IPRO It takes a team!
INTERPROFESSIONAL PROJECTS PROGRAM

IPRO 307 - Final Report

Students:

Raquel Alvarez
Panagiotis Bakos
Sarah Guan
Jaeha Jun
Miry Kim
Anna Kutryn
Cheryl Mcdermott
Lorenzo Perez
Yoshio Piediscalzi
Matthew Pirkle
Igor Seryapin
Erin Skvorc
Stephanie Soltesz
Nerijus Steponavicius
Philip Theisen
Bryan Woods
Jay You
Mourad Zgourdah

ILLINOIS INSTITUTE OF TECHNOLOGY

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GOALS

- To design an intermodal facility utilizing the ATMS system with capability of supporting high-speed freight rail

- To plan parallel transportation enhancements in the Kankakee area

- Unlike past projects, develop a wholly “new” kind of facility

Kankakee County is located in central Illinois. The current population of Kankakee County is 113,449 people with 60% of the population residing in Bourbonnais and Kankakee townships. Kankakee County has the 18th largest population in the state. The county has a total area of 677 square miles which is ranked 28th in the state out of 102 counties.

Kankakee County's 10 top employers are as follows:

- Riverside Medical Center
- Shapiro Developmental Center
- Northfield Square Mall
- Provena St. Mary's Hospital
- Cigna Healthcare
- Baker & Taylor (Publisher)
- CSL Behring L.L.C (Medical)
- Kankakee Community College
- Olivet Nazarene University
- Sears Logistics Services, Inc

Three railroads pass through Kankakee County which are shown below:

Norfolk Southern Railroad

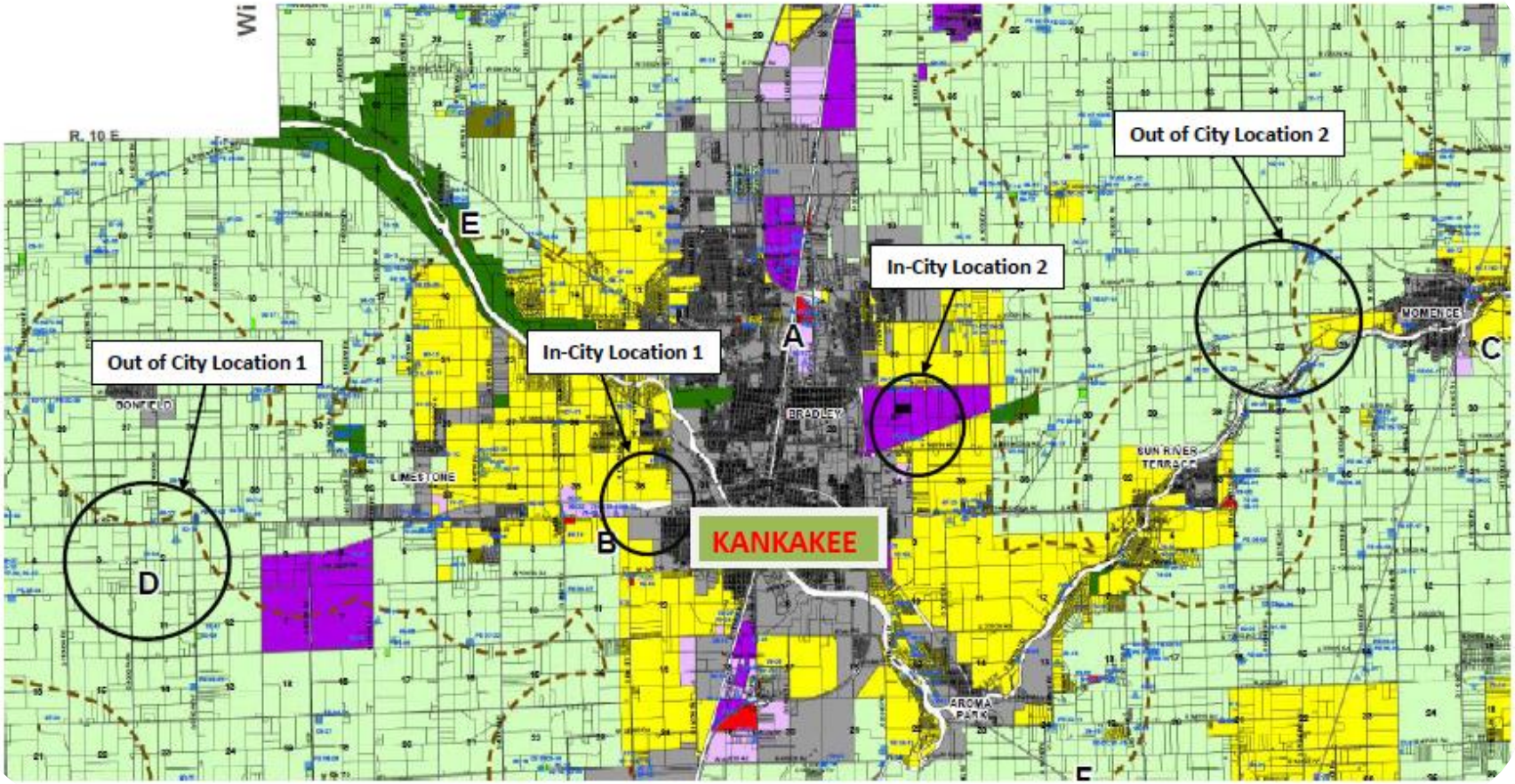
Canadian National Railroad

Union Pacific Railroad

Kankakee Beaver and Southern

Interstate 57

Possible locations for Intermodal facility



- There were 4 sites that were chosen as possible locations for the Intermodal Facility:
  - 2 In-City Locations
  - 2 Out-of-City Locations

Criteria for In-City Location

- Located in Kankakee, Il
- Requires total of 90 Acres
- Would only contain the Intermodal Facility
- Have to locate sites with Industrial Zoning
- Minimize Impact with residential areas
- Would be located approximately 30 miles from I-55 and I-65

In-city Location 1

- Currently a small NS storage yard
- Would have to purchase 45 acres of additional land
- Will accommodate for a 5000 ft ATMS

In-city Location 2

- Currently used for agriculture purposes
- Zoned for Industrial

- Will accommodate for 8000 ft ATMS
- Located on NS Railroad

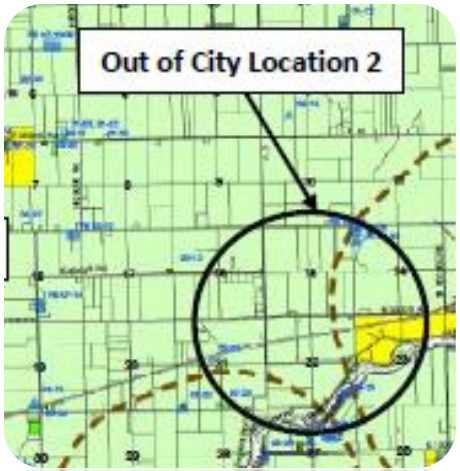
Criteria for Out-of-City Location

- Requires a total of 3,500 acres
  - Compared to UP facility North of Joliet
- Close to Kankakee, Il
- Would contain the following:
  - Intermodal Facility
  - Residential Area
  - Industrial Area (Warehouses)
    - 20 One million sq ft facilities
- Would require the rezoning of Agricultural Zone to Industrial, Commercial, and Residential Zones
  - This is a planned urban development

Out of City Location 1

- South of Bonfield, IL
- 44 Miles from Roselawn, IN (I-65)
- 13 Miles from Kankakee (I-57)
- 17 Miles from Dwight (I-55)
- Located on NS Railroad

Out of City Location 2



- West of Momence, Il
- 22 Miles from Roselawn, IN (I-65)
- 11 Miles from Kankakee, Il (I-57)
- 43 Miles from Dwight, Il (I-55)
- Located on NS Railroad

REZONING PROCESS FOR KANKAKEE COUNTY

APPLICATION

BASE FEE: $600
PER ACRE: 0-50 $30 PER ACRE
51-100 $20 PER ACRE
101+ $10 PER ACRE
3500 ACRE SITE
$600 + $10 * 3500 = $35,600

INCLUDES

NATURAL RESOURCE INVENTORY

LAND EVALUATION & SITE ASSESSMENT
BASE FEE: $400 FOR 0-5 ACRES
$15 FOR EACH ADDITIONAL ACRE
$400 + $15 * 3495 = $52,825

ECOCAT

ECOLOGICAL COMPLIANCE ASSESSMENT TOOL
TO DETERMINE IF PROPOSED ACTION IS IN THE
VICINITY OF ANY PROTECTED NATURAL RESOURCES
FREE OF CHARGE

APPLICATION CHECKLIST

SITE/PLOT PLAN
PLAT OF SURVEY/FLOODPLAIN SURVEY
AERIAL PHOTOGRAPH
NATURAL RESOURCE INVENTORY
ECOCAT REPORT
ATTORNEY RECOMMENDED

APPROXIMATE TOTAL COST = $100,000
COST PER ACRE = $28

REZONING PROCESS FOR WILL COUNTY

APPLICATION	NATURAL RESOURCE INVENTORY
3500 ACRE SITE $15,325 + $15 * 3000 = $60,325	$400 + $15 * 3495 = $52,825

APPROXIMATE TOTAL COST = $125,000
COST PER ACRE = $35

REZONING PROCESS FOR LAKE COUNTY, IN

APPLICATION	NATURAL RESOURCE INVENTORY
3500 ACRE SITE $400 + $25 * 3500 = $87,900	$400 + $15 * 3495 = $52,825

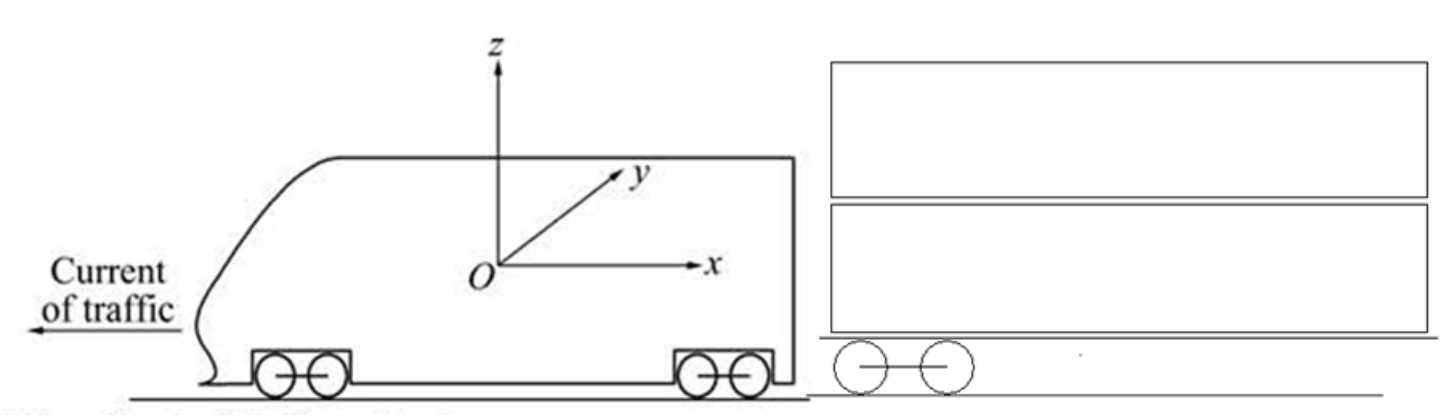
APPROXIMATE TOTAL COST = $150,000
COST PER ACRE = $42

COUNTY	COST/ACRE
KANKAKEE	$28
WILL	$35
LAKE, IN	$42

Aerodynamic Drag of a High Speed Freight Train

Problem

- What is the drag force of a high speed freight train at 60 and 90 mph?
- Two trains; 8000 and 10000 ft long, each hauling double stacked containers
- What is the coupler force between cars?



Analysis

$$F_{drag} = \frac{1}{2}\rho S_x C_x v_t^2$$

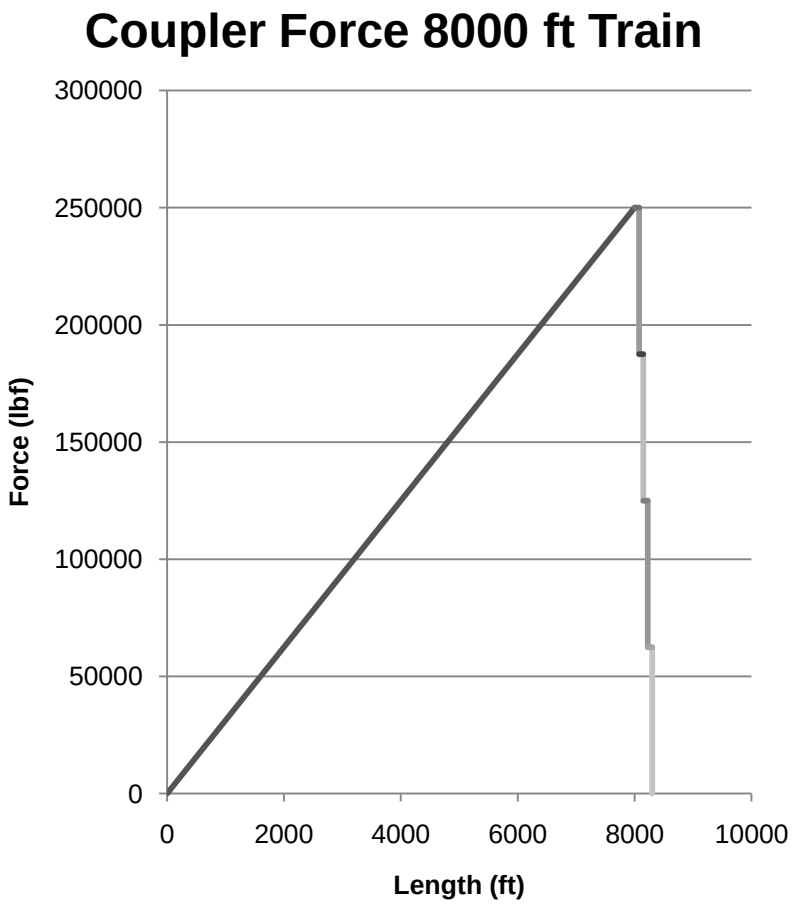
$$C_x = C_{xt} + \sum_{1}^{n} C_{xz}(i) + C_{xw}$$

$$R = (1.3wn + 29n) + bwnV + CAV^2 + 20wnG$$

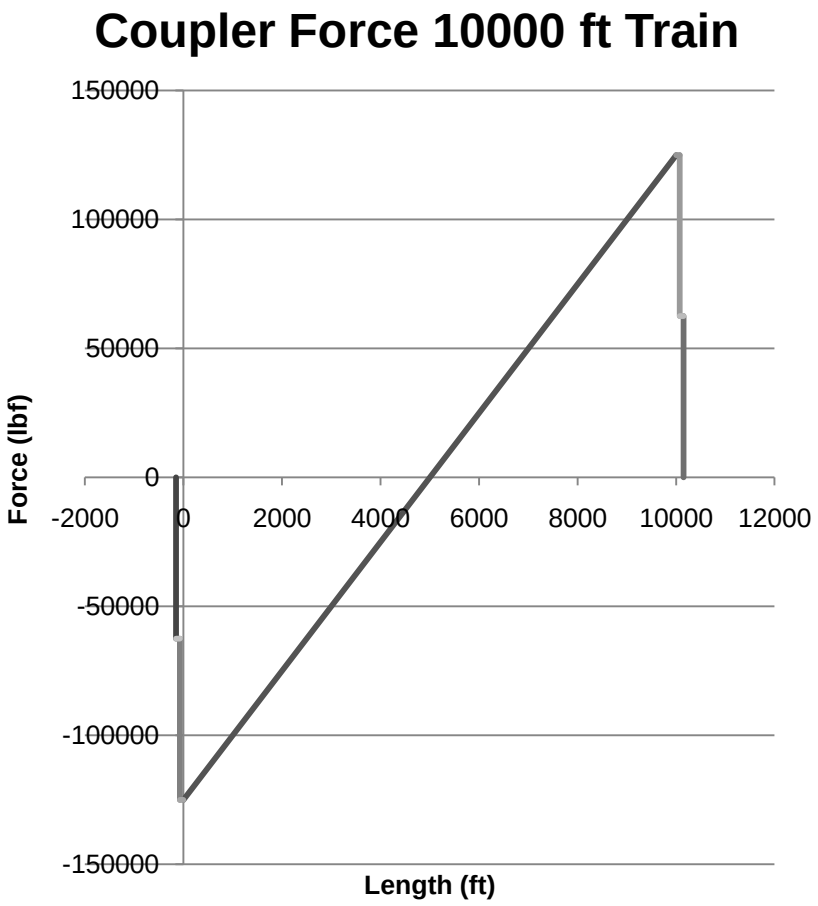
Results

	Velocity (mph)	Aero Drag (lbf)	Total Drag (lbf)	Total Drag (.84% Grade) (lbf)	Total Weight of Train (lbf)
8000 ft Train	60	116,820	34,459,132	465,883,132	55,440,000
	90	262,845	34,891,132	466,315,132	
10000 ft Train	60	145,165	42,571,132	578,827,886	65,840,000
	90	326,622	43,003,132	579,259,886	

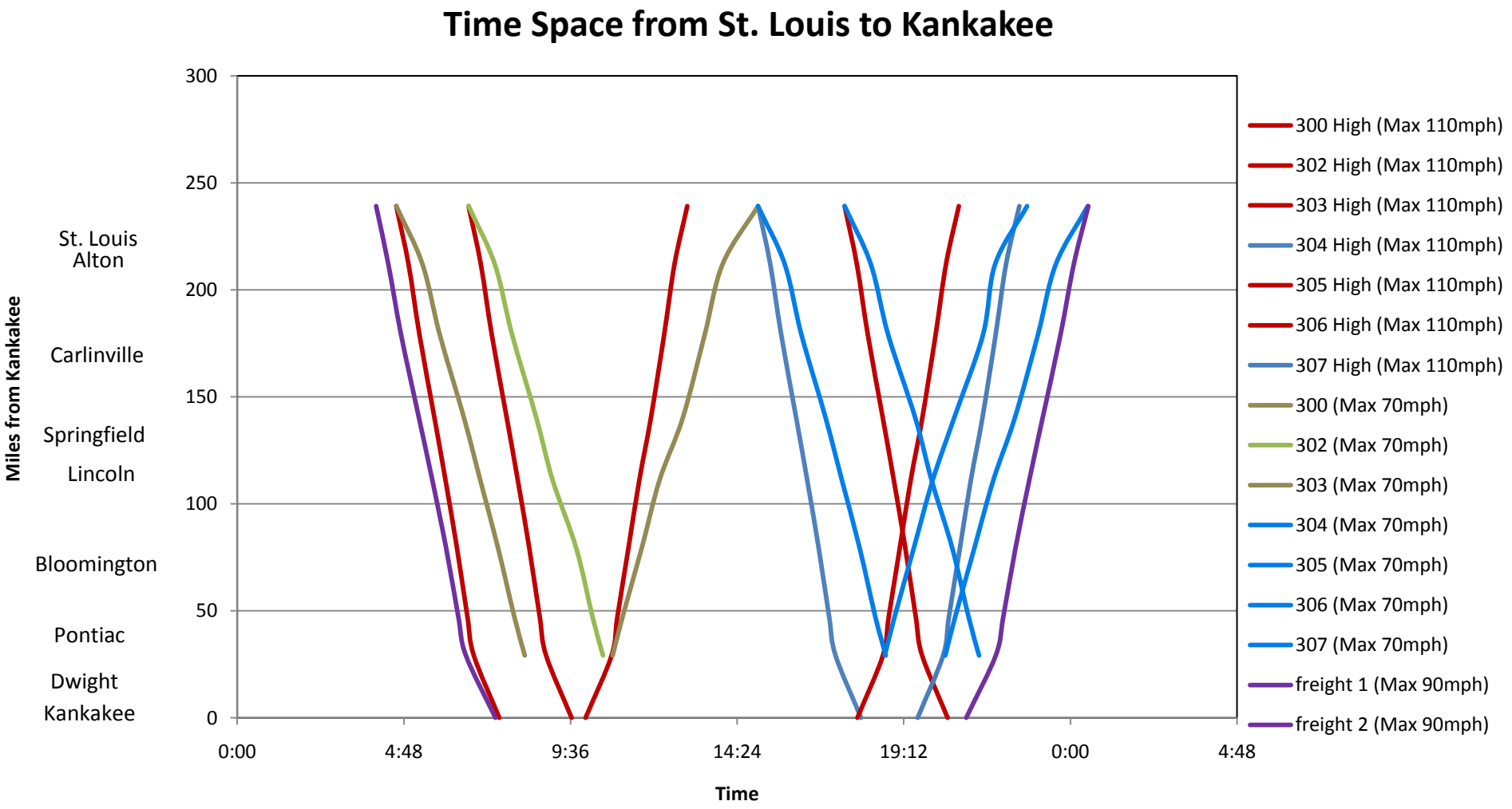
Coupler Force



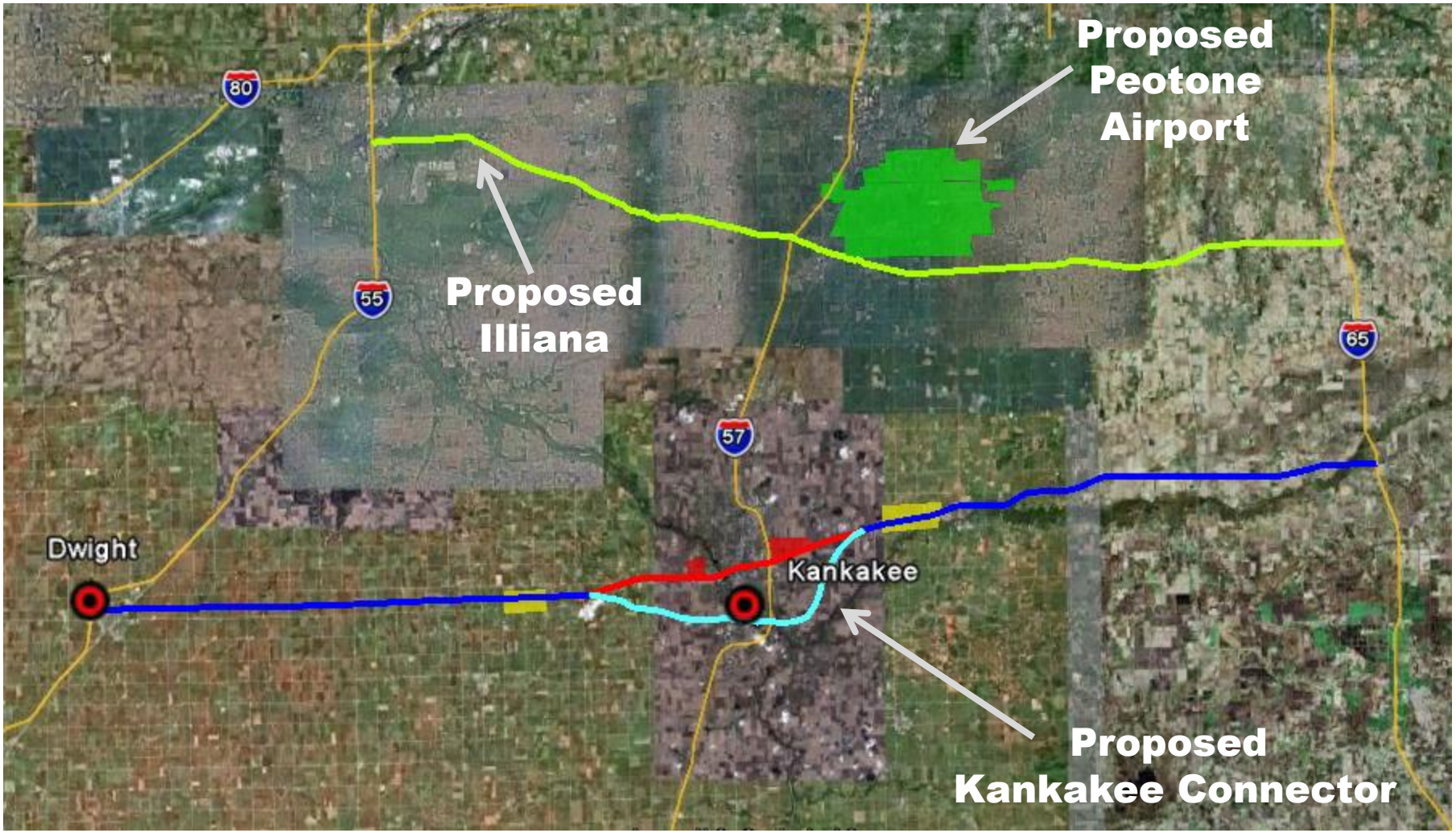
Enclosed Area: 1,046,875,000 lbf·ft



Enclosed Area: 648,437,500 lbf·ft


Time Space from St. Louis to Kankakee
Miles from Kankakee
300
250
200
150
100
50
0
St. Louis
Alton
Carlinville
Springfield
Lincoln
Bloomington
Pontiac
Dwight
Kankakee
0:00
4:48
9:36
14:24
19:12
0:00
4:48
Time
300 High (Max 110mph)
302 High (Max 110mph)
303 High (Max 110mph)
304 High (Max 110mph)
305 High (Max 110mph)
306 High (Max 110mph)
307 High (Max 110mph)
300 (Max 70mph)
302 (Max 70mph)
303 (Max 70mph)
304 (Max 70mph)
305 (Max 70mph)
306 (Max 70mph)
307 (Max 70mph)
freight 1 (Max 90mph)
freight 2 (Max 90mph)

Kankakee Connector



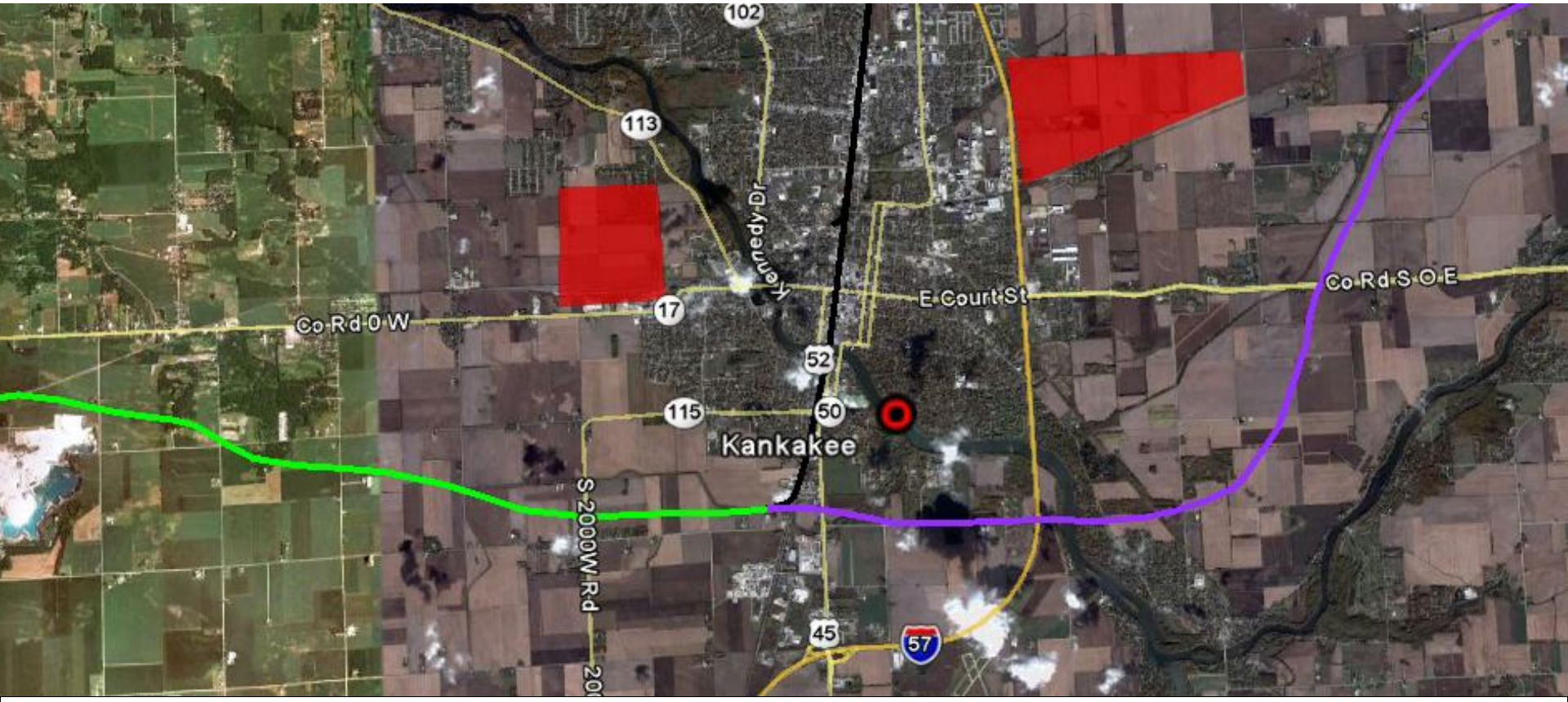
Kankakee Connector Layout Options

Option 1

- 13.3 miles
- Runs along the NS track
- In-city facilities located extremely close

- Approx. 16.4 miles south of proposed Illiana Expwy (on I-57)

Option 2



- 15.5 miles
- Runs outside of Kankakee

- Approx. 19.2 miles south of proposed Illiana Expwy (on I-57)

Option 1 Exits

- Illinois 17
  - 1.6 miles (from start of option)
- I-57
  - 8.8 miles (7.2 miles exit-to-exit)
- County Highway 54
  - 12.2 miles (3.4 mi exit-to-exit)

Option 2 Exits

- Illinois 115
  - 4.9 miles (from start of option)
- US 45/52
  - 6.9 miles (2.0 mi exit-to-exit)
- I-57
  - 8.8 miles (1.8 mi exit-to-exit)
- Illinois 17
  - 12.4 miles (3.6 mi exit-to-exit)

Comparison

Option 1	Option 2
• Length of 13.3 miles	• Length of 15.5 miles
• Runs through Kankakee	• Runs outside of Kankakee (to the south)
• Runs on along existing NS track	• Necessary acquisition of land (approx. 659 acres)
• 16.4 miles south of Illiana	• 19.2 miles south of Illiana
• 3 possible exits	• 4 possible exits

Area needed for length of Roadway

$$15.5\ miles * \frac{5280\ ft}{1\ mile} * 200\ ft = 16{,}368{,}000\ ft^2 = 375.75\ acres$$

*15.5 mile long segment; 200 ft wide R.O.W

Additional area needed for interchanges

$$4(2400\ ft - 200\ ft)(1400\ ft) = 12{,}320{,}000\ ft^2 = 282.8\ acres$$

*4 interchanges; 1400 ft long; 2200 ft wide (outside the road R.O.W)

RECOMMENDED
Combination of Option 1 & 2

3 level (Hi-speed, Freight, Highway)

2 level (Freight, Highway)

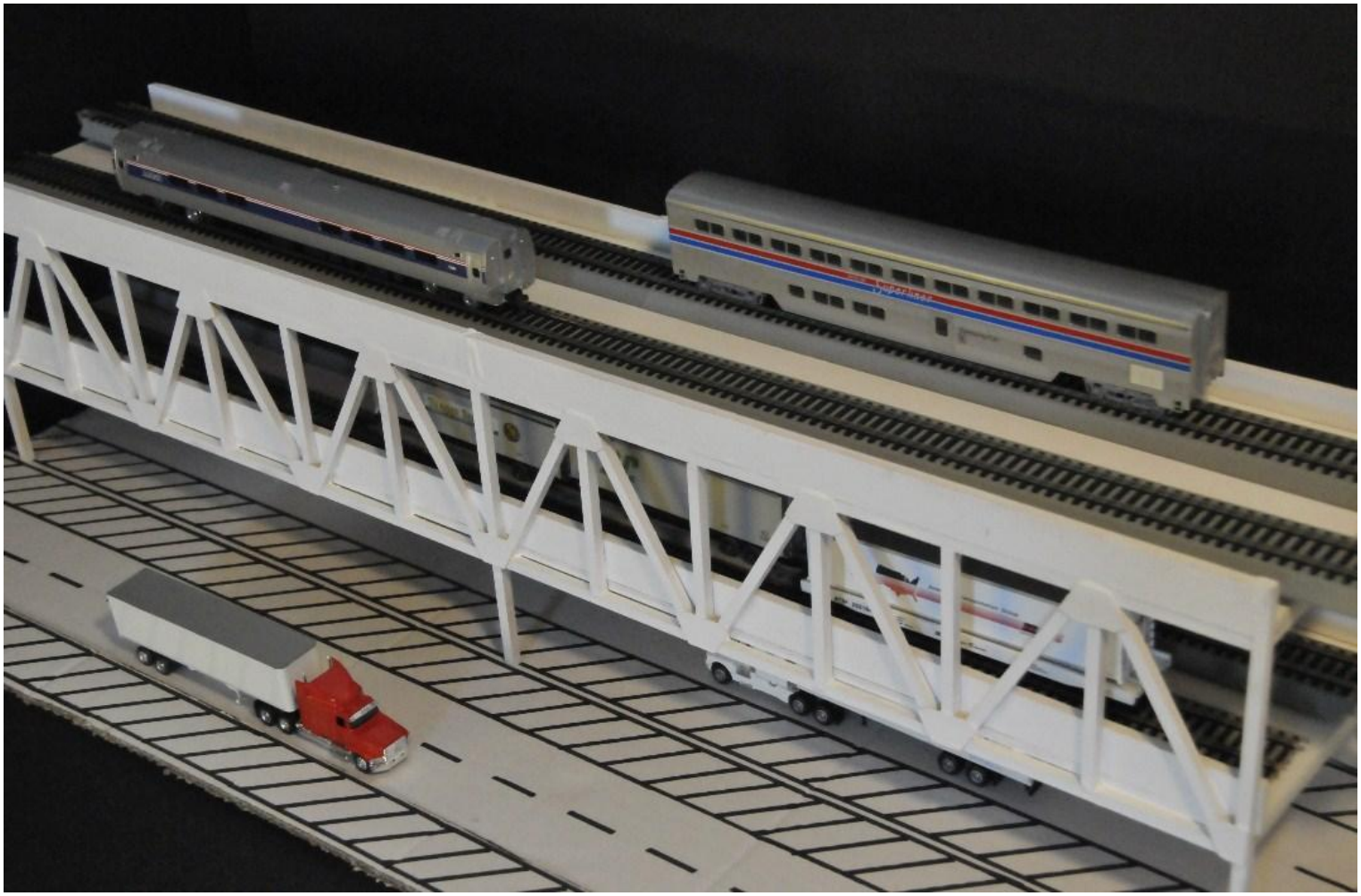
1 level (Highway)

1 level (Freight)

2 level (Hi-speed, Freight)

1 level (Hi-speed)

Kankakee Connector Viaduct



3D Viaduct Model

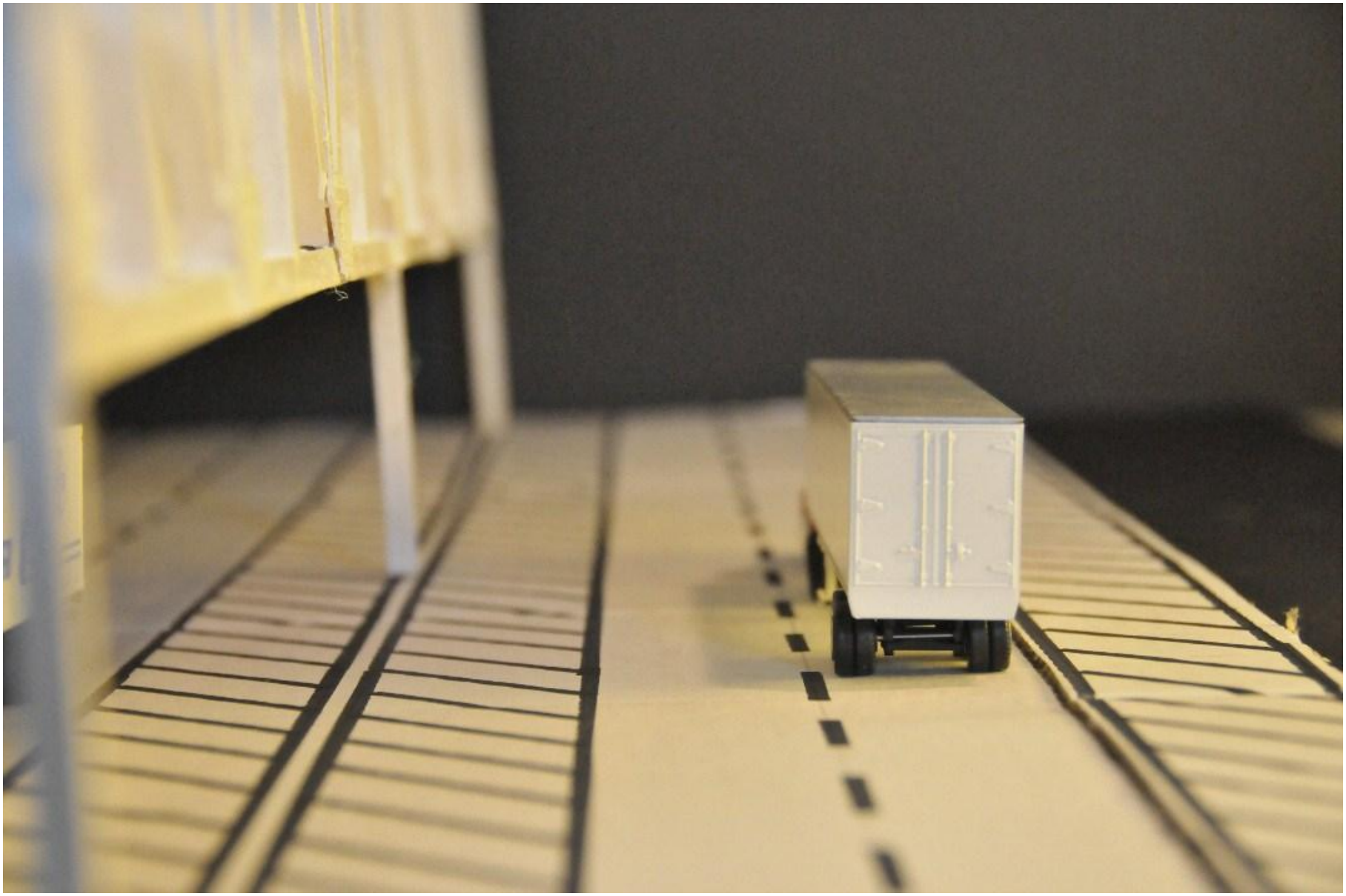

Santa Fe
Santa Fe
RSK


Santa Fe

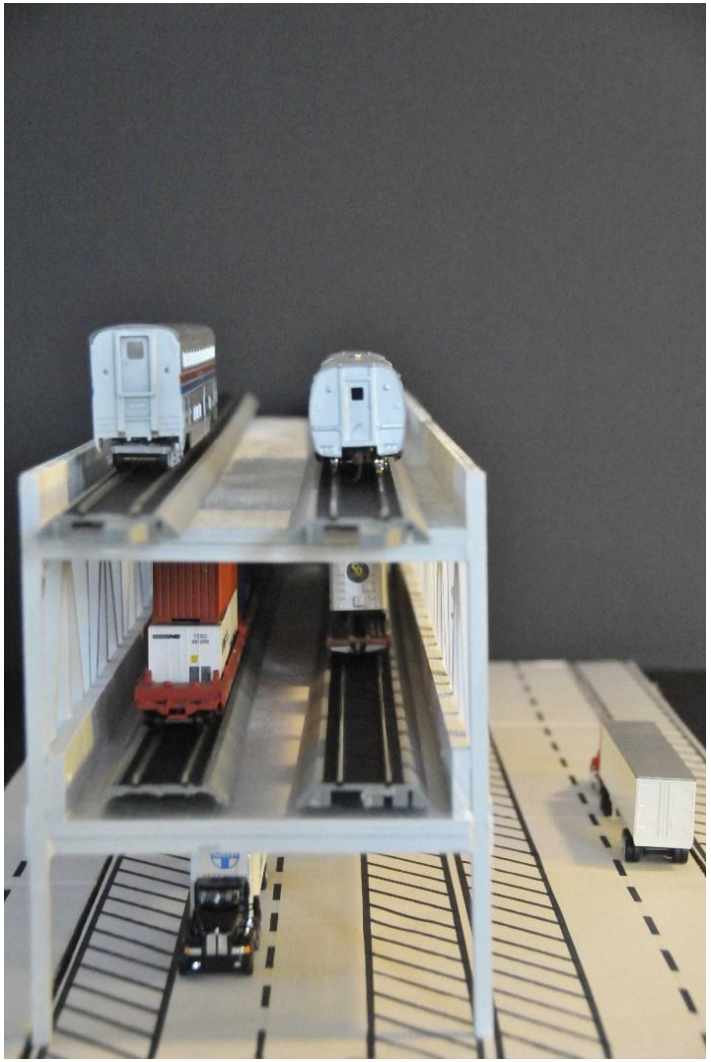
Top Level- High Speed Passenger Rail

Middle Level- Freight Railroad

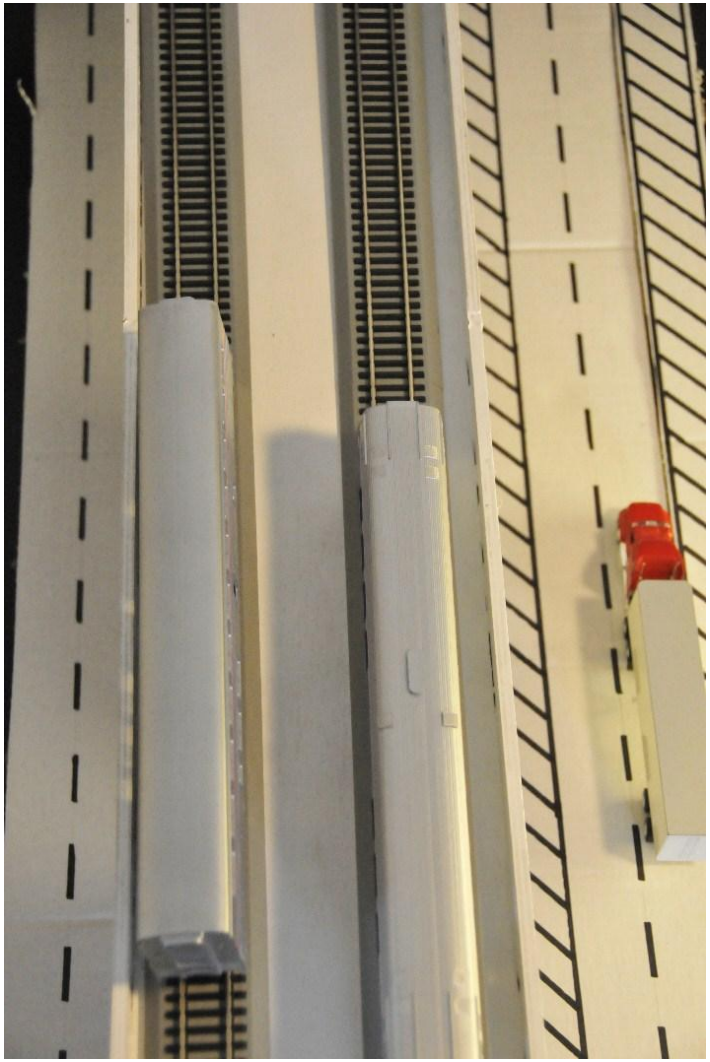
Lower Level (below Viaduct) - 2 lane Expressway with Shoulders



Lower Level (outside Viaduct) - 2 lane Expressway



Cross Sectional View (4 lanes)



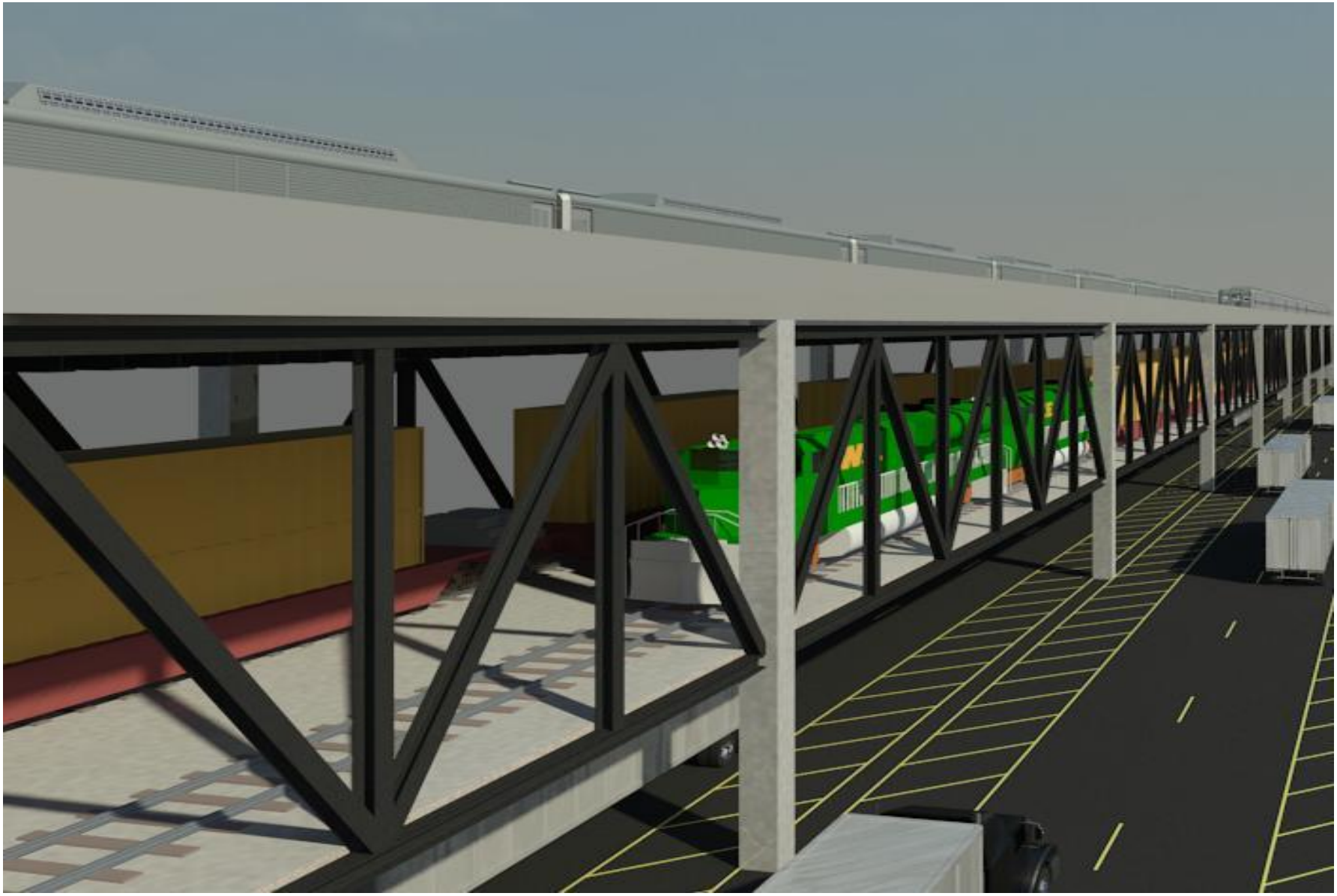
Above View

Top Level: High Speed Passenger Rail allows passengers the best view of surroundings, and has the lightest vehicle weight.

Middle Level: Intermodal Railroad

Lower Level: 4 Lane Expressway for Cars and Trucks, 2 Lanes under Viaduct and 2 Lanes outside ground level to facilitate street interchanges and frontage roads.

2 Level Model



3 Level Model

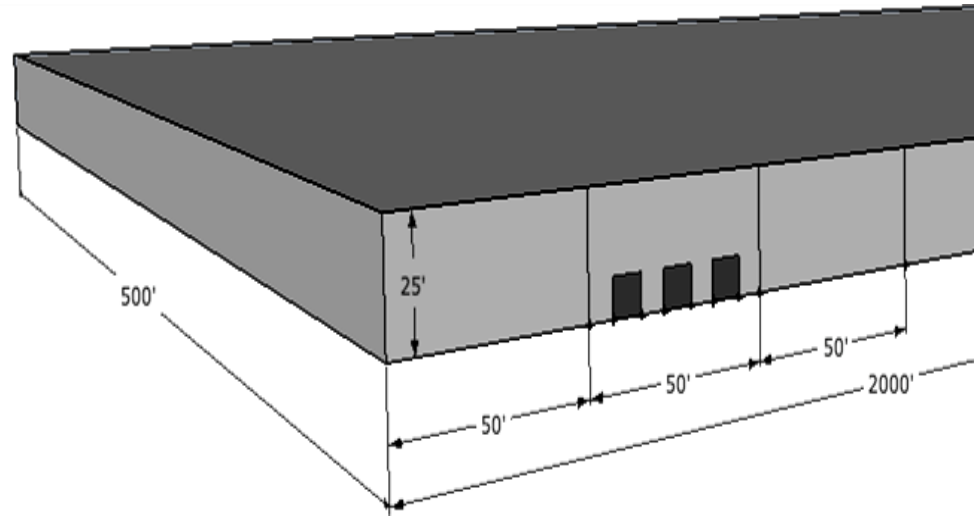
The Kankakee Connector provides access to the newly-developed intermodal facility.

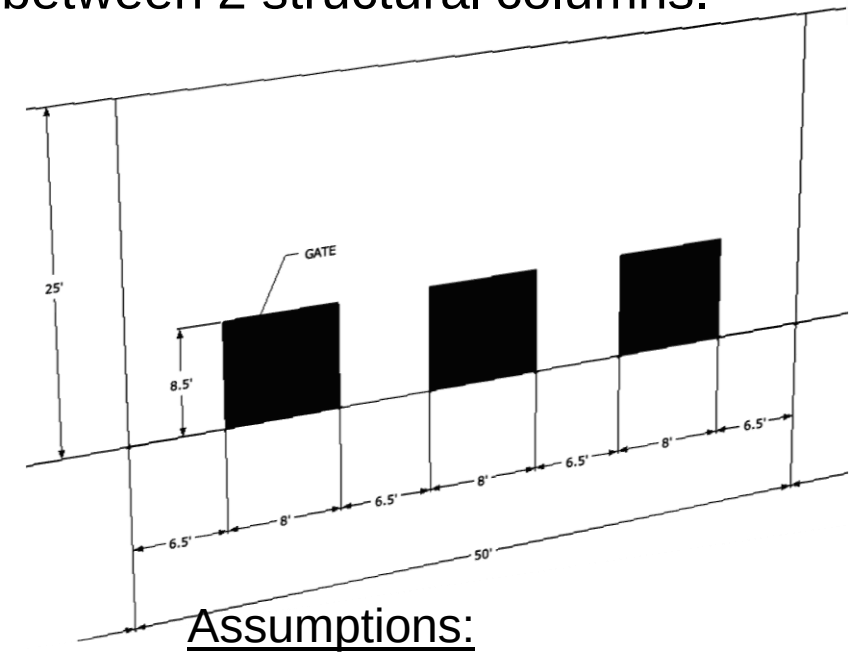
Home to:

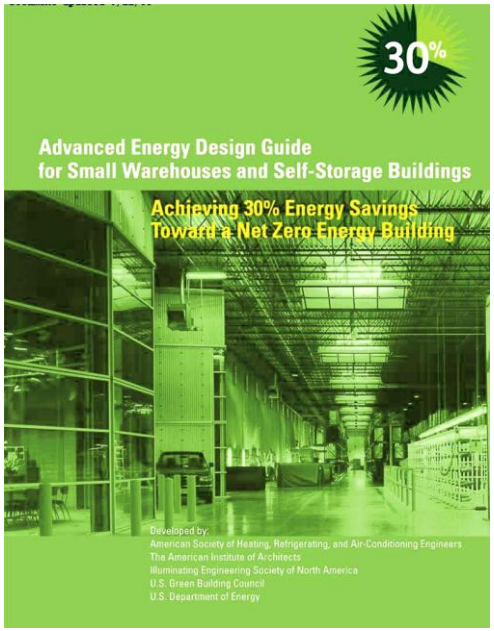
- Multiple warehouses
- Residential community
- Pathway to the Future

Energy Efficient Warehouses

<u>Dimensions of the warehouse:</u>
Area 1,000,000 ft^2
L 2,000 ft x W 500 ft x H 25 ft
<u>Dimensions of the loading gate:</u>
H 8.5 ft x W 8 ft
50 ft span, 3 gates can be placed between 2 structural columns.



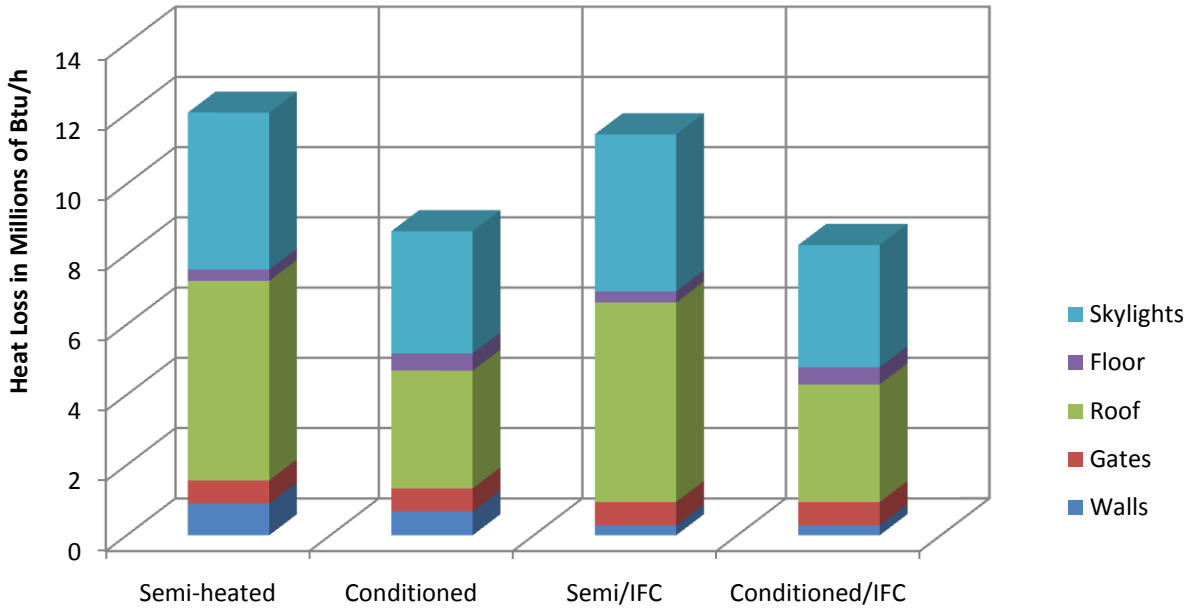




<u>Assumptions:</u>
- Location: Midway Airport Outdoor Design Conditions
- Zone 5 of ASHRAE Recommendation Guide.

Heat Loss Charts

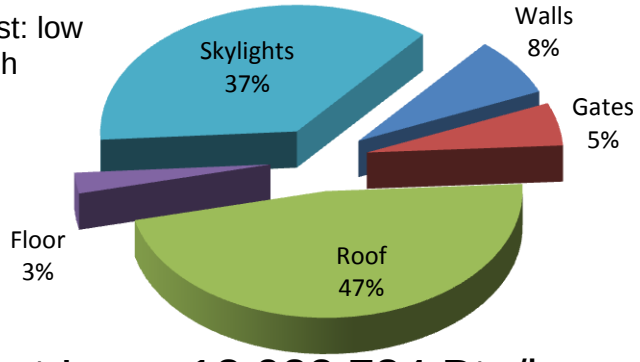
(Calculated for the worst weather condition, $T_{outside}$=-1.6°F)



Percentage of Heat loss
Semi-Heated Warehouse

Initial Construction cost: low
Maintenance cost: high

Natural gas cost: $47,000

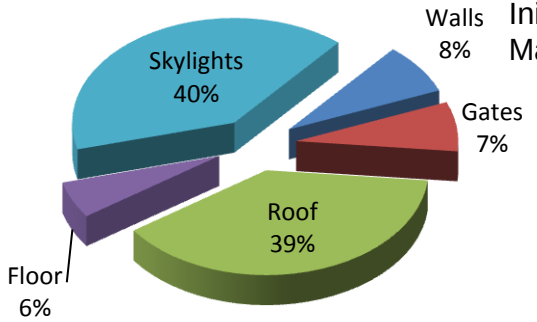


Total Heat Loss: 12,032,734 Btu/hr

Percentage of Heat loss
Conditioned Warehouse

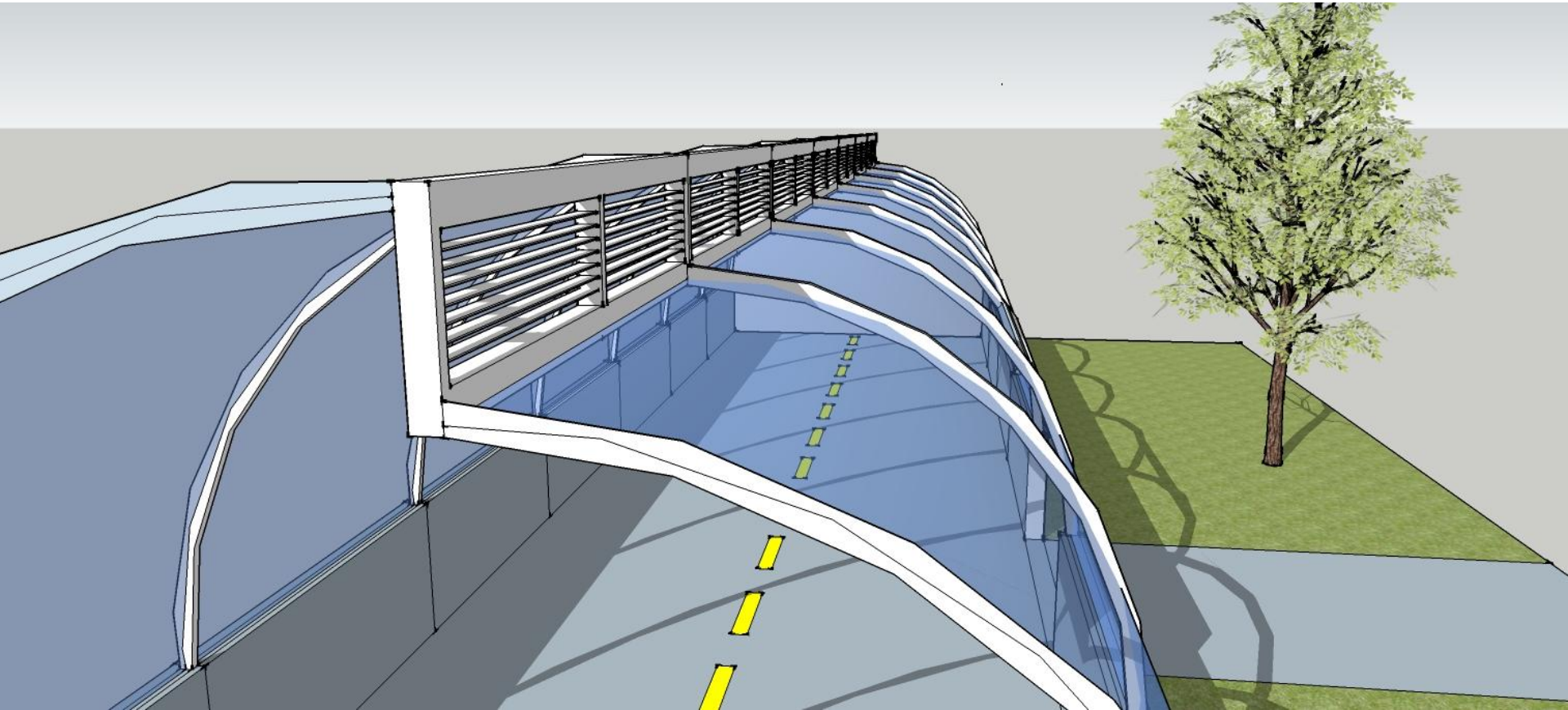
Initial Construction cost: high
Maintenance cost: low

Natural gas cost: $20,000



Total Heat Loss: 8,656,231 Btu/hr

Pathway to the “Future”

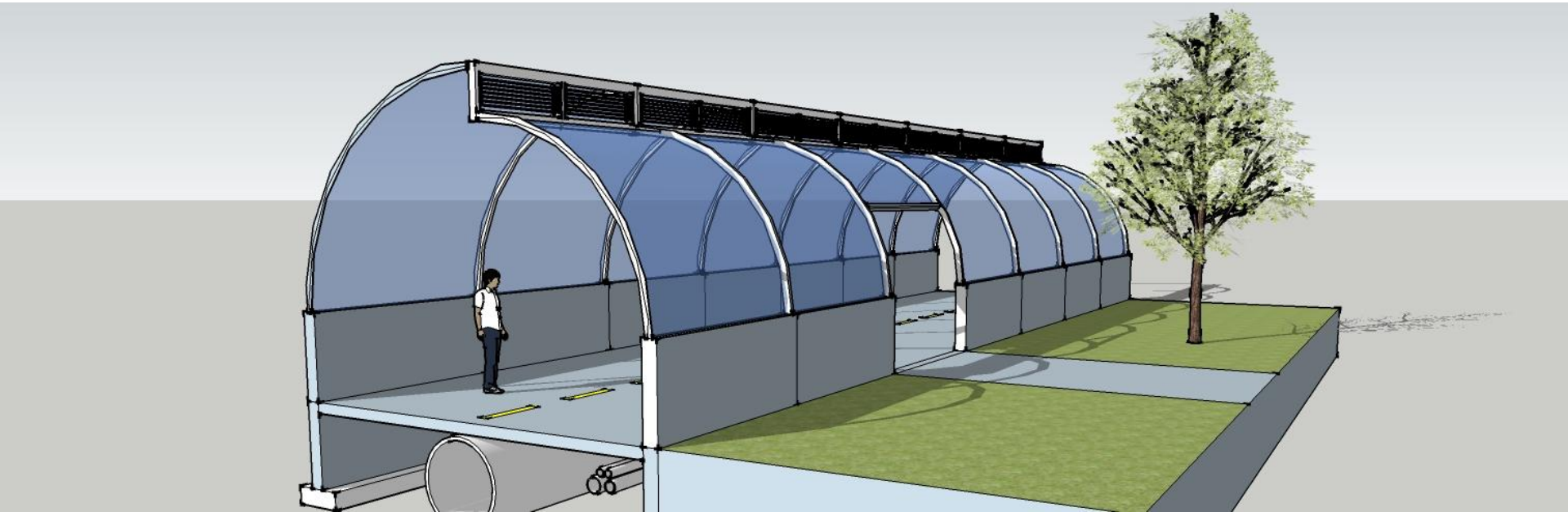


Construction

Crude	Better
• Polycarbonate panels	• Double glazing low e
• Brick 4” w/o ins.	• Concrete 8” w/ ins.
• Concrete floor	• Super ins. floor

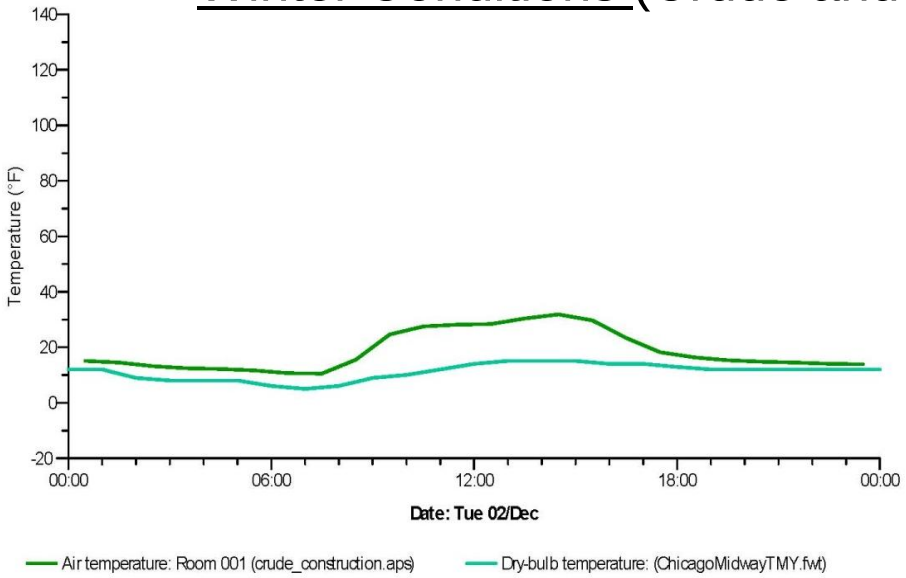
Orientation of pathway: North/South

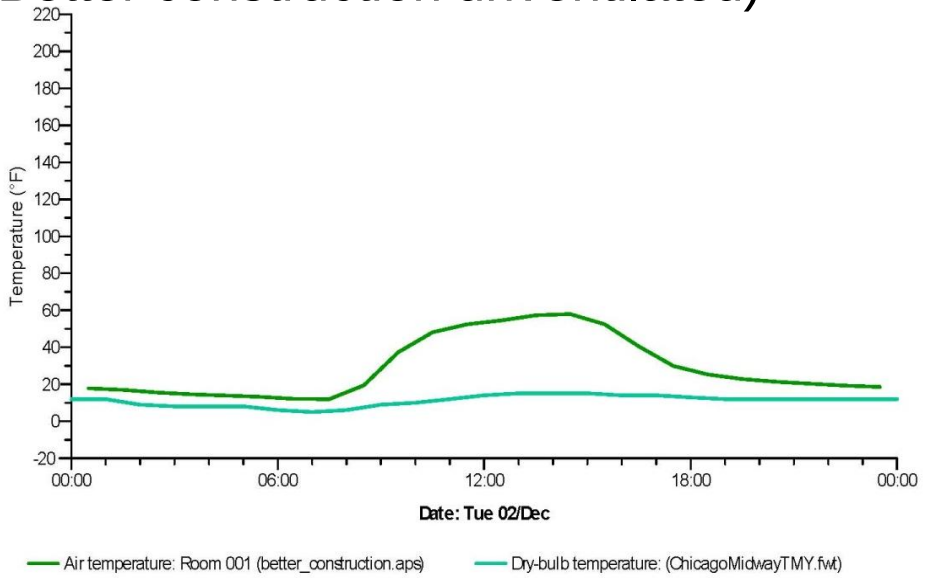
Model simulated on IES software



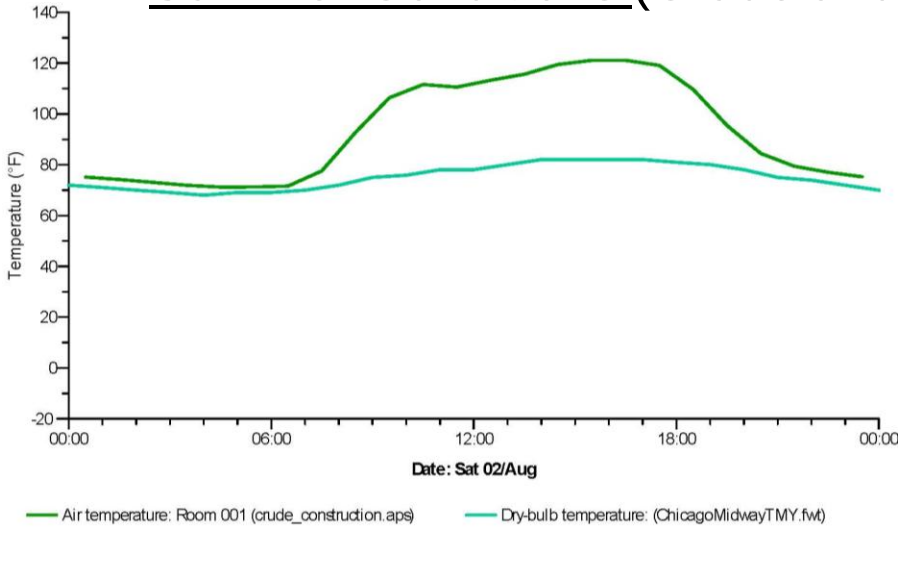
Solar Heat Gain Calculations

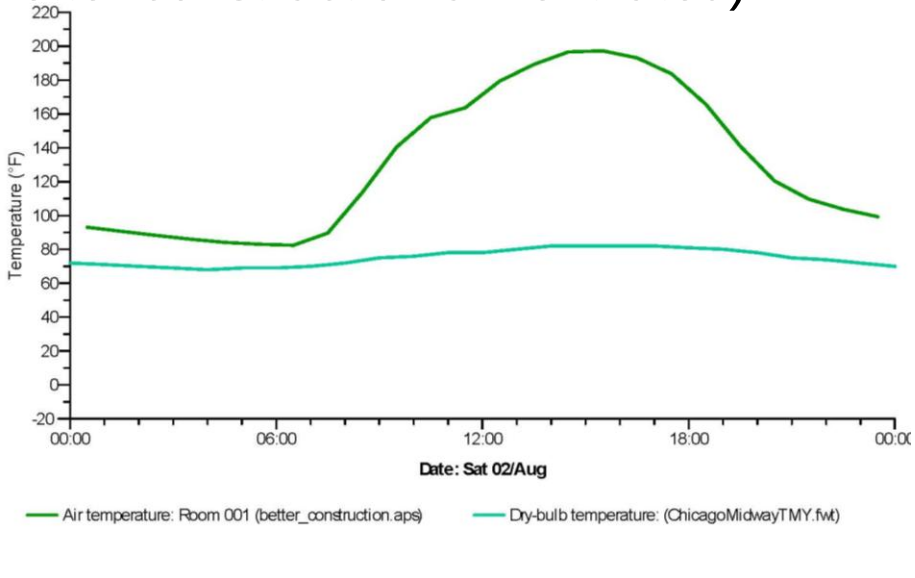
Winter Conditions (Crude and Better construction unventilated)





Summer Conditions (Crude and Better construction unventilated)



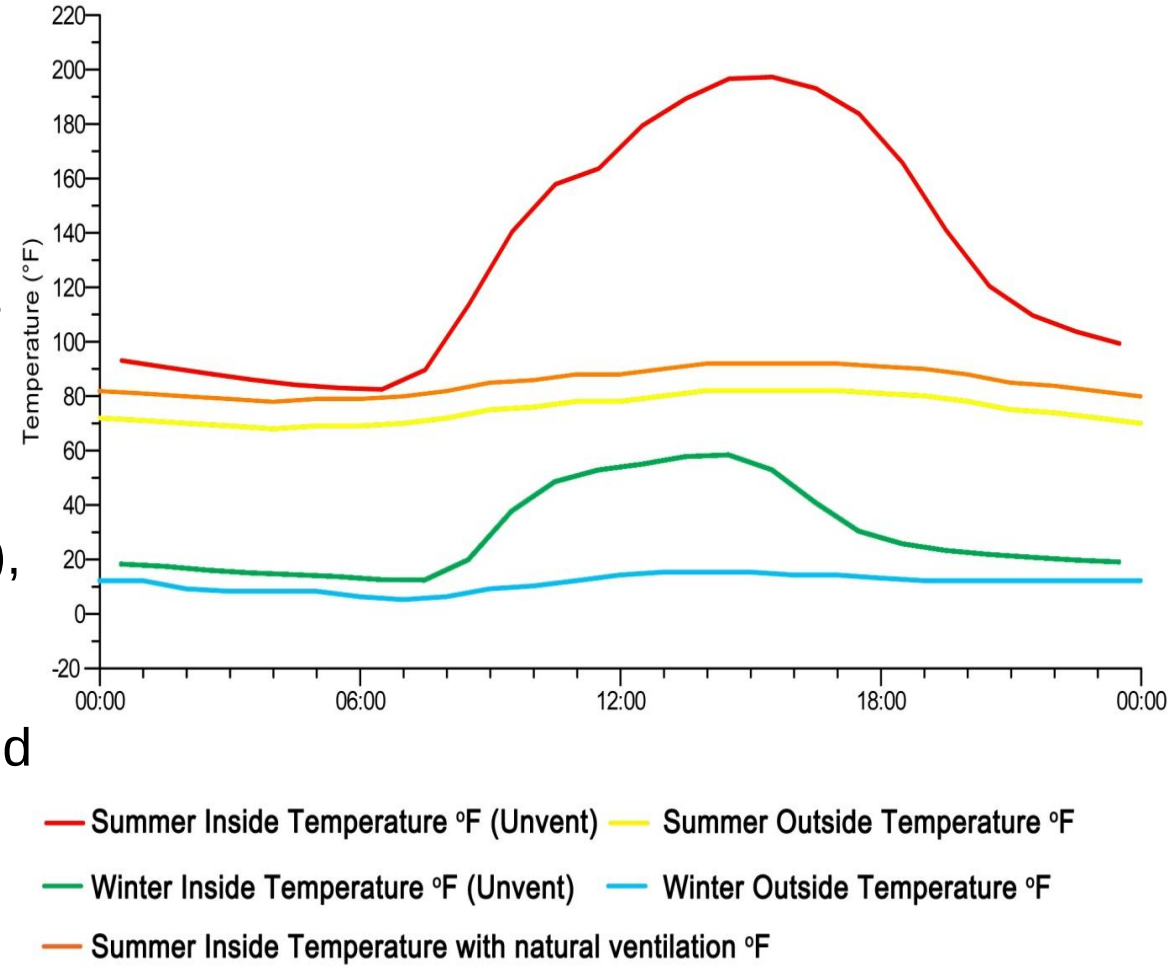


Proposal

Better Construction:

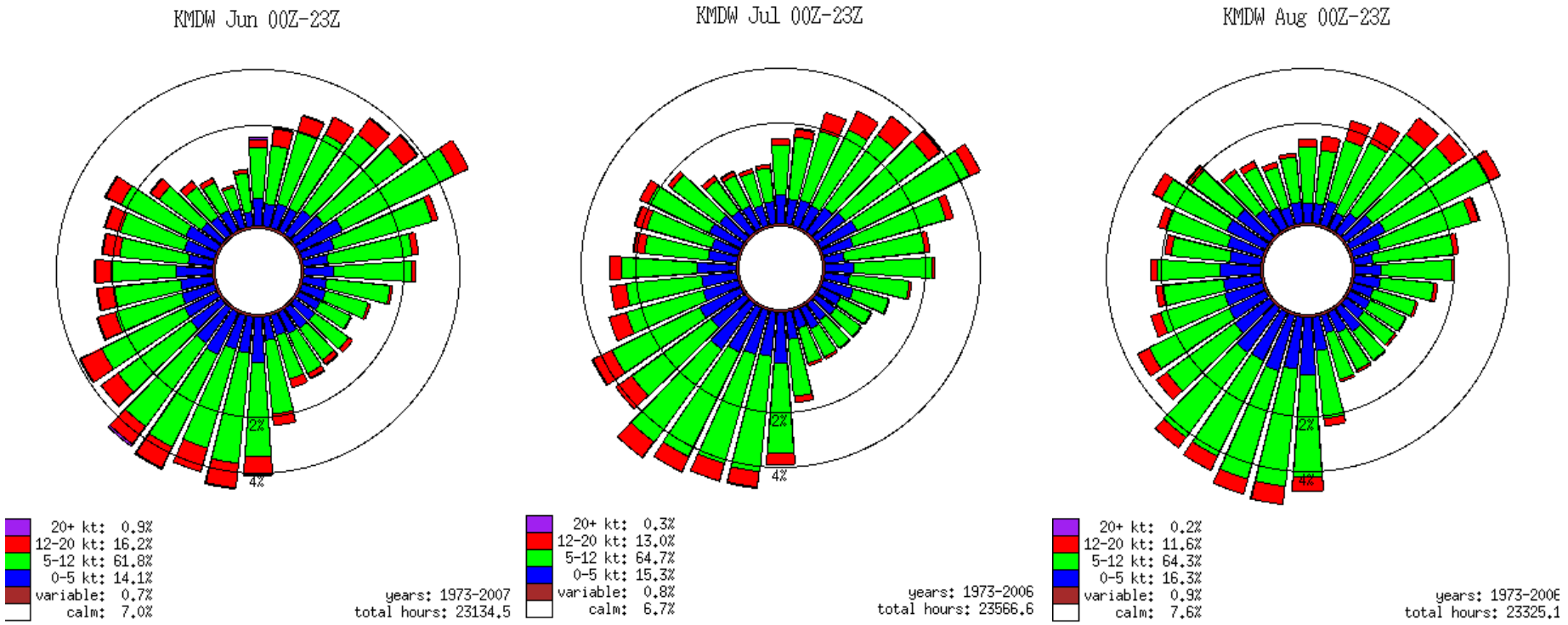
For Winter (Green line),
•Scheduled ventilation during night (~2 hours).
•Use of electronic sensors to activate ventilation when needed during day.

For Summer (Orange line),
•Vents fully open 24 hours/day.
•Operable louvers mounted on the bottom of the side doors to force natural ventilation.



Wind Rose Plots

- Station: Midway Airport, IL
- Critical months for natural ventilation: June, July, August



Wind Rose Description: The *wind roses* show the frequency of winds blowing <u>from</u> particular directions during a given month over 30 years period for Midway airport. The Wind roses represent a 24-hour average. The length of each spoke indicates the percentage of time the wind is from a certain direction. The color-shading indicates what percentage of time the wind speed is from that direction. Units in Knots (1 kt = 1.151 mph).

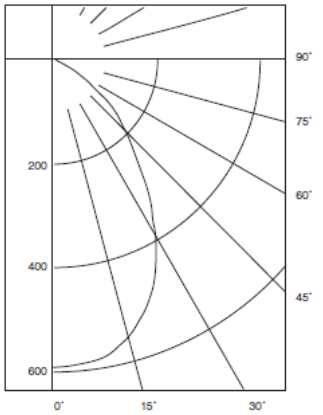
Source: http://www.crh.noaa.gov/lot/?n=avnclimo

LED Pathway Lighting

- Operation Temperature: -40 F up to 85 F
- Less energy consumption
- Up to 50,000 hours of operation
- Dimmable up to 20%
- 5 year Warranty

Photometry

LR6 -DR1000 Based on OnSpex 30012426-F



Intensity (Candlepower) Summary

ANGLE	MEAN CP
0°	597
5°	593
15°	559
25°	463
35°	329
45°	207
55°	120
65°	61
75°	32
85°	7
90°	0

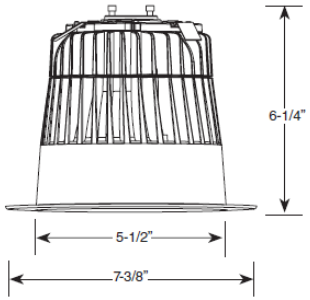
Zonal Lumen Summary

ZONE	LUMENS	%LAMP	%FIX
0°- 30°	424	42.42	42.42
0°- 40°	629	62.89	62.89
0°- 60°	897	89.71	89.71
0°- 90°	1000	100.00	100.00

LR6C-DR1000

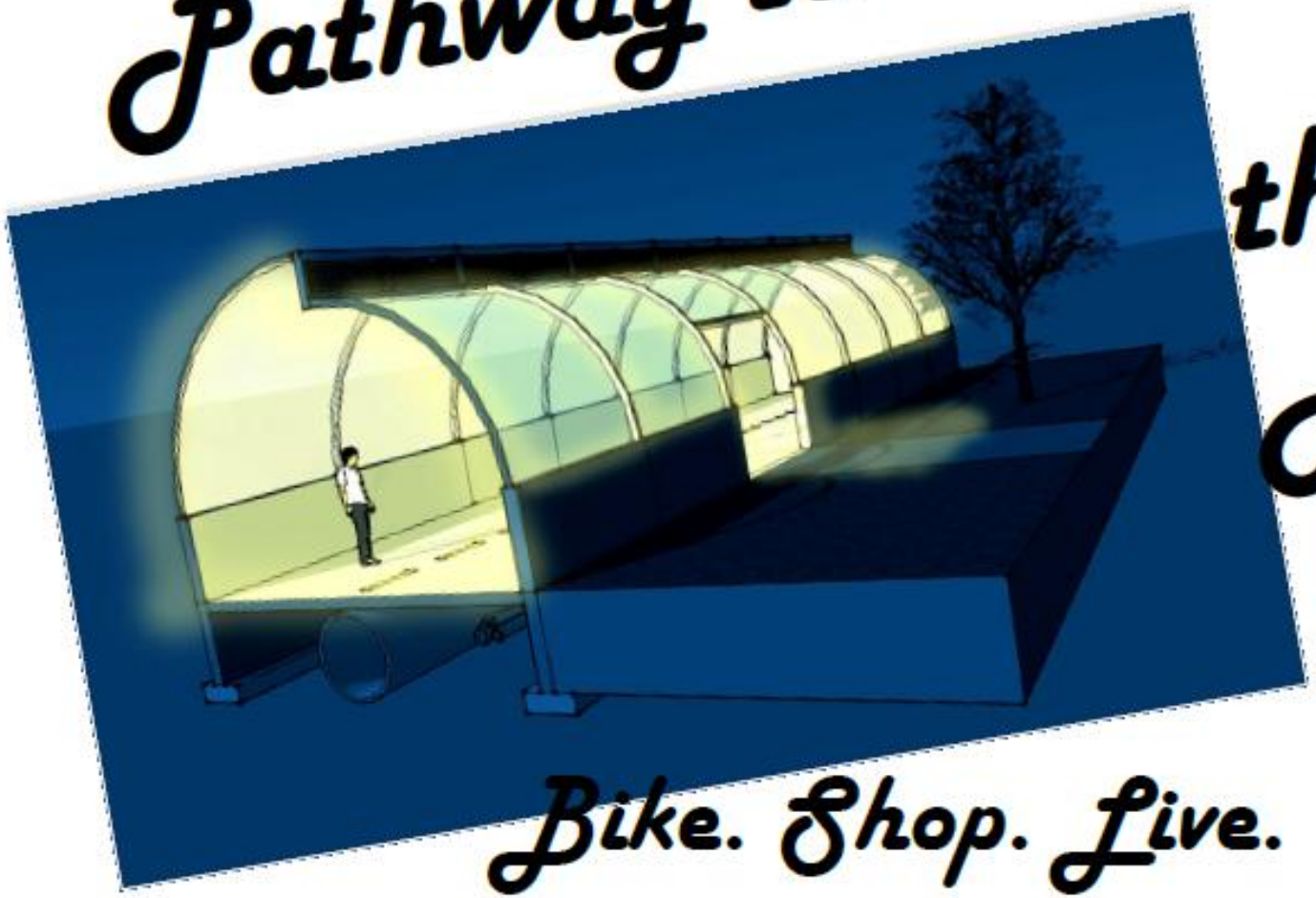
Performance Summary

- Utilizes Cree TrueWhite® Technology
- Delivered Light Output = 1,000 lumens
- Input Power = 12.5 Watts
- CRI = 90
- CCT = 2700K or 3500K
- Dimmable to 20%
- Five Year Warranty



LED LR6-DR100 Luminaire installed every 20 ft

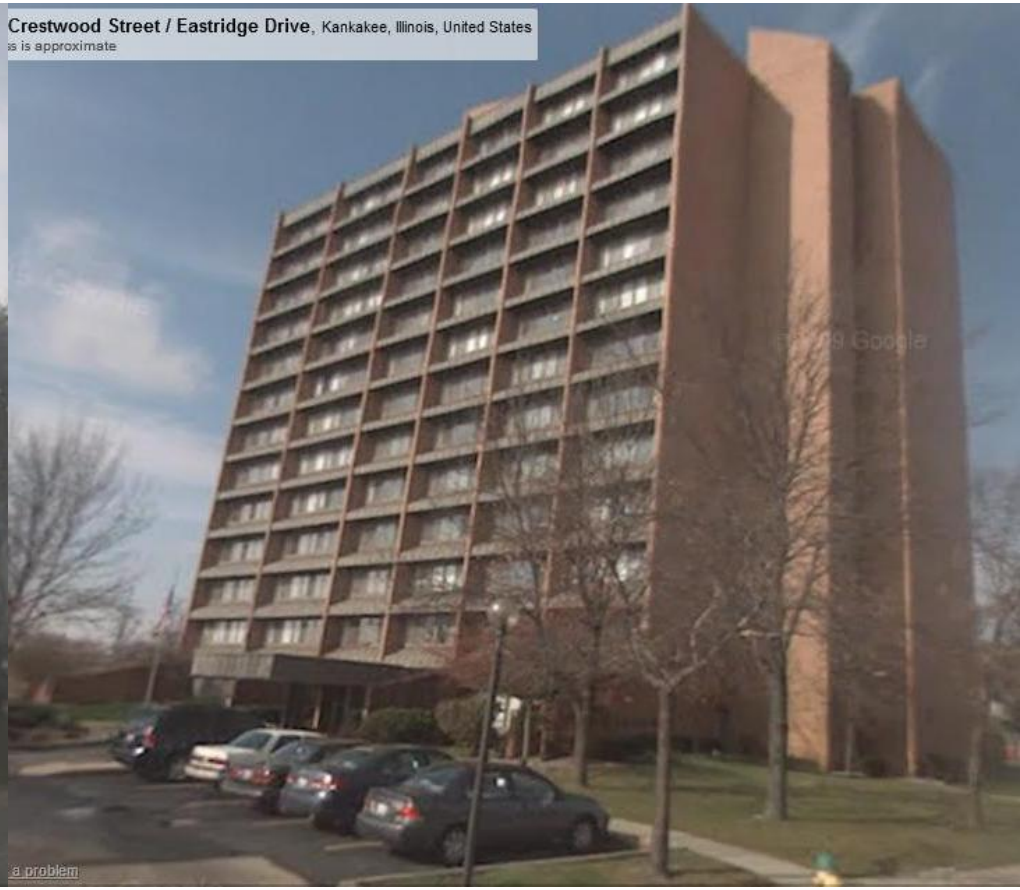
Pathway to the Future



Bike. Shop. Live.
All Year Round.

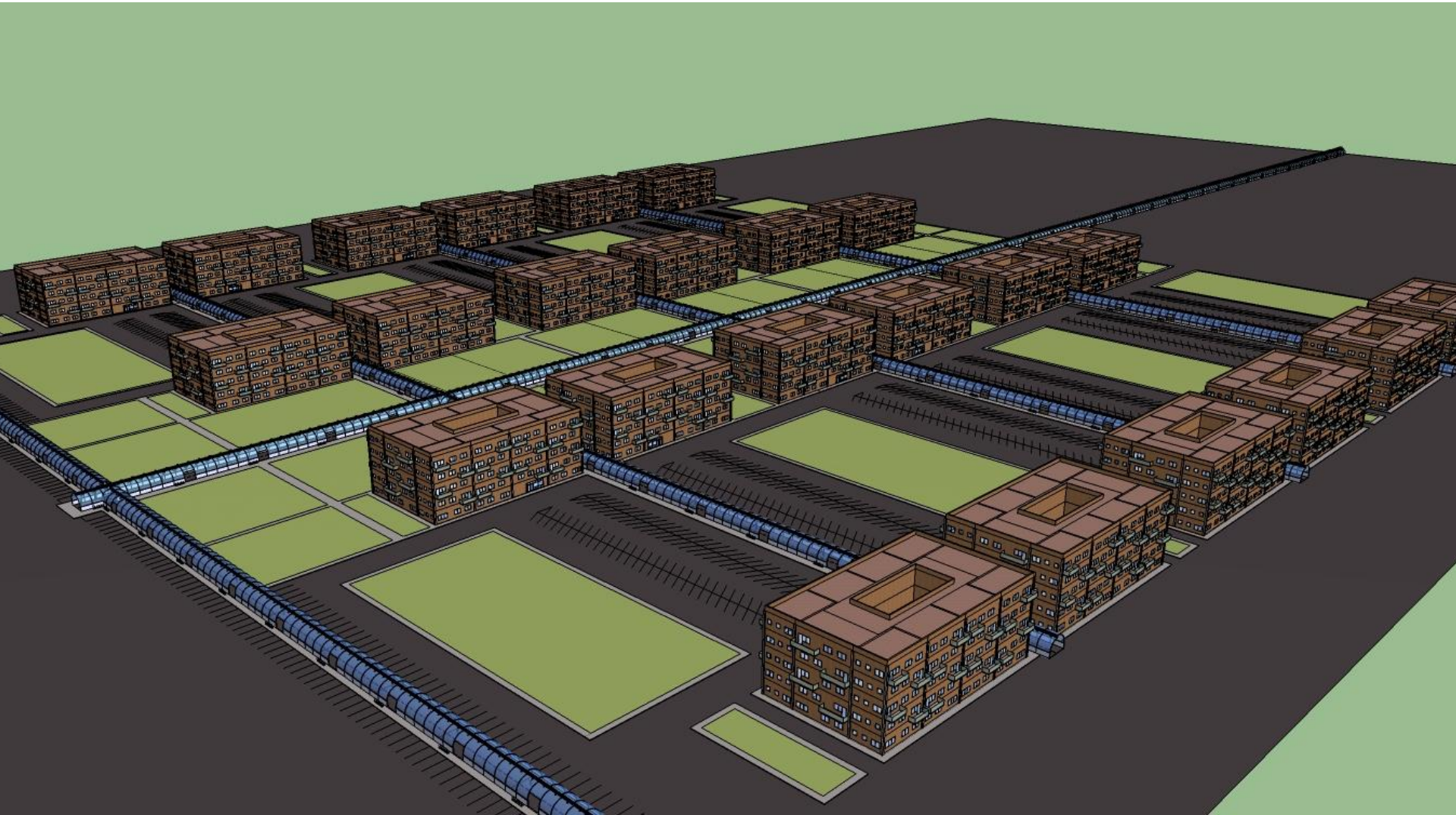
Current Kankakee Housing

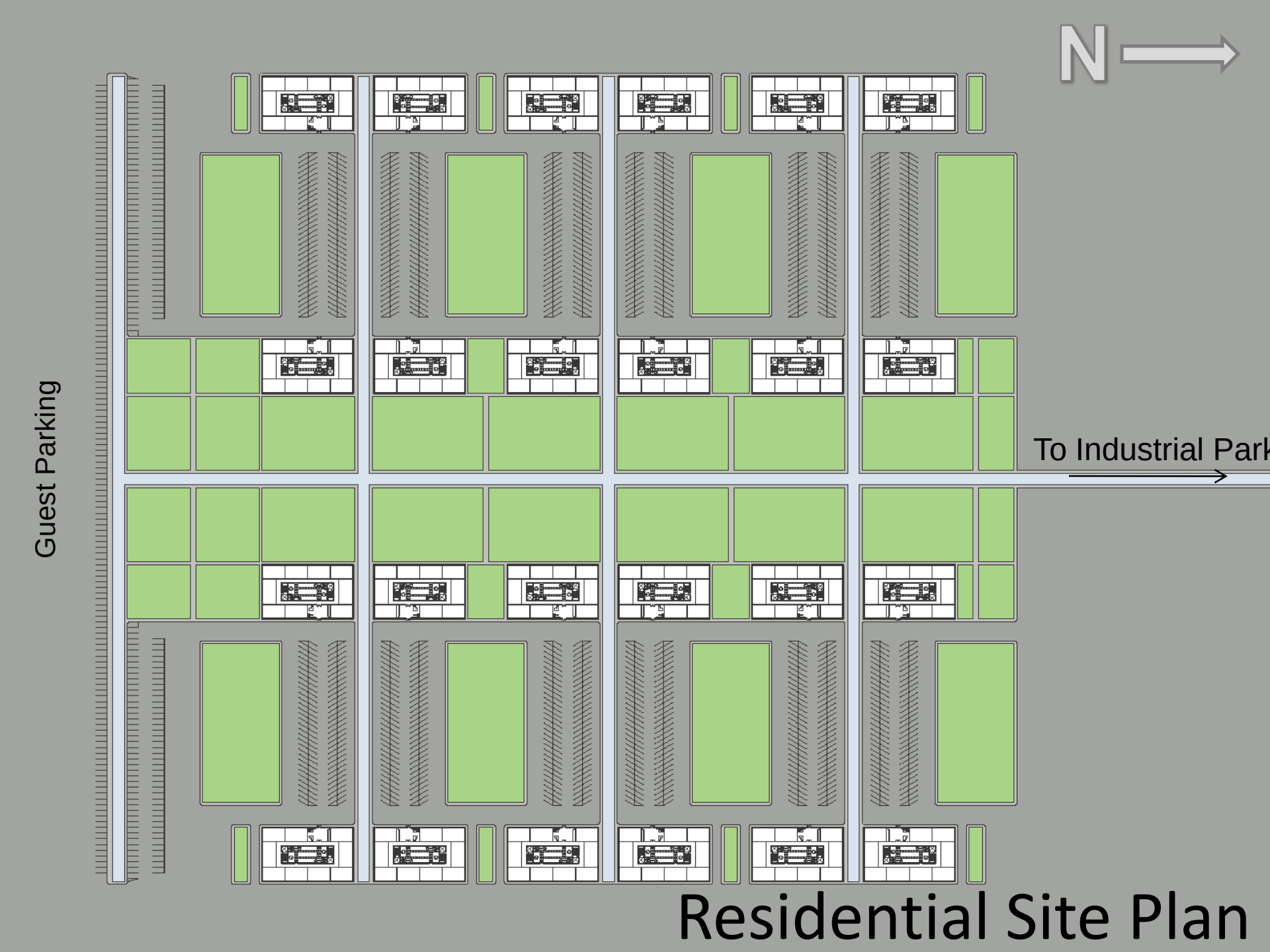
Riverwoods Apartments



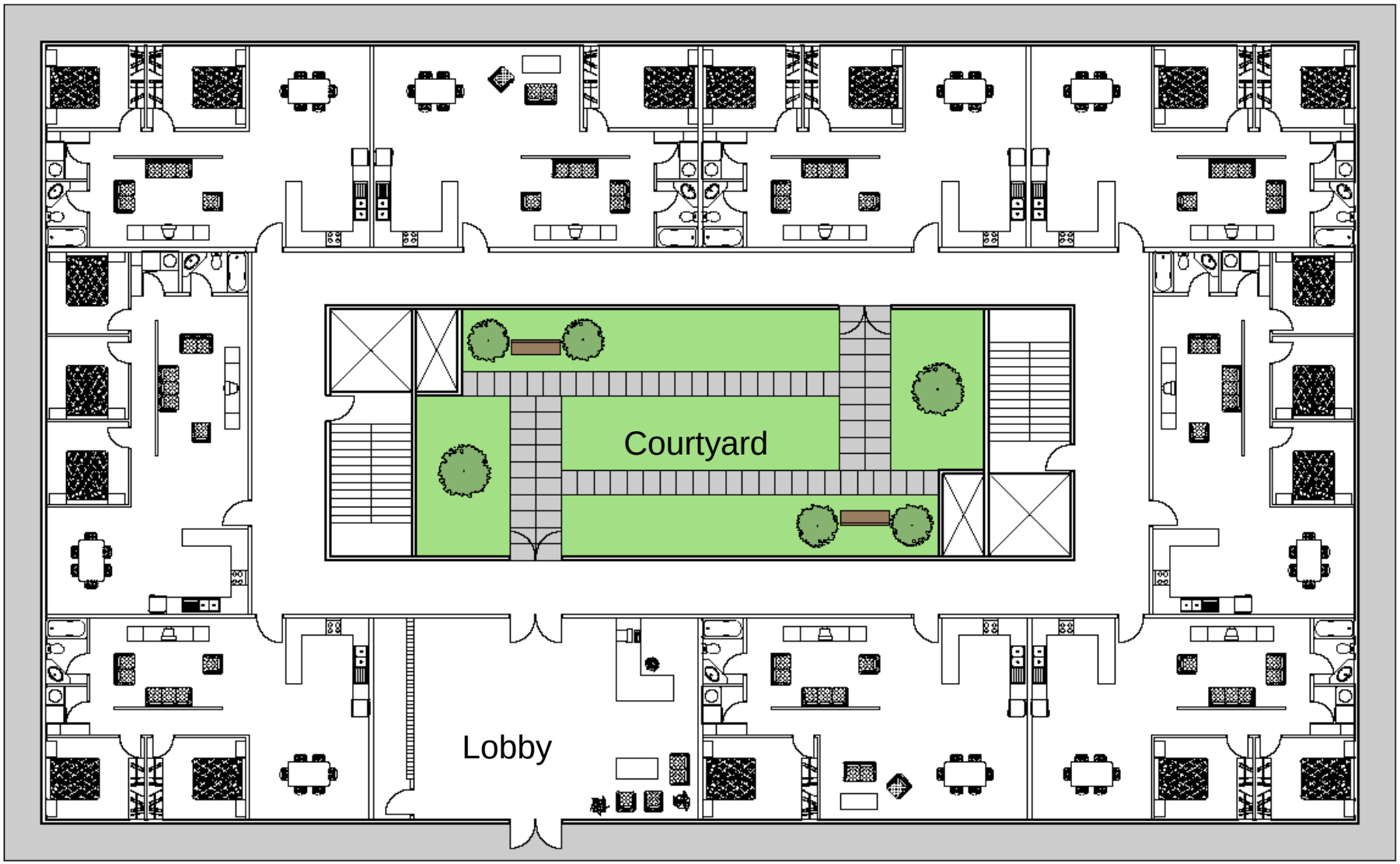
East Court Apartments

Site Bird’s Eye View

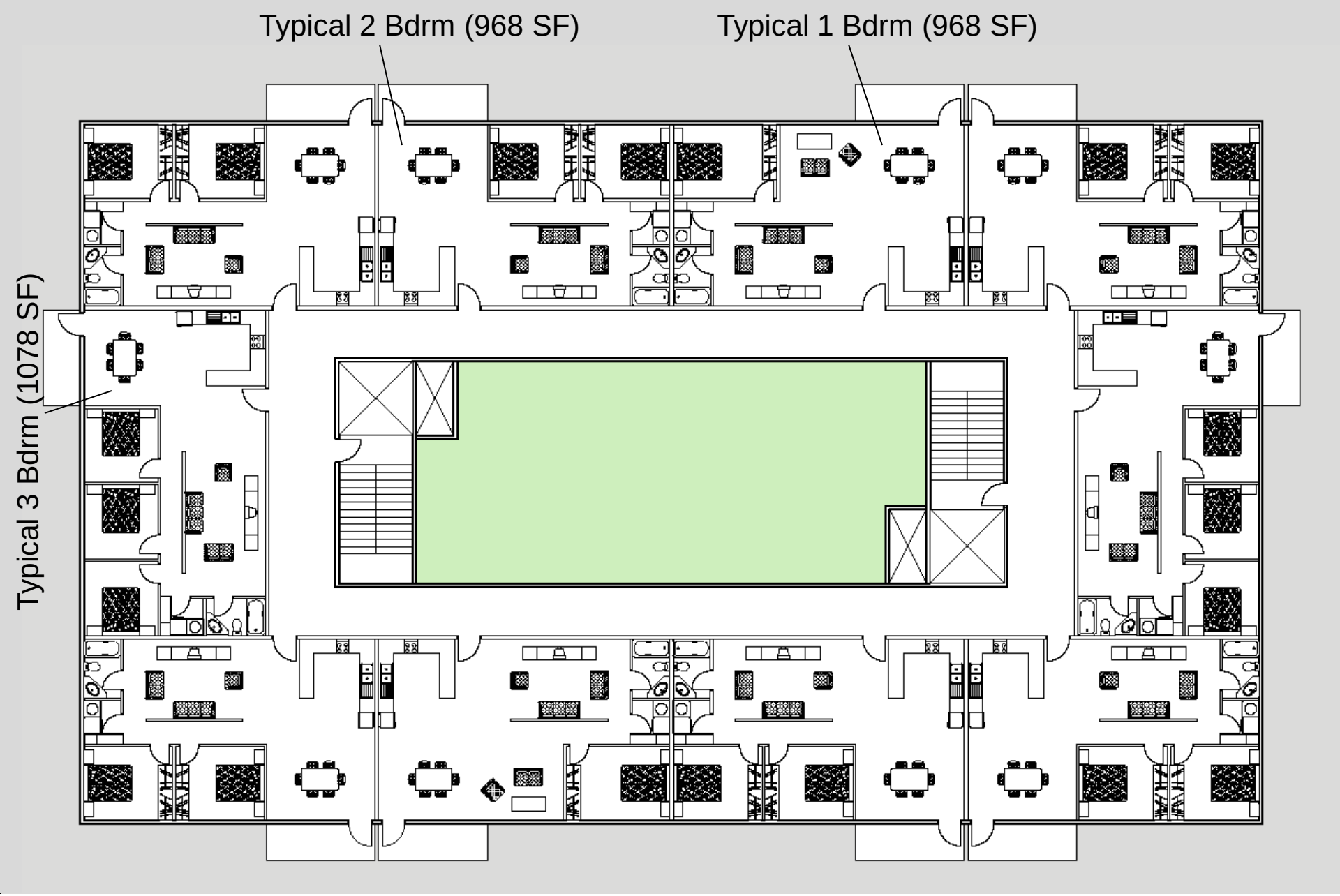




Residential Site Plan



Ground Floor



Typical Floor

Main Elevation

Minor Elevation

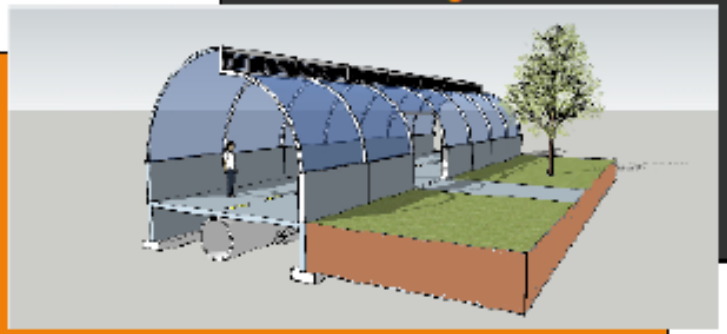
Bird’s Eye View

Street View

Pathway

Future Avenues

Bike.
Shop.
Live.
All year 'round.



With access to the Pathway to the Future.

Housing for 1200 families

The Pathway to the Future

Provides a safe environment for exercise, while connecting the residents to shops and the Intermodal Facility.

A Community for Work and Play.

Kankakee,

Kankakee,
Illinois , 60901
Year 2011 Quarter 1

Date: 27-Apr-11

Cost Estimate Report
CostWorks
RSMeans

Unit Summary Report

Pathway to the Future (Crude Construction)

Prepared By:
Raquel Alvarez
Illinois Institute of Technology

Division Description		Total
Division 03 Concrete		$17,940.00
Division 04 Masonry		$45,984.00
Division 08 Openings		$314,187.50
Division 26 Electrical		$5,340.00
SubTotal		$383,451.50
General Contractor's Markup on Subs	3.00%	$0.00
SubTotal		$383,451.50
General Conditions	3.00%	$11,503.55
SubTotal		$394,955.05
General Contractor's Overhead and Profit	3.00%	$11,848.65
Grand Total		**$406,803.70**

(400 ft) Total: $406,803.70

(7204 ft) Total: $7,326,534.64

Kankakee,

Kankakee,
Illinois , 60901
Year 2011 Quarter 1

Date: 27-Apr-11

Cost Estimate Report
CostWorks
RSMeans

Unit Summary Report

Pathway to the Future (Better Construction)

Prepared By:
Raquel Alvarez
Illinois Institute of Technology

Division Description		Total
Division 03 Concrete		$22,780.00
Division 07 Thermal and Moisture Protection		$32,292.00
Division 08 Openings		$394,218.00
Division 23 Heating, Ventilating, and Air Conditioning (HVAC)		$15,950.00
Division 26 Electrical		$5,340.00
SubTotal		$470,580.00
General Contractor's Markup on Subs	3.00%	$0.00
SubTotal		$470,580.00
General Conditions	3.00%	$14,117.40
SubTotal		$484,697.40
General Contractor's Overhead and Profit	3.00%	$14,540.92
Grand Total		**$499,238.32**

(400 ft) Total: $499,238.32

(7204 ft) Total: $8,991,282.14

TOTAL Cost of Kankakee Connector

# of Levels	Type	Length (mi)	Cost
3-Level	(highspeed rail/freight/highway)	23.60	413000000
2-Level	(highspeed rail/freight)	7.10	82833333
2-Level	(freight/highway)	24.70	288166667
1-Level	(freight)	6.30	36750000
1-Level	(highway)	15.50	90416667
		Total	**911,166,667**

	Crude Construction	Better Construction
Concrete	17,940	22,780
Masonry	45,984	—
Thermal and Moisture Protection	—	32292
Openings	314,187.50	394218
HVAC	—	15950
Electrical	5,340	5,340
General Contractor's Markup on Subs	3%	3%
General Conditions	3%	3%
General Contractor's Overhead a &Profit	3%	3%
TOTAL Per 400 ft. Section	406,803.70	499,238.32
TOTAL (7204 ft. Section)	**7,326,534.64**	**8,991,282.14**

	Crude Construction ($)	Better Construction ($)
Concrete	18,000	23,000
Masonry	46,000	—
Thermal and Moisture Protection	—	32292
Openings	300,000	400,000
HVAC	—	15950
Electrical	5,000	5,000
General Contractor's Markup on Subs	3%	3%
General Conditions	3%	3%
General Contractor's Overhead a &Profit	3%	3%
TOTAL Per 400 ft. Section	400,000	500,000
TOTAL (7204 ft. Section)	**7,000,000**	**9,000,000**