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Association Of American Railroads

RTC Modeling of CREATE EW2 and P2 Projects

Chicago, Illinois
Revised
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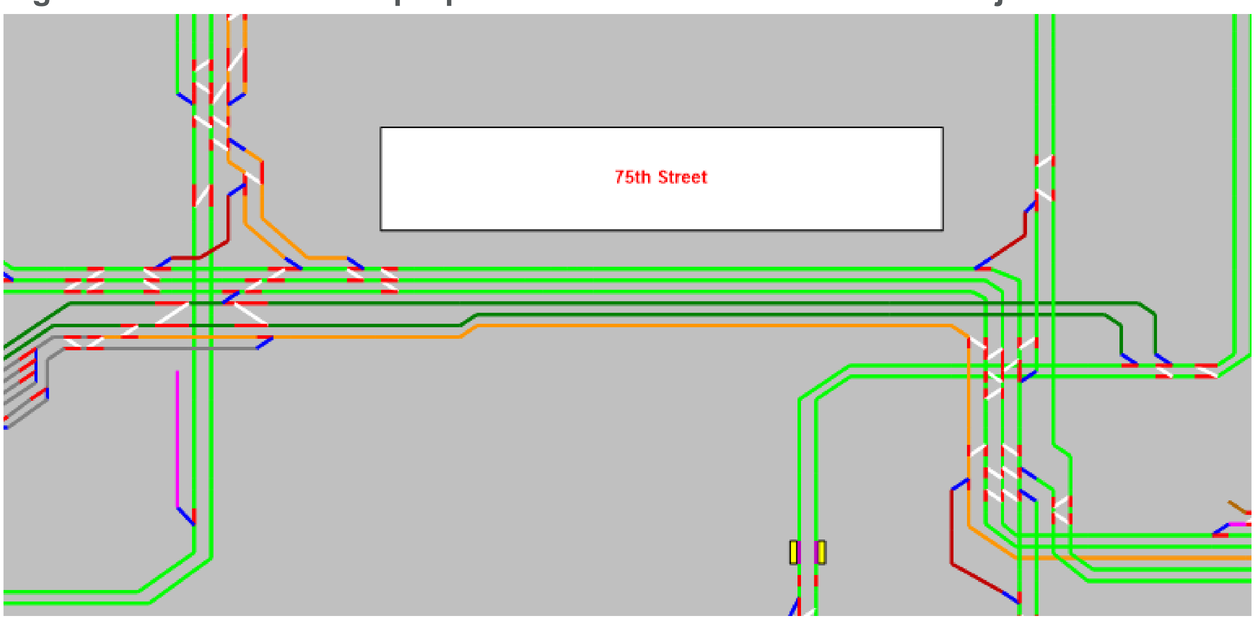
1 Introduction

The Association of American Railroads (AAR), as directed by the Chicago Transportation Coordination Office (CTCO), asked HDR to update the Chicago Terminal District's Rail Traffic Controller (RTC) model. This version of the model, originally created in 2015, uses updated traffic data provided by the Railinc for passenger and freight trains operating in late 2021. In addition, the model incorporates rail infrastructure as of 2022, which includes speeds, track configuration, traffic flow direction, sidings, etc. The model includes all planned, programmed, and funded Chicago Region Environmental and Transportation Efficiency (CREATE) improvements per the direction of the Chicago Transportation Coordination Office (CTCO). The model software was updated to operate with the latest RTC release (76T, dated January 3, 2023).

AAR is preparing an application for funding to advance work on the CREATE EW2 project at Belt Junction, 80th Street and the new P2 connection to the Metra Rock Island main, which is part of the 75th Street Corridor Improvement Project. One required component of the grant application is a Benefit-Cost Analysis (BCA) that provides monetized projections of the public benefits generated by the EW2/P2 Project. BCA preparation is dependent on inputs, including data related to train operations and performance.

AAR requested technical assistance to run the rail simulations using the updated RTC model to generate performance data used to develop the BCA. The train performance data sets for this task are all within the Chicago Terminal. Figure 1–1 depicts the RTC Build Model infrastructure through the 75th Street Corridor, incorporating both the EW2 and P2 improvements.

Figure 1–1 Schematic for proposed infrastructure for EW2/P2 Project



2 EW2/P2 Project Scope

Once updated and validated by CTCO, HDR assisted CTCO in modeling the EW2/P2 project for grant application support. The following is the first set of models developed:

- Base Case – Defines the existing freight and passenger operations in the model and includes any planned, programmed, or funded infrastructure improvements. CTCO reviewed and validated the base case to ensure that it replicates the existing operations within the Chicago Terminal area.
- No-Build Cases – Future-year cases at 5-year increments (up to 30 years), incorporating national freight train growth data. The No-Build Cases included completion of the CREATE P3, EW3 and WA11 projects.
- Build Cases – Future year cases at 5-year increments (up to 30 years) incorporating the EW2/P2 projects.

CTCO then requested several other scenarios:

- HDR reran the No-Build and Build Case using regional freight train growth.
- Three different modeling scenarios simulating varying degrees of out of service bridge failures at Ashland Avenue on the 75th Street Corridor included:
  - All four tracks out of service
  - Three tracks out of service with the northernmost track open
  - Three tracks out of service with the southernmost track open
- An analysis of grade crossing blockage times compared No-Build and Build Case metrics

The report includes assumptions and results for all scenarios in further detail.

3 Rail Traffic Controller Modeling

3.1 Operations Simulation

3.1.1 Overview

Operations simulation consists of understanding the effects of a proposed or anticipated change in infrastructure, trains, or both on all trains that operate on a selected portion of a railroad. “Changes” typically consist of additional trains, additions, or subtractions to fixed infrastructure (e.g., a new siding), a modification to train characteristics (e.g., longer, or faster trains), or a modification to when trains operate (i.e., a new train schedule). To understand the change’s effects, multiple operations simulation cases are prepared to enable comparisons between alternative future conditions in which the change is and not implemented. Formally, the “No-Build Case” forecasts how all trains would operate over the railroad *without* the proposed change. The “Build Case” forecasts how all trains would operate over the railroad *with* the proposed change.

Operations simulation models seek to replicate “real world” train operations. The model attempts to dispatch trains such that each train obtains its best performance and outcome independently given its priority among all trains, within a set of rules that limit train behavior, such as maximum speed, acceleration and braking rates determined by tonnage and horsepower, and required station and terminal stops. The operations simulation model then delivers metrics that inform the user about train performance in the world that the user defined. To find out how trains would operate in a different world, the user must define the world differently and create a new operations model.

The software used for the operations simulation is the RTC operations simulation model, developed and licensed by Berkeley Simulation Software, LLC. Additional HDR developed data pre-and post-processing tools to automate the input and output of data from the model. These tools do not affect train dispatching or performance within the RTC model itself.

3.2 Modeling Assumptions

3.2.1 Simulation Period

All cases dispatch for a 3-day period, exclusive of 12-hour warm-up and 12-hour cool-down periods. The purpose of the warm-up and cool-down is to obtain a steady state of operation. During the warm-up period, train volumes and train conflicts taper upward as trains have not yet entered and fully populated the network. During the cool-down period, train volumes and train conflicts decline as trains begin to exit the network without new seed train replacement. In both warm-up and cool-down periods, train volumes and dispatching conflicts are unrealistic; thus, metrics captured from these periods and averaged with the steady state condition would overestimate network performance.

3.2.2 Train Priority

The Chicago Terminal Operating Protocol requires that passenger trains have priority over freight trains in the case of a conflict at a control point or major rail / rail crossing. The model is configured to adhere to this protocol.

3.2.3 Delay Metrics

Two train delay metrics calculations:

- Total Delay Hours: The total number of train delay hours during the 3-day modeling period
- Delay Minutes per 100 Train Miles: The total number of delay minutes per the amount of time it takes a train to operate 100 miles

A comparison of the No-Build and Build models' delay metrics help determine how the network will perform in the future with and without EW2/P2 improvements.

3.2.4 Lifespan to Service Outage

25 years for a service outage of the Ashland Ave structure, with the base year of 2022. This structure would be 137 years old by 2047 in a no-build scenario, beyond its recommended service life (100 years). Routine maintenance will allow for service life to be extended beyond 100 years, but a subsequent increase in maintenance costs over time increases the chance of a future outage over the next 25 years. (Source: Belt Railway of Chicago - April 19, 2024)

3.2.5 Chance of Service Outage

A 10% chance of outage of the Ashland Ave structure by 2047. On average, the chance of structure outage increases by 1.5 times per year in the no build scenario. However, routine maintenance and repairs mitigate the continued increase in probability of a service outage. In turn, the 10% service outage risk between 2032-2047 acknowledges the continued presence of a risk that is being managed. (Source: Belt Railway of Chicago - April 19, 2024)

3.2.6 Service Outage Duration

With 2047 standing as the year that a critical impact is forecasted to occur on the corridor, a service outage period of 5 years was identified as the minimum duration necessary for delivering a long-term solution to the service outage, versus a temporary measure. The five-year period does not assume or imply what the solution entails, thus aligning with USDOT BCA guidance, but rather it limits the analysis period as a measure of conservativeness.

3.3 Modeling Scenarios

3.3.1 Scenario 1: No-Build and Build Cases with Updated Freight Growth

This scenario used regional forecasted Chicago annual growth rates (CAGR) disaggregated by directionality and traffic type based on the most recent FHWA Freight Analysis Framework (FAF5). The Chicago Department of Transportation (DOT) and Cambridge Systematics provided the growth rates in Table 3-1.

Table 3-1 Recommended Greater Chicagoland Regional Freight Forecasted Annual Growth Rates

Freight Traffic Type (Regional Forecasts)	Thru Traffic CAGR	In/Out/Intra Traffic CAGR	All Traffic CAGR
Intermodal	1.25%	2.41%	1.81%
Carload Rail (Regional, FAF5)	0.80%	2.81%	1.85%
Manifest	2.43%	3.24%	2.86%
Unit (Except Coal)	-0.05%	2.17%	1.49%
Coal Unit	-4.61%	-0.61%	-4.41%
Combined Intermodal/Carload Rail	**1.01%**	**2.64%**	**1.83%**

Source: FHWA FAF5. Intermodal is domestic mode 5-Multiple Modes. Note: CAGR calculated between 2019-2050. See the methodology section of this memorandum for more information.

The model uses compounded annual growth rates in 5-year increments up to 30 years. There was no growth assumed for Metra or Amtrak passenger trains. Passenger train schedules are pre-Covid except for Metra SouthWest Service, which used schedules effective January 16, 2023. Table 3-2 shows these compounded freight growth rates.

Table 3-2 Compounded Freight Growth Rates

	2020	2025	2030	2035	2040	2045	2050
Number of Years from 2020	0	5	10	15	20	25	30
Compound Annual Growth Rate	**0.000%**	**0.769%**	**0.774%**	**0.793%**	**0.870%**	**0.906%**	**0.754%**
% Growth from 2020	0.00%	3.90%	8.01%	12.57%	18.91%	25.28%	25.28%

Metrics are both network-wide and for only trains routed via the 75th Street Corridor. Modeling results are tabulated for Total Delay Hours and Delay Minutes per 100 Train Miles in Table 3-3, Table 3-4, Table 3-5, and Table 3-6.

Table 3-3 Total Delay Hours (3 Day Capture) Network Wide Stats

All Trains			
YEAR	**NO-BUILD**	**BUILD**	**DIFF**
00	**202.1**	**189.4**	**-6.28%**
05	**230.8**	**210.9**	**-8.63%**
10	**297.0**	**261.4**	**-12.00%**
15	**363.2**	**345.2**	**-4.96%**
20	**446.5**	**396.7**	**-11.15%**
25	**535.9**	**515.9**	**-3.74%**
30	**729.3**	**661.1**	**-9.35%**

Table 3-4 Delay Minutes per 100 TM (3 Day Capture) Network Wide Stats

All Trains			
YEAR	**NO-BUILD**	**BUILD**	**DIFF**
00	**16.0**	**14.9**	**-6.55%**
05	**17.8**	**16.2**	**-8.92%**

10	22.3	19.6	-12.27%
15	26.2	24.8	-5.28%
20	31.3	27.7	-11.44%
25	36.5	35.1	-4.02%
30	48.0	43.4	-9.63%

Table 3-5 Total Delay Hours (3 Day Capture) 75th Street Stats

All Trains			
YEAR	NO-BUILD	BUILD	DIFF
00	8.9	6.0	-33.13%
05	11.2	6.8	-39.83%
10	16.8	15.2	-9.36%
15	17.2	14.5	-15.95%
20	26.8	21.4	-20.36%
25	33.4	30.7	-8.02%
30	41.2	34.8	-15.56%

Table 3-6 Delay Minutes per 100 TM (3 Day Capture) 75th Street Stats

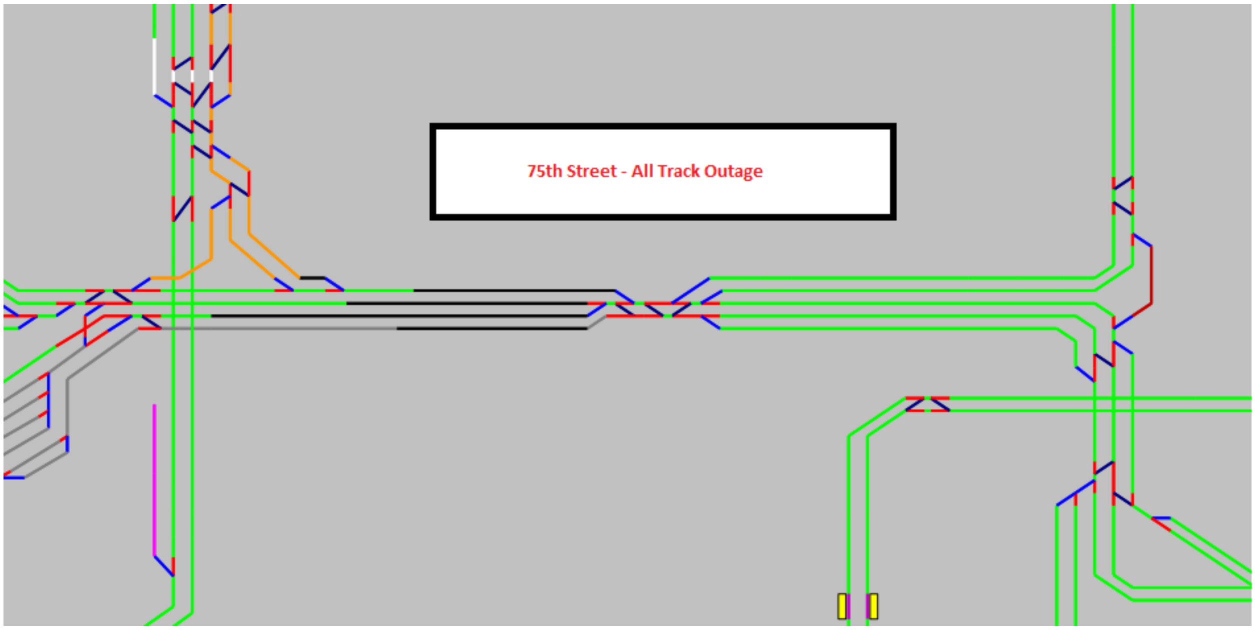
All Trains			
YEAR	NO-BUILD	BUILD	DIFF
00	47.1	28.6	-39.25%
05	51.7	28.7	-44.54%
10	72.8	59.8	-17.92%
15	70.8	54.1	-23.50%
20	105.5	76.5	-27.52%
25	123.2	104.3	-15.35%
30	139.2	109.6	-21.27%

In this scenario, both Delay Hours and Delay Minutes per 100 Train Miles increased significantly in the No-Build Cases compared to the Build Cases. Increases in delay metrics were more pronounced for trains currently operating through the 75th Street Corridor (freight and Metra SouthWest Service).

3.3.2 Scenario 2: Out of service Bridge Failure at Ashland Avenue, All Four Tracks not usable

This scenario assumes that a significant structural failure at the Ashland Avenue bridge results in all four existing rail tracks taken out of service for an extended period. Figure 3–1 shows a screenshot of the outage infrastructure:

Figure 3–1 Out of Service Bridge Failure at Ashland Avenue



In the 3-day RTC model period, 229 out of 903 total freight trains traveled over the 75th St. Corridor (approximately 25 percent of the network total). Each of those trains need to be rerouted, per the following assumptions:

- **Metra SouthWest Service:** There are no feasible reroutes. The service is discontinued through the duration of the outage, due to safety concerns and project delay impacts. (Source: Metra stakeholder interview - April 19, 2024)
- **Crew issues on rerouted trains:** All freight trains have some ability to use alternate routes between their origins and destinations within the Chicago Terminal. CTCO agreed that a high percentage of train crews would not be qualified on trains rerouted on foreign lines, meaning the host railroad would have to provide a pilot to get those trains across those sections. It was determined to add 90 minutes for each impacted train, near where a pilot may board the train, to cover having to wait for a pilot to get to the train before it can start moving on the alternative route. For example, trains built and originating at NS Landers Yard would have to wait 90 minutes until it could depart with an Indiana Harbor Belt Railroad (IHB) pilot. Movements coming from outside the model limits would hold on the main at the reroute point for 90 minutes.
- **Alternate routes selected:** In discussion with CTCO, it was determined to use the following reroutes in the model:
  - Between CPKC Bensenville and CSX Barr or CSX/UP Villa Grove Sub – IHB
  - Between CPKC Bensenville and NS Chicago Line- IHB/CSX to NS near Pine Junction
  - Between CPKC Bensenville and NS Calumet or BRC South Chicago – IHB to BNSF Congress Park to NS 21st Street
  - Between CPKC Schiller Park and CSX – IHB
  - Between BRC Clearing and CSX Barr and beyond – CSX Elsdon Sub

- Between BRC Clearing and UP Dolton – CSX Elsdon Sub
- Between BRC Clearing and NS Calumet or Chicago Line – BRC and NS through Ashland Avenue or north via BNSF to NS at 21st Street
- Between BRC Clearing and BRC South Chicago Yard – same route as above
- Between NS Landers and everywhere – IHB at Chicago Ridge

- **NS Landers back up and forward moves on/off the IHB:** The only route available for trains arriving at or departing NS Landers yard is for trains to back up and onto the IHB at Chicago Ridge. NS stated they would probably have a switch crew pull the train out of Landers onto the IHB with locomotives, then head power back to Landers after the outbound train starts moving. On inbound, the reverse holds true. The inbound train would pull clear of the Metra diamond and the switch crew would couple on and pull the train in. An additional 20 minutes of extra dwell time is added on/off the IHB.
- **Cascading delays outside of the model area**: The model cannot track delays that cascade outside the model limits. Westbound NS trains attempting to enter Chicago, for example, may need to hold at Elkhart, Burns Harbor, or on a main track in Indiana for an extended amount of time before a slot may open in Chicago.

Out of 229 total freight trains operating through the 75th Street Corridor, 42 would be rerouted over a foreign railroad and require a pilot. This adds approximately 3,780 minutes of delays over the 3-day period, not including longer route miles and interactions with other trains. The remaining freight trains would be rerouted over segments where the crews would most likely be qualified to operate. Modeling results for Total Delay Hours and Delay Minutes per 100 Train Miles are in Table 3-7 and Table 3-8, respectively.

Table 3-7 Total Delay Hours (3 Day Capture) Network Wide Stats

Freight Train Only			
YEAR	NO-BUILD	OUTAGE	DIFF
00	187.8	268.2	42.85%
05	218.1	323.6	48.36%
10	281.0	410.4	46.05%
15	339.2	476.3	40.42%
20	420.4	597.8	42.18%
25	519.7	696.2	33.96%
30	707.8	965.7	36.43%

Table 3-8 Delay Minutes per 100 TM (3 Day Capture) Network Wide Stats

Freight Train Only			
YEAR	NO-BUILD	OUTAGE	DIFF
00	49.4	68.5	38.78%
05	49.5	71.3	43.89%
10	59.0	83.5	41.64%
15	64.0	87.2	36.34%
20	73.6	101.7	38.17%

25	84.8	110.4	**30.19%**
30	106.6	141.2	**32.42%**

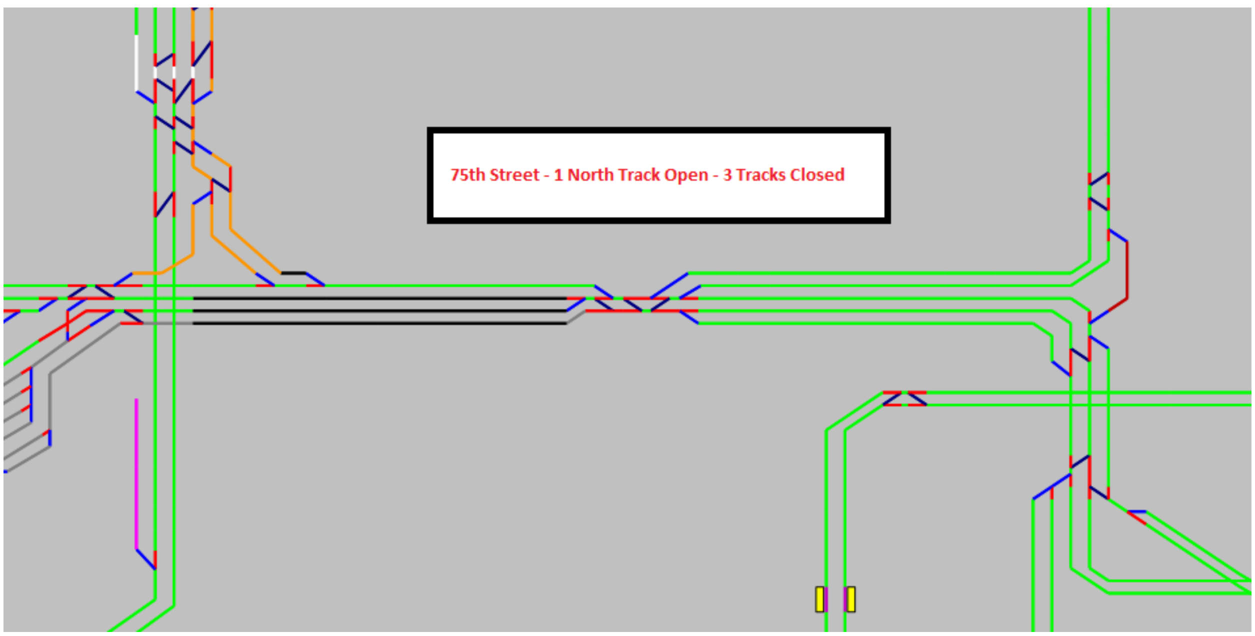
As expected, the temporary loss of a key rail corridor had cascading delay impacts on the entire Chicago Terminal network, with delay metrics increasing from 30 to 48 percent, depending on the delay value and growth year.

Actual delays may well be higher than what the model indicates. For example, the model does not include the extensive switching operations at the NS Ashland Avenue Yard; it just models train movements over the main tracks. Extreme congestion at Ashland, one of the main reroute segments, may worsen delays beyond what the model's results indicate. Also, allocating 90 minutes for a train to wait for a host railroad pilot does not take into full consideration the impact providing multiple pilots may have to certain crew bases (like IHB). Trains may hold for longer than 90 minutes waiting for an available pilot.

3.3.3 Scenario 3: Three track out of service Bridge Failure at Ashland Avenue, Northernmost Track in Service

This scenario assumes that the structural failure at the Ashland Avenue bridge causes removal of three tracks from service, leaving only the northernmost track in service. Figure 3–2 shows a screenshot of the infrastructure.

Figure 3–2 Bridge Failure at Ashland Avenue – Northernmost Track Open



Under this scenario, trains operate over the damaged bridge at 3 miles per hour (mph) maximum speed to simulate ongoing construction and Form B limits. There is still a route available from BRC Clearing and CSX Blue Island Subdivision through the corridor, but some trains may take an alternate route to avoid congestion through the Form B limits. For example, UP trains operating between Proviso and Yard Center, which normally route through the corridor, would likely stay on the CSX Blue Island Subdivision to avoid this congestion, even though this may require a CSX pilot.

With only the north track open, there is no viable reroute for Metra SouthWest Service, and would cease operations. NS local and Landers Yard movements will reroute via the IHB at Chicago Ridge.

Out of 229 total freight trains operating through the 75th Street Corridor, 42 would be rerouted over a foreign railroad and require a pilot. This alone adds approximately 3,780 minutes of delays over the 3-day period, not including longer routes and interactions with other trains. Modeling results for Total Delay Hours and Delay Minutes per 100 Train Miles are in Table 3-9 and Table 3-10, respectively.

Table 3-9 Total Delay Hours (3 Day Capture) Network Wide Stats

Freight Train Only			
YEAR	NO-BUILD	OUTAGE	DIFF
00	187.8	289.0	53.91%
05	218.1	370.2	69.70%
10	281.0	453.7	61.48%
15	339.2	552.4	62.85%
20	420.4	777.6	84.95%
25	519.7	-	-
30	707.8	-	-

Table 3-10 Delay Minutes per 100 TM (3 Day Capture) Network Wide Stats

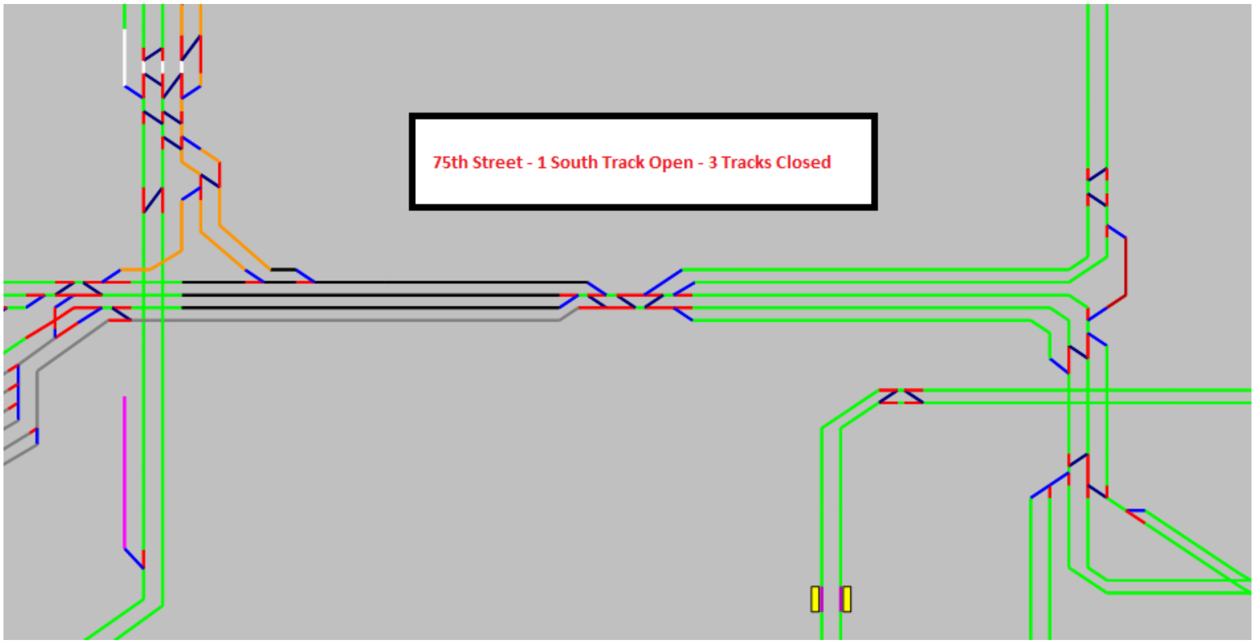
Freight Train Only			
YEAR	NO-BUILD	OUTAGE	DIFF
00	49.4	75.6	53.19%
05	49.5	83.6	68.70%
10	59.0	94.6	60.49%
15	64.0	103.5	61.89%
20	73.6	135.4	83.83%
25	84.8	-	-
30	106.6	-	-

With hundreds of trains and multiple reroute opportunities, RTC has a difficult time attempting to replicate real-life dispatching decisions. Delays are more significant in this case compared to Scenario 2, where all four tracks are out of service. RTC will attempt to keep each train to its original route, even if it may increase delays for that train. In real time, the railroads may choose to make the same decision, where they would rather take a delay on the train than reroute with the potential need for a host railroad pilot.

3.3.4 Scenario 4: Three track out of service Bridge Failure at Ashland Avenue, Southernmost Track in Service

This scenario assumes that the structural failure at the Ashland Avenue bridge causes removal of three existing rail tracks from service, leaving only the southernmost track in service. Figure 3–3 shows a screenshot of the infrastructure.

Figure 3–3 Bridge Failure at Ashland Avenue – Southernmost Track Open



Under this scenario, trains operate over the bridge at 3 mph maximum speed to simulate ongoing construction and Form B limits. Metra SouthWest Service and NS local and Landers Yard movements would be able to operate through the corridor. All other trains would need to operate via reroutes, as described in Scenario 2. Modeling results for Total Delay Hours and Delay Minutes per 100 Train Miles are in Table 3-11 and Table 3-12, respectively.

Table 3-11 Total Delay Hours (3 Day Capture) Network Wide Stats

Freight Train Only			
YEAR	NO BUILD	OUTAGE	DIFF
00	187.8	283.1	50.78%
05	218.1	353.4	62.02%
10	281.0	452.0	60.88%
15	339.2	553.5	63.17%
20	420.4	644.8	53.37%
25	519.7	794.4	52.85%
30	707.8	-	-

Table 3-12 Delay Minutes per 100 TM (3 Day Capture) Network Wide Stats

Freight Train Only			
YEAR	NO BUILD	OUTAGE	DIFF
00	49.4	72.7	47.21%
05	49.5	78.3	58.06%
10	59.0	92.6	56.99%
15	64.0	101.9	59.37%
20	73.6	110.3	49.85%
25	84.8	126.7	49.38%
30	106.6	-	-

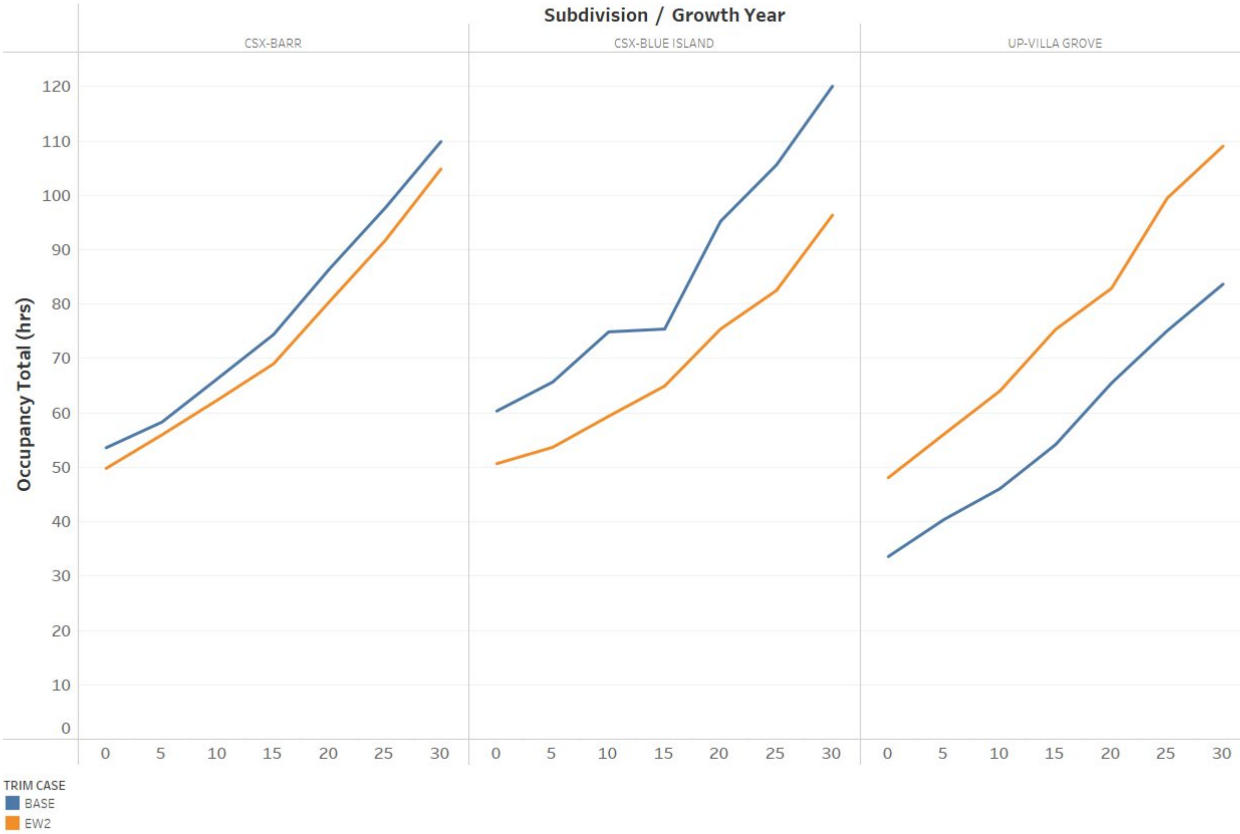
3.3.5 Scenario 5: Roadway Grade Crossing Delay Analysis

The construction of EW2 and P2 projects will provide CSX with a more efficient route for trains between BRC Clearing Yard, CSX Bedford Park Yard, CSX 59th Street Yard, and the UP Villa Grove Subdivision. Some trains route via either the CSX Blue Island or Elsdon Subdivisions, both of which have many at-grade crossings. Rerouting some trains via the 75th Street Corridor would reduce the amount of grade crossing blockage by trains on the other routes. A comparison of No-Build and Build EW2/P2 models shows the reduction in blocked roadway vehicle times for grade crossings on the CSX Blue Island and Elsdon Subdivisions and increases in blocked roadway vehicle times on the UP Villa Grove Subdivision with a change in some train routings via the UP Villa Grove Subdivision. The model measured and compared blocked roadway vehicle times in the No-Build and Build models for the years 2022 and 2052.

Using standard RTC outputs, node-level data was post-processed to derive individual road crossing occupancy times. This data reflects only the head-end arrival at one end of the crossing until the tail-end clears the crossing. It does not include additional time for gate arms to move to block or unblock vehicular traffic.

The data shown in Figure 3–4 filters out all subdivisions, except for the CSX Barr, CSX Blue Island, and UP Villa Grove. All road crossings specified within the RTC model combine to show an aggregate number by subdivision. The numbers on the horizontal access refer to the growth year of the model (0 through 30 years in 5-year increments) and the vertical axis shows the total road crossing occupancy time (in hours) for 4 days of simulation. The orange lines correspond with cases that contain the full EW2/P2 infrastructure in place while the blue lines correspond with base cases.

Figure 3–4 Total Occupancy Time in Hours for Key Roadway Crossings by Subdivision



The model indicates that grade crossing occupancy time does reduces on both the CSX Elsdon and Blue Island Subdivisions, but increases on the UP Villa Grove Subdivision, reflecting the rerouting of trains to via Villa Grove after completion of the EW2/P2 projects.