		X	
		N				Credit 4	**Enhanced Refrigerant Management**	2		X	
Y					3	Credit 5	**Measurement & Verification**	3		X	
		N				Credit 6	**Green Power**	2	X	X	
					8	**Materials & Resources**	14 Points			
Y						Prereq 1	**Storage & Collection of Recyclables**	Required			
		N	RP			Credit 1.1	**Building Reuse,** Maintain Existing Walls, Floors & Roof	1 to 3			X
		N	RP			Credit 1.2	**Building Reuse,** Maintain 50% of Interior Non-Structural Elements	1			X
Y					2	Credit 2	**Construction Waste Management**	1 to 2			X
		N				Credit 3	**Materials Reuse**	1 to 2		X	X
Y					2	Credit 4	**Recycled Content**	1 to 2			X
Y					2	Credit 5	**Regional Materials**	1 to 2			X
Y					1	Credit 6	**Rapidly Renewable Materials**	1			X
Y					1	Credit 7	**Certified Wood**	1			X
					12	**Indoor Environmental Quality**	15 Points			
Y						Prereq 1	**Minimum IAQ Performance**	Required			
Y						Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required			
Y					1	Credit 1	**Outdoor Air Delivery Monitoring**	1		X	
		N				Credit 2	**Increased Ventilation**	1		X	
Y					1	Credit 3.1	**Construction IAQ Management Plan,** During Construction	1			X
Y					1	Credit 3.2	**Construction IAQ Management Plan,** Before Occupancy	1			X
Y					1	Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1		X	X
Y					1	Credit 4.2	**Low-Emitting Materials,** Paints & Coatings	1		X	X
Y					1	Credit 4.3	**Low-Emitting Materials,** Flooring Systems	1		X	X
Y					1	Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber Products	1		X	X
Y					1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1		X	
		N				Credit 6.1	**Controllability of Systems,** Lighting	1		X	
		N				Credit 6.2	**Controllability of Systems,** Thermal Comfort	1		X	
Y					1	Credit 7.1	**Thermal Comfort,** Design	1		X	
Y					1	Credit 7.2	**Thermal Comfort,** Verification	1			X
Y					1	Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1		X	
Y					1	Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1		X	
					2	**Innovation & Design Process**	6 Points			
Y					1	Credit 1.1	**Innovation in Design**: On- Site Renewable Energy	1		X	
		N				Credit 1.2	**Innovation in Design**: Provide Specific Title	1			
		N				Credit 1.3	**Innovation in Design**: Provide Specific Title	1			
		N				Credit 1.4	**Innovation in Design**: Provide Specific Title	1			
		N				Credit 1.5	**Innovation in Design**: Provide Specific Title	1			
Y					1	Credit 2	**LEED® Accredited Professional**	1			X
					4	**Regional Priority**	4 Points			
Y					1	Credit 1.1	**Regional Priority**: Site Development: Protect or Restore Habitat	1			X
Y					1	Credit 1.2	**Regional Priority**: Innovative Wastewater Technologies	1		X	X
Y					1	Credit 1.3	**Regional Priority**: Water Use Reduction	1		X	X
Y					1	Credit 1.4	**Regional Priority**: On-Site Renewable Energy	1		X	
					74	**Project Totals** (pre-certification estimates)	GOLD = 72 / 110 Points			

Certified 40-49 points **Silver** 50-59 points **Gold** 60-79 points **Platinum** 80-110 points

LEED Checklist

Enviro-Logic Construction

Problem One LEED 2009 vs LEED v4

Enviro-Logic Construction

Part 2: Materials Category

The major compliance difference between LEED 2009 and LEED v4 is the **Building Product Disclosure and Optimization**. With this, you must have an environment product declaration. You must have 20 different permanently installed products from five different manufactures, with publicly available product information. The main difference documentation difference is **Corporate Sustainability Reports** for 100% of products contributing toward credit. This means you must have documentation of what the products are made of, how they were made, and how far they traveled. LEED v4 seems to be more focused on the **materials supplied,** focusing on what is going inside the building where as LEED 2009 focuses on **materials reuse** through recycling and renewables.

Credit	LEED 2009	
	Pros	**Cons**
Building Reuse- Maintaining Existing Walls, Floors, and Roof	• Not taking extra space • Building footprint present	• Can't have more than two times the existing square footage • Might not be material desired • Might be hazardous material in need of remediation
Building Reuse- Interior	• Good because there isn't a fee for layout/design • Saving money on interior, like drywall, floor coverings, etc.	• Tough to attain if it's an older building because it most likely has hazardous materials inside • Rare for new construction • Typically not desirable material
Construction Waste Management	• Helps organize and keep site clean • Many times the materials are collected all together with no sorting required by individual recyclers, making it faster and easier for your company to recycle on-site.	• Must pay tipping fee • Need to be close to a place that will take all material or transportation may become too expensive • If sorting is not made easy, this may make costs rise
Material Reuse	• Easier if you're tearing down a building where the new one is going up • The cost savings in reuse need to be close or more than using new materials	• Such a small amount, it might not be worth the hassle of saving materials • Hard if you aren't tearing down a building or if there isn't a recycling place nearby • Materials have to be in good shape and non-hazardous in order to be reused • Tough to justify spending extra time saving these materials
Recycled Content	• Reduces impacts resulting from extraction and processing of virgin materials • Most materials have already adopted this, steel, drywall, insulation, etc.	• Sometimes they are more expensive, but typically not much compared to what you are already paying.
Regional Materials	• Cuts down on transportation costs • Promotes local business • Less delivery costs	• Might not be available in the region
Rapidly Renewable Materials	• To reduce finite resources • Also can count towards other credits, like regional materials	• Materials could be harvested to early resulting in unreliable products
Certified Wood	• Fairly common, making this product easy to get.	• Slightly more expensive than normal wood

Credit	LEED v4	
	Pros	**Cons**
Building Life-Cycle Impact Reduction	• Lower carbon footprint and environmental impact on the ecosystem • Corporate Sustainability Reports (CSR) encourage corporate use of responsibly sourced materials while creating documentation for companies to compare • Lower life-cycle costs	• Requires numerous calculations and a lot of documentation • Limited suppliers- more work •
Building Product Disclosure and Optimization- Environmental Product Declarations	• Materials are safe for occupants- low amounts of hazardous substances • No negative environmental impact • Known ingredients in materials- Manufacturers must document and disclose product information and therefore you are able to make better educated decisions	• Reporting and documentation are time consuming • Tracking throughout the whole Construction process can be difficult • Must acquire some information from manufacturers- may be hard to find feasible ones
Building Product Disclosure and Optimization- Sourcing of Raw Materials	• Promotes recycling and a healthy earth • Promotes a more sustainable site by restricting groundwater pollution • Minimizes owners cost and maximizes owners return through decreasing tipping fees and selling valuable materials	• Extensive planning and implementation • Access to site could be selective • Transportation for waste diversion could be limited based on location and technology
Building Product Disclosure and Optimization- Material Ingredients	• Lower costs and environmental impacts/effects • Energy use and other lifetime building impacts are known and calculated • More informed design decisions- better end result	• Cannot accurately measure human health, as well as other specific environmental factors • Building reuse is difficult if you're wanting to adhere to specific requirements • Time and money involved in software and labor to calculate values and lifetime building costs
Construction and Demolition Waste	• Information about product life-cycle impacts are known • Environmental impacts of products are known • Overall sustainable impact. Lower carbon footprint	• Tracking throughout construction can be difficult • Documentation is time consuming

In order to be compliant with the LEED v4 Rating System, additional factors are considered within the Materials and Resources category that aren't present in the LEED 2009 rating system. Specific compliances to satisfy the v4 rating systems that differ from the 2009 system are listed below.

Storage and Collection of Recyclables

- Materials such as batteries, mercury-containing lamps, and electronics must have dedicated storage.

A **Construction Waste Management Plan** is required.

Building Life Cycle Reduction

- Materials Reuse **can incorporate both structural and nonstructural elements as long as they are not counted twice.**

Building Product Disclosure and Optimization- Environmental Product Declarations

- Use at least 20 different permanently installed products sourced from at least five different manufacturers that have product-specific declarations with publically available information.
- Environmental Product Declarations must conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 standards, and must have at least a cradle to gate scope, and a USGBC approved program.
- Materials such as mechanical fixtures, fittings, and rough-in materials that are considered nonmotorized MEP components.

Building Product Disclosure and Optimization- Sourcing of Raw Materials

- Resource Reuse- Materials that are reused on-site are no longer required to be repurposed.
- Regional Materials- The 500-mile radius requirement is decreased to 100 miles
- Rapidly Renewable Materials- Biobased materials are no longer defined by the harvest cycle of the raw materials; instead, products must meet the Sustainable Agriculture Standard to count toward this credit.

Building Product Disclosure and Optimization -Material Ingredients

- Use at least 20 different permanently installed products from at least five different manufacturers to demonstrate the chemical inventory of the product to at least 0.1% Manufacturer Inventory, Health Product Declaration, Cradle to Cradle, etc.
- Must use products that document their material ingredient optimization for at least 25%, by cost, of the total value of permanently installed products in the project.

Construction and Demolition Waste Management

- Total project waste reduction per gross floor area of the project.
- Multiple material streams must be diverted to earn the credit for waste diversion
- ADC has been specifically excluded from diversion calculations.
- Waste-to-energy may count as a diversion method if the facility meets European Union requirements for waste management and emissions into air, soil, surface water, and groundwater.

With regard to the Materials and Resources Category, LEED v4 compared to LEED 2009 requires thorough documentation with respect to building products, material ingredients, supply chain optimization, chemical inventory, and the tracking of diverted waste. Listed below are the required documentations for specific credits in the v4 rating system that are different from LEED 2009:

Construction and Demolition Waste Management Planning (Prereq)

- Project target for waste management
- Reporting for waste diversion rates and total construction waste generated

Construction and Demolition Waste Management

- Tracking of total and diverted waste amounts and material streams
- Total Waste per area

Building Product Disclosure and Optimization- Environmental Product Declarations

- Life-cycle impacts of products with Environmental Product Declarations

Building Product Disclosure and Optimization- Sourcing of Raw Materials

- Manufacturers must provide product information about land use practices, extraction locations, labor practices, etc.
- Building product disclosure and optimization calculator or equivalent tracking tool
- Corporate Sustainability Reports for 100% of the products
- Documentation of product claims for credit requirements or other USGBC-approved program

Building Product Disclosure and Optimization- Material Ingredient Reporting

- Ingredient chemical inventory reporting in approved programs like Health Product Declaration, Cradle 2 Cradle, and others, verification of ingredient optimization through the approved programs
- Supply chain optimization and ingredient sourcing

Building Life-Cycle Impact Reduction

- Documentation of historic designation status
- Documentation of how additions and alterations (if any) meet local review board requirements
- Description of LCA assumptions, scope, and analysis process for baseline building and proposed building
- Life Cycle impact assessment summary showing outputs of proposed building with percentage change from baseline building for all impact indicators.

Due to the intricate documentation required before construction in the LEED v4 rating system, Enviro-Logic Construction believes that the LEED 2009 rating system is more feasible and would be more effective for this project allowing a higher point value for Gold Certification.

Part 3: Recommendation of Rating System

Based on the above analysis, the **LEED v3 Rating System** is recommended to be registered and complied with for the Colorado Avenue- 4th Street Exposition Transit Project. We believe that by applying this rating system instead of LEED v4, we can achieve a higher total point value and a Gold Certification level. In using the LEED v3 system, we aim for a final point value of 74 but understand that through the process, some credits that seem feasible now may become unattainable after construction begins. With that in mind, we feel that even with the loss of credits we can still maintain a Gold certification while still **meeting the Owner's requirements**. Although a Platinum certification may be achievable on this project with Exemplary Performance and an increase in Green Power, we believe that a Gold certification level is comfortably feasible.

To support our conclusion, the LEED v3 and v4 checklists are attached.

Problem Two
Life Cycle Sustainability Analysis

INTENT

This problem asks our team to analyze various lighting options and subcontractor bids in order to determine the most efficient methods of minimizing energy use and life cycle costs. Finding a balance between energy use and life cycle costs is a delicate and intricate process, so Enviro-Logic Construction strives to maximize that balance by carefully analyzing energy usage and costs, and meticulously reviewing subcontractor bids. Furthermore, the lighting analysis provides information relating to Energy and Atmosphere credits for LEED Certification.

PART 1: ANNUAL ENERGY USE OF EACH OPTION – 2 PTS

X-6A: 25W/1000 = .025kWh*24 hours*365 days = 219 kWh

X-6B: 32W/1000 = .032kWh*24 hours*365 days = 280.32 kWh

X-6C: 40W/1000 = .04kWh*24 hours*365 days = 350.4 kWh

X-6A Alternate: 17.7W/1000= .0177kWh*24 hours*365 days = 155 kWh

X-6B Alternate: 23.63W/1000 = .0236kWh*24 hours*365 days = 207 kWh

X-6C Alternate: 29.5W/1000= .0295kWh*24 hours*365 days = 285.42 kWh

Problem Two
Life Cycle Sustainability Analysis

Part 2: Life Cycle Costing
Part 3: Subcontractor Selection

PART 2: LIFE CYCLE ANALYSIS

Lighting Fixture LCA

LCC = First Cost(Including Construction & Design Fees) + Maintenance(PV) +Total Energy Cost(PV) + Replacement Cost(PV) - Salvage Value (PV)
*Using 4% inflation rate

FOY GROUP

	Fixture	# of Fixtures	Initial Cost per Fixture	Replacement Cost per Fixture	Yearly Energy Use	Avg. Yearly Energy Cost	Overhead (Maintenance)	Profit (Maintenance)	Salvage Value	Construction Fee	Design Fee	Lifecycle Costs	Lifecycle Cost - Initial Fixture Cost	Discounted Lifecycle Costs
Option 1	X-6A	64	$188	$125	219 kWh	$ 50.37	$5.04	$2.52	10%	12%	6%	$21,551.18	$9,519.18	$37,904.83
	X-6B	0	$213	$125	280.32 kWh	$ 64.47	$6.45	$3.26	10%			$0.00	$0.00	$0.00
	X-6C	144	$234	$125	350.4 kWh	$ 80.59	$8.06	$4.03	10%			$55,282.23	$21,586.23	$92,366.22
Option 2	X-6A Alternative	64	$298	$145	155 kWh	$ 35.65	$3.57	$1.79	10%			$30,271.78	$11,199.78	$49,511.82
	X-6B Alternative	0	$315	$145	207 kWh	$ 47.61	$4.76	$2.38	10%			$0.00	$0.00	$0.00
	X-6C Alternative	144	$388	$145	285.42 kWh	$ 65.65	$6.57	$3.30	10%			$81,947.32	$26,075.32	$126,741.85

*Maintenance costs for 7 years only (don't include warranty period)

Option 1: $130,271.05
Option 2: $176,253.67

MCKINSTRY

	Fixture		Initial Cost per Fixture	Replacement Cost per Fixture	Yearly Energy Use	Avg. Yearly Energy Cost	Overhead (Maintenance)	Profit (Maintenance)	Salvage Value	Construction Fee	Design Fee	Lifecycle Costs	Lifecycle Cost - Initial Fixture Cost	Discounted Lifecycle Costs
Option 1	X-6A	64	$194	$113	219 kWh	$ 50.37	Included	Included	10%	15%	10%	$22,014.10	$9,598.10	$38,490.40
	X-6B	0	$220	$113	280.32 kWh	$ 64.47	Included	Included	10%			$0.00	$0.00	$0
	X-6C	144	$241	$113	350.4 kWh	$ 80.59	Included	Included	10%			$56,987.52	$22,283.52	$95,268.69
Option 2	X-6A Alternative	64	$307	$113	155 kWh	$ 35.65	Included	Included	10%			$30,183.70	$10,535.70	$48,283.50
	X-6B Alternative	0	$325	$113	207 kWh	$ 47.61	Included	Included	10%			$0.00	$0.00	$0.00
	X-6C Alternative	144	$400	$113	285.42 kWh	$ 65.65	Included	Included	10%			$83,168.47	$25,568.47	$127,092.83

Option 1: $133,759.09
Option 2: $175,376.33

COCHRAN

	Fixture		Initial Cost per Fixture	Replacement Cost per Fixture	Yearly Energy Use	Avg. Yearly Energy Cost	Overhead (Change Order)	Profit (Change Order)	Salvage Value	Construction Fee	Design Fee	Lifecycle Costs	Lifecycle Cost - Initial Fixture Cost	Discounted Lifecycle Costs
Option 1	X-6A	64	$213	$125	219 kWh	$ 50.37	n/a	n/a	10%	13.50%	$2,500	$25,112.82	$11,480.82	$44,835.37
	X-6B	0	$242	$125	280.32 kWh	$ 64.47	n/a	n/a	10%		$2,500	$0.00	$0.00	$0.00
	X-6C	144	$52	$125	350.4 kWh	$ 80.59	n/a	n/a	10%		$2,500	$29,056.00	$21,568.00	$66,107.49
Option 2	X-6A Alternative	64	$338	$145	155 kWh	$ 35.65	n/a	n/a	10%		$2,500	$34,525.62	$12,893.62	$56,676.22
	X-6B Alternative	0	$358	$145	207 kWh	$ 47.61	n/a	n/a	10%		$2,500	$0.00	$0.00	$0.00
	X-6C Alternative	144	$388	$145	285.42 kWh	$ 65.65	n/a	n/a	10%		$2,500	$81,863.99	$25,991.99	$126,516.02

Option 1: $110,942.86
Option 2: $183,192.24

PART 3: SUBCONTRACTOR SELECTION

Based off the Life Cycle Analysis above, we would seek to buy out McKinstry as the Exposition Transit Project Lighting Subcontractor. After careful analysis, we determined that McKinstry provided the lowest total lifecycle cost for the LED alternate fixtures, and second lowest total lifecycle cost for the specified fixtures (X-6A, X-6B, X-6C).

As sustainable builders, we believe that providing low cost, energy efficient alternatives is paramount to facilitating an owner's sustainable project. Additionally, McKinstry included overhead and profit as a "lump sum" in the cost/fixture estimate, simplifying the bid selection process.

Enviro-Logic Construction

Problem Two
Life Cycle Sustainability Analysis

PART 4: INCENTIVES & REBATES

There are a number of incentives and rebates that will assist with the feasibility of the more energy efficient lighting technology. Both the State of California and the local municipality (City of Santa Monica) provide incentives for energy efficiency technology.
The State of California, for example, along with the City of Santa Monica, has a "Green Building Incentive Program" for LEED certified buildings that meet the required eligible efficiency standards. The City of Santa Monica allows for **priority plan check** processing for projects that are registered with the USGBC for LEED certification. By submitting proof of LEED registration and a checklist of all the credits planned to pursue, the city will **grant expedited permitting, saving time and money for the owner**. Applicants are required to clearly specify the materials, systems, and strategies they will use to achieve the credits in the plans submitted to the City for plan check approval.
Additionally, Los Angeles County offers a **"PACE Financing Program"** for projects using eligible efficiency technologies including lighting, lighting controls/sensors, and other **green technologies.** This program would allow the owner to finance energy and water efficiency projects, which are then repaid through a special assessment on the project's property taxes.

PART 5: INCENTIVES & REBATES

Based on the above analyses, our team recommends using the **LED alternative fixtures** for the Exposition Transit Project. While our lifecycle cost analysis shows that the LED alternatives **cost approximately 30% more** than the specified fixtures, we believe that the benefits of selecting the LED alternative fixtures **far outweigh that cost**.
As stated above, by selecting energy efficient fixtures, the owner qualifies for the City of Santa Monica's "Green Building Incentive Program" which grants expedited permitting for projects registered with the program. The time saved by permit expediting alone can outweigh the additional costs of the alternative LED fixtures.
Additionally, by selecting the LED alternative fixtures, the owner also qualifies for LA County's "PACE Financing Program," which provides financing opportunities that grant the owner the ability better leverage their debt, and further invest in their project while **minimizing their debt service ratio**.
Lastly, by choosing the LED fixtures, we **promote the owner's LEED Certification** initiative by minimizing energy use and enhancing energy performance, further qualifying Enviro-Logic Construction's proposed LEED scorecard for this project.

Enviro-Logic Construction

Problem Three
Concrete Carbon Footprint

INTENT

At Enviro-Logic Construction two of our main core values is Environment and Economics. With this in mind, our Intent is to analyze the Carbon Footprint of Concrete on the 4th Street/ Colorado Avenue Station along with the commute for the concrete pouring crew. In addition, our team realizes the importance of this analysis as it pertains to Materials and Resource Credits in the LEED V3 Scorecard and the Sourcing of raw materials in LEED Scorecard V4. Also Carbon Calculations pertain to Living Building Challenge certification

Part 1: Bid Comparison

1. Determine the Cubic Yards of Concrete needed for the 4th Street/Colorado Ave. Station:

Platform Footings	= 185.84 C.Y.
Platform Walls	= 141.56 C.Y.
Sidewalk Footings & Walls	= 31.04 C.Y.
TC & C Footings & Walls	= 47.15 C.Y
SOG @ Ramp	= 18.83 C.Y.
Double HSS & Landing Slab	= 7.16 C.Y.
TOS Structure	= 92 C.Y.
Subtotal of C.Y. of Concrete	= 523.58 C.Y
7 % Waste Factor	= 36.65 C.Y
Subtotal.	= 560.23 C.Y.
TOTAL C.Y OF CONCRETE	**= 561 C.Y.***

*We qualify that this total excludes all precast panels, concrete benches and concrete pavers.

2. Determine the Total Price of each Concrete Supplier and choose the lowest price. Based on May 4th, 2012 material pricing. Also we qualify that material will be ordered within 30 days from the price quoted and ordered during normal business hours. We also qualify that City Park Concrete will not be including a fuel surcharge per load.
    - **White Castle Concrete**
        - $64.00 / C.Y. for 4000psi 1" aggregate
        - $64.00 x 561 C.Y. = $35,904
        - $20 x 59 loads = $1180
        - **TOTAL = $37,084**
    - **Slip Diamond Ready Mix**
        - $73.500 / C.Y. for 4000psi 1" aggregate
        - $73.50 x 561 C.Y. = $41,233.50
        - Fuel Surcharge per load = $20
        - Number of Loads: #59
        - $20 x 59 = $1180
        - **TOTAL = $42,413.50**
    - **City Park Concrete**
        - $63.00 / C.Y. for 4000psi 1" aggregate
        - $63.00 x 561 C.Y. = $35,343
        - No Fuel Surcharge
        - **TOTAL = $35,343**

    Lowest Price Supplier = City Park Concrete
3. Determine the Carbon footprint of each supplier and which one has lowest footprint.
    - Include transportation of the cement, fly ash, and aggregate (source to batch plant) and concrete truck (plant to project).
    - We assume that the transportation carbon footprint was based of a direct route from supplier to batch plant for Fly-ash, Cement, and Aggregate. Also the transportation was done by a Semi Truck receiving an average of 6mpg. In addition, while calculating carbon footprint for the Concrete Transportation we based it off a Concrete truck average mile per gallon of 3.4. Also this is based on a trip from the batch plant to the job site plus a trip from the job site to the batch plant.

    White Castle Concrete
        - *Fly-ash (Headwaters Resources to Batch Plant)* = 340 miles
            - 40 miles / 6 mpg (avg. 18 wheeler gas mileage) = 56.67 gallons of diesel
            - 56.67 gallons of diesel x .0111 tons of CO_2 per gallon of diesel = .5497 tons of CO_2

Enviro-Logic Construction

- *Cement (La Mirada Cement (supplier to CEMEX) to Batch Plant)* = 25.1 miles
  - 25.1 miles / 6 mpg = 4.183 gallons of diesel
  - 4.183 gallons of diesel x .0111 tons of CO2 per gallon of diesel = .0464 tons of CO2
- *Aggregate (Polaris Minerals Corporation to Batch Plant)* = 1281 miles
  - 1281 miles / 6 mpg = 213.5 gallons of diesel
  - 213.5 gallons of diesel x .0111 tons of CO2 per gallon of diesel = 2.3699 tons of CO2
- *Concrete (Batch Plant to Site)* = 10.5 miles
  - 10.5 miles x 59 routes x 2 trips = 1239 miles
  - 1239 miles / 3.4mpg (avg. Concrete Truck mpg) = 364.4 gallons of diesel
  - 364.4 gallons of diesel x .0111 tons of CO2 per gallon of diesel = 4.04 Tons of CO2

White Castle Concrete : Total Carbon Footprint

4.04 + 2.3699+ .0464 = **6.4563 Tons of CO2**

Slip Diamond Ready Mix

- *Fly – ash (Salt River Materials Group Nevada Plant to Batch Plant)* = 400 miles

  400 miles / 6mpg = 66.67 gallons

  66.67 gallons x .0111 tons of CO2 per gallon of diesel =.74 tons of CO2
- *Cement (Standard Ready Mix to Batch Plant)* = 30.9 miles

  30.9 miles / 6 mpg = 5.15 gallons

  5.15 gallons x .0111 tons of CO2 per gallon of diesel = .0572 Tons of CO2
- *Aggregate (Saticoy Recycled to Batch Plant)* = 96.4 miles

  96.4 miles / 6 mpg = 16.06 gallons of diesel

  16.06 gallons x .0111 tons of CO2 per gallon of diesel = .1783 tons of CO2
- *Concrete (Slip Diamond Ready Mix to site)* = 51.4 miles

  51.4 miles x 59 routes x 2 trips = 6065.2 miles

  6065.2 / 3.4mpg = 1783.88 gallons of diesel

  1783.88 x .0111 tons of CO2 per gallons of diesel = 19.8 tons of CO2
- **Slip Diamond Ready Mix: Total Carbon Footprint**

  .74 + .0572 +.1783 + 19.8 **= 20.78 tons of CO2**

City Park Concrete

- *Fly – ash* = Mix does not specify fly ash.
- *Cement (Cal Portland Cement to Batch Plant)* = 50.4 miles

  50.4 miles / 6 mpg = 8.45 gallons

  8.45 gallons x .0111 tons of CO2 per gallon of diesel = .094 Tons of CO2
- *Aggregate (VULCAN Sun Valley Aggregates to Batch Plant)* = 24.7 miles

  24.7 miles / 6 mpg = 4.117 gallons of diesel

  4.117 gallons x .0111 tons of CO2 per gallon of diesel = .046 tons of CO2

- *Concrete (W. Los Angeles* batch plant to site)* = 3.7 miles

  3.7 miles x 59 routes x 2 trips = 436.6 miles

  436.6/ 3.4mpg = 128.41 gallons of diesel

  128.41 gallons x .0111 tons of CO2 per gallons of diesel = 1.43 tons of CO2

  We chose W. Los Angeles Batch plant due to proximity to the jobsite. We have realized in our calculations that the biggest Carbon Footprint impact is based on the diesel burned going from the batch plant to the jobsite.

City Park Concrete : Total Carbon Footprint

.094 + .046 + 1.43 **= 1.57 tons of CO2**

Lowest Carbon Footprint = City Park Concrete

4. Analyze the Bid comparison from number 2 to include CO2 emission ($40/ton) and recommend the best value supplier. We qualify that City Park Concrete will not charge a fuel surcharge and they will use their closes batch plant (W. Los Angeles)

White Castle Concrete

- $64.00 / C.Y. for 4000psi 1" aggregate
- $64.00 x 561 C.Y. = $35,904
- $20 x 59 = $1180
- CO2 emission surcharge = $40/ton * 6.456 tons = $258.24

TOTAL = $37,342.24

Slip Diamond Ready Mix

- $73.500 / C.Y. for 4000psi 1" aggregate
- $73.50 x 561 C.Y. = $41,233.50
- Fuel Surcharge per load = $20
- $20 x 59 = $1180
- CO2 emission surcharge = $40/ton * 20.78 tons = $831.20
- **TOTAL = $43,244.70**

City Park Concrete

- $63.00 / C.Y. for 4000psi 1" aggregate
- $63.00 x 561 C.Y. = $35,343
- No Fuel Surcharge
- CO2 emission surcharge = 40/ton * 1.57 tons = $62.80

TOTAL = $35,405.80

Best Value Supplier for Concrete including Carbon Footprint
= City Park Concrete

Part 2: Local vs. Out of Town Labor

1. Determine the carbon footprint of the crew for all concrete placements.
    - 11 concrete placements scheduled, Duration: 1 day, Crew : 4 laborers and 3 finishers, Transportation:2 workers (LA: 16 miles), 3 workers (Riverside: 70miles), 2 workers (Oceanside: 93 miles).
    - We qualify that workers cars will get 20 mpg and each worker is driving separately.
    - We also qualify that total trips include a trip to the jobsite and a trip home.

    LA Workers

    - 11 placements x 2 trips x 2 workers = 44 total trips
    - 44 trips x 16 miles = 704 total miles
    - 704 miles / 20 mpg = 35.2 gallons of gas
    - 35.2 gallons of gas x .008887 tons of CO_2 per gallon of gas = .31282 tons of CO_2

    Riverside Workers

    - 11 placements x 2 trips x 3 workers = 66 total trips
    - 66 trips x 70 miles = 4620 total miles
    - 4620 miles / 20 mpg = 231 gallons of gas
    - 231 gallons of gas x .008887 tons of CO_2 per gallon of gas = 2.05 tons of CO_2

    Oceanside Workers

    - 11 placements x 2 trips x 2 workers = 44 total trips
    - 44 trips x 93 miles = 4092 total miles
    - 4092 miles / 20 mpg = 204.6 gallons of gas
    - 204.6 gallons of gas x .008887 tons of CO2 per gallon of gas = 1.818 tons of CO_2

    Total Carbon Footprint of the Crew for all Placements =

    1.818 + 2.05 + .31282 = **4.18082 Tons of CO_2**

2. How many tons of CO2 could the carbon footprint be reduced if all laborers lived within 15 miles of the job?
    - We qualify that workers cars will get 20 mpg and each worker is driving separately.
    - We also qualify that total trips include a trip to the jobsite and a trip home.

    All Workers within 15 Miles

    - 11 placements x 2 trips x 7 workers = 154 total trips
    - 154 trips x 15 miles = 2310 total miles
    - 2310 miles / 20 mpg = 115.5 gallons of gas
    - 115.5 gallons of gas x .008887 tons of CO_2 per gallon of gas = 1.02645 tons of CO_2

    Total Carbon Reduced

    - 4.18082 tons of CO_2 – 1.02645 tons of CO_2 **= 3.15437 tons of CO_2 Saved**

3. Determine how many tons of CO2 could the carbon footprint be reduced if the out of town workers carpooled with each other?

We qualify that workers cars will get 20 mpg and each option includes different combinations for carpooling. We also qualify that total trips include a trip to the jobsite and a trip home.

Option 1: One carpool from Los Angeles (2 workers/car)

LA Workers Carpooling

- 11 placements x 2 trips = 22 total trips
- 22 trips x 16 miles = 352 total miles
- 352 miles / 20 mpg = 17.6 gallons of gas
- 17.6 gallons of gas x.008887 tons of CO_2 per gallon of gas = .1564 tons of $C0_2$

Riverside Workers = 2.05 tons of CO_2

Oceanside Workers = 1.818 tons of CO_2

Total Carbon Reduced

- .1564 + 2.05 + 1.818 = 4.024 tons of CO2
- 4.18082 Tons of CO2 – 4.024 tons of CO2 **= .1564 Tons of CO2 Reduced**

Option 2: One carpool from Oceanside (2 workers/car)

Oceanside Workers Carpooling

- 11 placements x 2 trips = 22 total trips
- 22 trips x 93 miles = 2046 total miles
- 2046 / 20 mpg = 102.3 gallons of gas
- 102.3 gallons of gas x .008887 tons of CO2 per gallon of gas = .909 tons of CO2

Riverside Workers = 2.05 tons of CO_2

Los Angeles Workers = .31282 tons of CO_2

Total Carbon Reduced

- .909 + .31282 + 2.05 = 3.2718 Tons of CO2
- 4.18082 tons of CO2 – 3.2718 Tons of CO2 **= .909 Tons of CO2 Reduced**

Option 3: One carpool from Riverside (3 workers/car)

Riverside Workers Carpooling

- 11 placements x 2 trips = 22 total trips
- 22 trips x 70 miles = 1540 miles
- 1540 miles / 20 mpg = 77 gallons of gas
- 77 gallons of gas x .008887 Tons of CO2 per gallon of gas = .6843 tons of CO2

Oceanside Workers = 1.818 tons of CO_2

Los Angeles Workers = .31282 tons of CO_2

Total Carbon Reduced

- .6483 + 1.818 + .31282 = 2.779 Tons of CO2
- 4.18082 tons of CO2 – 2.779 Tons of CO2 **= 1.401 Tons of CO2 Reduced**

Option 4: One Carpool from Los Angeles (2 workers/car) and one carpool from Oceanside (2 workers/car)

Los Angeles Workers Carpooling = .1564 tons of $C0_2$

Oceanside Workers Carpooling = .909 tons of CO2

Riverside Workers = 2.05 tons of CO_2

Total Carbon Reduced

- .1564 + .909 + 2.05 = 3.1154 Tons of CO2
- 4.18082 – 3.1154 Tons of CO2

= 1.0654 Tons of CO2 Reduced

Option 5 : One Carpool from Los Angeles (2 workers/car) and one carpool from Riverside (3 workers/car)

Los Angeles Workers Carpooling = .1564 tons of $C0_2$

Riverside Workers Carpooling = .6843 tons of CO2

Oceanside Workers = 1.818 tons of CO_2

Total Carbon Reduced

- .1564 + .6843 + 1.818 = 2.6587 Tons of CO2
- 4.18082 tons of CO2 – 2.6587 Tons of CO2

= 1.5221 Tons of CO2 Reduced

Option 6 : One Carpool from Oceanside (2 workers/car) and one carpool from Riverside (3 workers/car)

Oceanside Workers Carpooling = .909 tons of CO2

Riverside Workers Carpooling = .6843 tons of CO2

Los Angeles Workers = .31282 tons of CO_2

Total Carbon Reduced

.909 + .6843 + .31282 = 1.9061 Tons of CO2

4.18082 tons of CO2 – 1.9061 Tons of CO2

= 2.2747 Tons of CO2 Reduced

Option 7 : One Carpool from Los Angeles (2 workers/car), One carpool from Riverside (3 workers/car) and one carpool from Oceanside (2 workers/car)

Los Angeles Workers Carpooling = .1564 tons of $C0_2$

Riverside Workers Carpooling = .6843 tons of CO2

Oceanside Workers Carpooling = .909 tons of CO2

Total Carbon Reduced

- .909 + .6843 + .1564 = 1.7497 Tons of CO2
- 4.18082 tons of CO2 – 1.7497 Tons of CO2

= 2.4311 Tons of CO2 Reduced

Problem Four
Water Collection and Usage

Intent

At Enviro-Logic, we recognize that potable water is one of Earth's most sparse resources that we must work to conserve at every opportunity presented to us. With irrigation being the largest consumer of potable water, it is our goal to reduce the amount we use for this purpose. To do so, we intend to collect and store rain water in an underground concrete cistern to be used to irrigate the landscape areas at the 4th Street Station. This problem statement relates to LEED Water Efficiency Credits 1 & 2: Water Efficient Landscaping and Innovative Wastewater Technologies respectively.

Part 1: Irrigation Consumption

Based on the drawings given, irrigation is required for 7,933 Square Feet of landscaping, including areas to the North, North West, and South West of the station. According to City of Los Angeles Irrigation Guidelines, he project's Estimated Total Water Use is calculated using the following formula:

Where:

ETWU = Estimated Total Water Use (gallons per year)

ETo = Reference Evapotranspiration (inches per year)

PF = Plant Factor

HA= Hydrozone Area (square feet)

SLA = Special Landscape Area (square feet)

0.62 = Conversion Factor (to gallons per square feet)

IE = Irrigation Efficiency

According to City of Los Angeles Irrigation Guidelines, the Annual ETo for Santa Monica, CA is 44.2" and the average IE is 0.71. Incorporating this and given information and assuming there is no Special Landscape Area, the calculation is as follows:

ETWU = (44.2)(0.62)[(0.5 x 7,933)/(0.71) + 0] = **153,095.73 gallons/year**

Dividing this Annual Number by 12 Months:

153,095.73 gallons/12 Months

- **12,758 Gallons/Month**

Part 2: Rain Water Collection

In order to reduce potable water usage, Enviro-Logic proposes the installation of an 54,730 gallon cistern. This size cistern will allow the owner to irrigate the entire landscape without needing a supplemental water source. To calculate this number, we ran an Estimated Total Water Usage analysis (using the formula from Part 1) for the peak irrigation months of June, July and August. We view these months as the "dry period" for the city of Santa Monica due to very low levels of rainfall. According to U.S. Climate Data, these months average 0.04", 0.00" and 0.12" of rain respectively. With such little rainfall, the cistern would need to already contain enough water to fully irrigate the site during this time. The calculations are as follows:

- June: (5.0)(0.62)[(0.5x7933)/0.71)] = **17,319 gallons**
- July: (5.4)(0.62)[(0.5x7933)/0.71)] = **18,704 gallons**
- August: (5.4)(0.62)[(0.5x7933)/0.71)] = **18,704 gallons**
- **Total: 54,730 gallon cistern needed.**

We also calculated the expected catchable rainfall based on the roof-catchment area available for collecting rainfall and the rainfall available for use in Santa Monica, CA. According to U.S. Climate Data, Santa Monica, CA averages 13.23" of rainfall annually. Assuming that our project has 1,138.76 square feet of catchable roof space and our rain collection system will catch 80% of the rainfall, we can expect to catch 7,470.27 gallons off the roof annually.

- 13.23" x 80% = **10.58" Catchable Rainfall/sqft./Year**
- Converting to gallons: 10.58" x 0.62 = **6.56 Gallons/sqft./Year**
- 6.56 gallons/sqft/year x 1,138.76 = **7,470.27 Gallons Catchable/Year**

Based on these calculations, including annual and monthly rainfall data, we do not believe it is feasible to maintain irrigation without including a supplemental water source.

Part 3: Cistern

Bike Module "C" on the North end of the station provides the best space to place our underground, concrete cistern.

A) This area measures 33'-0" x 26'-0". In order to install the cast-in-place cistern, we need to excavate 12'-0" below the plaza precast pavers. Incorporating the required 1'-0" thick walls and 1'-0" thick top and bottom horizontal slabs, the finish dimensions would be **31'-0" x 24'-0" x 10'-0"**

Converting to cubic inches:

- 372" x 288" x 120" = **12,856,320 cu in.**

With 231 cu in. in 1 US Gallon:

- 12,856,320 cu in./231 cu in./gallon = **55,655.06 Gallon Cistern**

This calculation yields the total capacity of the cast-in-place cistern.

B) Using the Estimated Total Water Use from Part 1, the landscaping areas at the 4th Street Station require 153,095.73 Gallons/year. The cistern to be installed under Bike Module "C" is designed to hold 55,655.06 Gallons/year, as demonstrated in the preview calculations. To determine the supplemental water needed:

- 153,095.73-55,655.06 = **97,440.67 Gallons/year**

By month:

- 97,440.67/12 months = **8,120.10 Gallons of Supplemental Water Required by Month**

Problem Five
On-Site Renewable Energy

Intent

Enviro-logic understands the importance of on-site renewable energy, with that being said we have calculated the amount of solar panels needed on this project to obtain 8% renewable energy and net zero energy. Our company has also looked into alternative renewable energy options in addition to solar panels, and recommend what we believe is to be the best option. The On-site renewable energy analysis relates to the Energy and Atmosphere credits of the LEED certification.

Part 1: Solar Panel Design

1) Quantity of Panels Required - See attached calculation sheet #1
    a. Sunmodule Plus SW275 Mono: 1**5 Panels**
    b. Sunpower X32-345: **12 Panels**
    c. Grape Solar GS-Start-10W: **39 Panels**
    d. See Attachment 1 for the marked-up drawings showing the solar panel
2) The solar panel that provides the best value to the customer is the **Sunpower X21-345** model the total cost for these panel would come to **$5,580**. Enviro-logic believes this would be the best choice for the project seeing that it is the cheapest option, but also there is less panels leading to lower maintenance cost in the long run.
    a. Sunpower: 12 panels x $465/panel = **$5,580**
    b. Sunmodule Plus: 15 panels x $450/panel = **$6,750**
    c. Grape Solar- 39 Panels x $150/panel= **$5,850**
3) Optimal Orientation
    a. Direction of solar Panels:
        i. The solar panels should face **true south** since we are in the northern hemisphere.
    b. Magnetic Declination
        i. The magnetic declination for the project according to the National Geophysical Data Center is **12.28°E**
    c. Two Optimal adjustment dates and optimal panel angle for each period
        i. Two Optimal adjustment dates to change the tilt of solar panels are **March 30th** for the summer and **September 12th** for the winter.
            1. Tilt Angle for Summer (Renewable Energy Concepts):
                a. (34.01348° x .(92)-24.3°)**= 7°**
            2. Tilt Angle for Winter (Renewable Energy Concepts):
                a. (34.01348° x (.89)+24) = **54.272°**

Part 2: Additional Renewable Energy – Options to Net Zero

Enviro-Logic has chosen the **Sunpower X21-345** to meet the owner's requirements for achieving a Net Zero Energy building. With this panel **141 panels** would need to be installed. (If the owner wishes to achieve the requirements of the Living Building Challenge Energy Petal 148 panels would be needed to achieve the 105%) – see attached calculation sheet #2

Cost Analysis

i. The total cost of the system is $286,254, Enviro-logic is assuming an interest rate of 10% with monthly payments of $3,782.86 and a 10 year loan period the solar panel system would cost **$774,899.89**.

1. Recovery Period: $774,899.89/$2,000= **387 years**
    a. Energy Cost: $1.75/sf x 1,1387sf= $2000

Cost of Net Zero Option

a.	Sunpower X21-345 Cost: 141 Panels * $465/panel	$65,565
b.	Ancillary Cost	$220689
	Total Cost	**$286254**

i. 150 feet of 4" Conduit with 3-1000kcm Wire	$6,000
ii. DC-to-AC inverter- $0.50/watt * (221,379 watts)	$110,689
iii. Disconnect Switch	$2,000
iv. 1000 Amp Breaker	$10,000
v. Digital Readout Panel	$2,000
vi. Back-up Battery	$45,000
vii. Charge Controller	$20,000
viii. Transfer Switch	$15,000
ix. Accessories 1	$10,000

3) Maintenance cost of a system
   a. The maintenance of solar panel systems with batteries are relatively low, Enviro-Logic estimated that over the 10 year life cycle cost that the maintenance cost will be roughly 10% of the initial cost which will equate to **$61,000 over the 10 years**. We will be implementing a building automotive system on this project, according to EMS energy limited a **BAS system** will cost roughly **$25,000**.

Part 3: Alternative Renewable Energy Sources

1) Provide Rational for selection or rejecting the provided alternative

a. Biofuel-based electrical system:

According to the Sacramento Business Journal, California leads the country with biofuel companies, the state has a total of 30 advanced biofuel companies, with this being said Enviro-logic believes this would be the **most viable alternative renewable energy source** for the project. With so many companies using this technology in California already it will not be a first which means there is many available resources to help the project make this happen. The project can use a variety of materials to create energy ranging from wood, to grain to animal waste this process helps reduce the waste in the country by turning one person's waste into another one's energy.

b. Geothermal energy systems:

According to the California Energy Commission, and a known geothermal resource area map on their website, the area where the rail system is located (Santa Monica) has not been known to be capable for producing geothermal energy. With this being said Enviro-logic does not believe this would be a viable option.

c. Hydroelectric power systems:

Seeing that the small site that has been leased to the project is not on the water at Envrio-logic we believe that this is not a feasible option to provide the building with renewable energy.

d. Micro wind turbines:

Santa Monica has an average wind speed of 7mph in the spring and around 5mph in the fall according to the National Weather Center. An average micro wind turbine requires around 6-9mph (YouGen- Energy made easy) of wind speed consistently to produce power, with this being said we believe that Micro-wind turbines is not a viable option for this project.

Calculation Sheet #2

Solar Panel Quanity Calculator

Sunpower Model

Panel Information	Quanity	Units
Panel Size	17.56323	SF
Rated Watt Per Panel	0.345	KW
Performace Factor	0.75	
Actual Watts/panel	0.25875	KW
Average Solar Radiation	6.1	sunhours/day
Total From Panel	1.578375	KWh/day

Building Energy Use		
C/S Building Energy Use	70	KWh/sqft/yr
Per day	0.191781	KWh/sqft/day
Square Foot of ProposedBuilding	704	
Total C/S Energy	135.0137	KWh/day
TOS Building Energy Use	131.2	Kwh/day
Per day	0.359452	KWh/sqft/day
Square Foot of ProposedBuilding	434.76	sf
Total TOS Energy	156.2754	
Estimate Energy	291.2891	KWh/day
LEED Reduction (based on 7 point LEED - 24%)	69.90938	KWh/day
Total Energy	221.3797	KWh/day

Solar Panel Energy Needed		
% of energy needed	1	
Total Solar Needed	221.3797	KWh/Day
Total Panels Needed	140.258	Panels

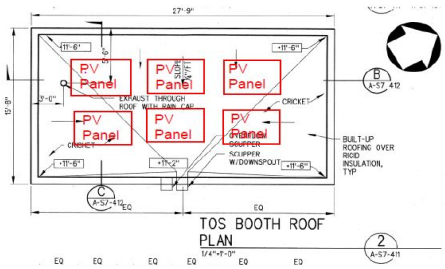
Feasible		
Total SF Needed	2463.383	SF
Total Roof SF	1138.76	SF
Roof Reduction	0.4	%
Total Available Roof	683.256	SF
Feasible?	-1780.13	

Overview		
	Quanity	Units
Number of Panels Needed	141	Panels
Toal Energy Produced by Panels	221.3797	KWh/day
Feasible based on size	Yes	

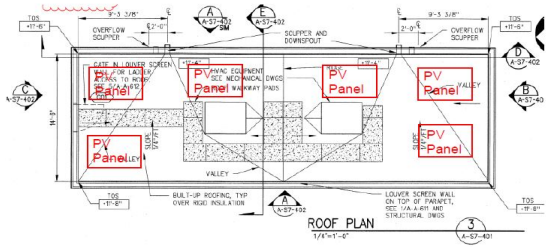
Cost for total System 65565

Attachment 1

TOS Booth Roof Plan:



C/S Building Roof Plan:



Calculation Sheet #1

Solar Panel Quanity Calculator

(The Performance effiency is alreasy calculated into the Watts per panel)

Sunmodule

Panel Information	Quanity	Units
Panel Size	18.04558	SF
Rated Watt Per Panel	0.275	KW
Performance Factor	0.75	
Actual Watts/panel	0.20625	KW
Average Solar Radiation	6.1	sunhours/day
Total From Panel	1.258125	KWh/day

Building Energy Use		
C/S Building Energy Use	70	KWh/sqft/yr
Per day	0.191781	KWh/sqft/day
Square Foot of ProposedBuilding	704	
Total C/S Energy	135.0137	KWh/day
TOS Building Energy Use	131.2	
Per day	0.359452	
Square Foot of ProposedBuilding	434.76	sf
Total TOS Energy	156.2754	
Estimate Energy	291.2891	KWh/day
LEED Reduction (based on 7 point LEED - 24%)	69.90938	KWh/day
Total Energy	221.3797	KWh/day

Solar Panel Energy Needed		
% of energy needed	0.08	
Total Solar Needed	17.71038	KWh/Day
Total Panels Needed	14.0768	Panels

Feasible		
Total SF Needed	254.024	SF
Total Roof SF	1138.76	SF
Roof Reduction	0.4	%
Total Available Roof	683.256	SF
Feasible?	429.232	

Overview		
	Quanity	Units
Number of Panels Needed	15	Panels
Toal Energy Produced by Panels	17.71038	KWh/day
Feasible based on size	Yes	

Cost for total System 6750

Grape Solar

Panel Information	Quanity	Units
Panel Size	7.361625	SF
Rated Watt Per Panel	0.1	KW
Performance Factor	0.75	
Actual Watts/panel	0.075	KW
Average Solar Radiation	6.1	sunhours/day
Total From Panel	0.4575	KWh/day

Building Energy Use		
C/S Building Energy Use	70	KWh/sqft/yr
Per day	0.191781	KWh/sqft/day
Square Foot of ProposedBuilding	704	
Total C/S Energy	135.0137	KWh/day
TOS Building Energy Use	131.2	KWh/yr
Per day	0.359452	KWh/day
Square Foot of ProposedBuilding	434.76	sf
Total TOS Energy	156.2754	KWh/day
Estimate Energy	291.2891	KWh/day
LEED Reduction (based on 7 point LEED - 24%)	69.90938	KWh/day
Total Energy	221.3797	KWh/day

Solar Panel Energy Needed		
% of energy needed	0.08	
Total Solar Needed	17.71038	KWh/Day
Total Panels Needed	38.7112	Panels

Feasible		
Total SF Needed	284.9774	SF
Total Roof SF	1138.76	SF
Roof Reduction	0.4	%
Total Available Roof	683.256	SF
Feasible?	398.2786	

Overview		
	Quanity	Units
Number of Panels Needed	39	Panels
Toal Energy Produced by Pane	17.71038	KWh/day
Feasible based on roof size	Yes	

Cost for total System 5850

Sunpower Model

Panel Information	Quanity	Units
Panel Size	17.563	SF
Rated Watt Per Panel	0.345	KW
Performance Factor	0.75	
Actual Watts/panel	0.2588	KW
Average Solar Radiation	6.1	sunhours/day
Total From Panel	1.5784	KWh/day

Building Energy Use		
C/S Building Energy Use	70	KWh/sqft/yr
Per day	0.1918	KWh/sqft/day
Square Foot of ProposedBuilding	704	
Total C/S Energy	135.01	KWh/day
TOS Building Energy Use	131.2	Kwh/day
Per day	0.3595	KWh/sqft/day
Square Foot of ProposedBuilding	434.76	sf
Total TOS Energy	156.28	
Estimate Energy	291.29	KWh/day
LEED Reduction (based on 7 point LEED - 24%)	69.909	KWh/day
Total Energy	221.38	KWh/day

Solar Panel Energy Needed		
% of energy needed	0.08	
Total Solar Needed	17.71	KWh/Day
Total Panels Needed	11.221	Panels

Feasible		
Total SF Needed	197.07	SF
Total Roof SF	1138.8	SF
Roof Reduction	0.4	%
Total Available Roof	683.26	SF
Feasible?	486.19	

Overview		
	Quanity	Units
Number of Panels Needed	12	Panels
Toal Energy Produced by Panels	17.71	KWh/day
Feasible based on size	Yes	

Cost for total System 5580

Calculations

Enviro-Logic Construction

Safety

Safety Within the Fence

As we partner with Skanska, we plan to maintain our goal to create an **injury-free environment**. We believe that a project is not successful if we do not meet this injury-free standard. We go above and beyond the average safety regulations to ensure a safe work environment. We believe that with **proper training** to all of our workers and subcontractors we can greatly decrease the number on-site injuries. With this, we take time before each job to thoroughly train our staff. Each morning we go over our safety goals for that specific day and ensure everyone has on the **proper protective equipment** before they step out on to the jobsite. We pride ourselves with **zero OSHA violations** in our company and we work hard every day to keep that prestige.
As we partner with Skanska we understand the importance of a meeting of minds involving many aspects of business, but especially safety, we admire Skanksa's safety policy and plan to work together to create an injury-free workplace.

Safety Beyond the Fence

We understand the effect we have on the day-to-day lives of our **community** and we plan to minimize this effect as little as possible. Our goal is to create an **accident-free zone** outside of the fence. We will do what ever possible to ensure our workers, suppliers, and community are not effected by all of our commotion as we build our next project. We add fences, put up signs, and control all **traffic management**. Safety for us goes beyond the workday, we worry about how workers get to and from the site, we worry about the site being locked at night, and we worry about all equipment being properly stored. We realize we cannot pick our location to build, but it is our job to protect the community we are adding to. Safety is more than just a requirement at Enviro-Logic, it is **our way of life**.