IPRO 307 - Final Report

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Stephanie Soltesz
Nerijus Steponavicius
Philip Theisen
Bryan Woods
Jay You
Mourad Zgourdah
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<td>59-63</td>
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</table>
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
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 | $400 + $15 \times 3495 = $52,825
$15,325 + $15 \times 3000 = $60,325

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

REZONING PROCESS FOR LAKE COUNTY, IN

APPLICATION | NATURAL RESOURCE INVENTORY
--- | ---
3500 ACRE SITE | $400 + $15 \times 3495 = $52,825
$400 + $25 \times 3500 = $87,900

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

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<th>COUNTY</th>
<th>COST/ACRE</th>
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<tr>
<td>KANKAKEE</td>
<td>$28</td>
</tr>
<tr>
<td>WILL</td>
<td>$35</td>
</tr>
<tr>
<td>LAKE, IN</td>
<td>$42</td>
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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

\[ F_{\text{drag}} = \frac{1}{2} \rho S_x C_x v_t^2 \]

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

\[ R = (1.3wn + 29n) + bwnV + CAV^2 + 20wnG \]
## Results

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

**Coupler Force 8000 ft Train**

Enclosed Area: 1,046,875,000 lbf·ft

**Coupler Force 10000 ft Train**

Enclosed Area: 648,437,500 lbf·ft
Kankakee Connector
Kankakee Connector
Layout Options

Option 1

Option 2
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

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Option 2</th>
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<tbody>
<tr>
<td>• Length of 13.3 miles</td>
<td>• Length of 15.5 miles</td>
</tr>
<tr>
<td>• Runs through Kankakee</td>
<td>• Runs outside of Kankakee (to the south)</td>
</tr>
<tr>
<td>• Runs on along existing NS track</td>
<td>• Necessary acquisition of land (approx. 659 acres)</td>
</tr>
<tr>
<td>• 16.4 miles south of Illiana</td>
<td>• 19.2 miles south of Illiana</td>
</tr>
<tr>
<td>• 3 possible exits</td>
<td>• 4 possible exits</td>
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</tbody>
</table>
Area needed for length of Roadway

\[ 15.5 \text{ miles} \times \frac{5280 \text{ ft}}{1 \text{ mile}} \times 200 \text{ ft} = 16,368,000 \text{ ft}^2 = 375.75 \text{ acres} \]

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

Additional area needed for interchanges

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

*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
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

Dimensions of the warehouse:
Area 1,000,000 ft$^2$
L 2,000 ft x W 500 ft x H 25 ft

Dimensions of the loading gate:
H 8.5 ft x W 8 ft
50 ft span, 3 gates can be placed between 2 structural columns.

Assumptions:
• Location: Midway Airport Outdoor Design Conditions
• Zone 5 of ASHRAE Recommendation Guide.
Heat Loss Charts
(Calculated for the worst weather condition, $T_{outside} = -1.6^\circ F$)

- **Semi-heated Warehouse**
  - Initial Construction cost: low
  - Maintenance cost: high
  - Natural gas cost: $47,000
  - Total Heat Loss: 12,032,734 Btu/hr

- **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
- Polycarbonate panels
- Brick 4” w/o ins.
- Concrete floor

Better
- Double glazing low e
- Concrete 8” w/ ins.
- 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 from 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

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
Main Elevation
Minor Elevation
Bird’s Eye View
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.
### Unit Summary Report

Pathway to the Future (Crude Construction)

<table>
<thead>
<tr>
<th>Division Description</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division 03 Concrete</td>
<td>$17,940.00</td>
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<tr>
<td>Division 04 Masonry</td>
<td>$45,984.00</td>
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<tr>
<td>Division 08 Openings</td>
<td>$314,187.50</td>
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<tr>
<td>Division 26 Electrical</td>
<td>$5,340.00</td>
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<tr>
<td><strong>SubTotal</strong></td>
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<tr>
<td><strong>SubTotal</strong></td>
<td><strong>$383,451.50</strong></td>
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<tr>
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<td><strong>SubTotal</strong></td>
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<tr>
<td>General Contractor's Overhead and Profit</td>
<td>3.00%</td>
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<tr>
<td><strong>Grand Total</strong></td>
<td><strong>$406,803.70</strong></td>
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(400 ft) Total: $406,803.70

(7204 ft) Total: $7,326,534.64
# Unit Summary Report

Pathway to the Future (Better Construction)

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<td>Division 07 Thermal and Moisture Protection</td>
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<td>Division 08 Openings</td>
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<td>Division 22 Heating, Ventilating, and Air Conditioning (HVAC)</td>
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(400 ft) Total: $499,238.32

(7204 ft) Total: $8,991,282.14
### TOTAL Cost of Kankakee Connector

<table>
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<th># of Levels</th>
<th>Type</th>
<th>Length (mi)</th>
<th>Cost</th>
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<td>3-Level</td>
<td>(highspeed rail/freight/highway)</td>
<td>23.60</td>
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<td>2-Level</td>
<td>(highspeed rail/freight)</td>
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<tr>
<td>Concrete</td>
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<td>Openings</td>
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<tr>
<td><strong>TOTAL Per 400 ft. Section</strong></td>
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<td><strong>499,238.32</strong></td>
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<tr>
<td><strong>TOTAL (7204 ft. Section)</strong></td>
<td><strong>7,326,534.64</strong></td>
<td><strong>8,991,282.14</strong></td>
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<tr>
<td></td>
<td>Crude Construction ($)</td>
<td>Better Construction ($)</td>
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<td>------------------------</td>
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<tr>
<td>Concrete</td>
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<tr>
<td>General Contractor’s Overhead a &amp; Profit</td>
<td>3%</td>
<td>3%</td>
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<tr>
<td><strong>TOTAL Per 400 ft. Section</strong></td>
<td><strong>400,000</strong></td>
<td><strong>500,000</strong></td>
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<tr>
<td><strong>TOTAL (7204 ft. Section)</strong></td>
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<td><strong>9,000,000</strong></td>
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