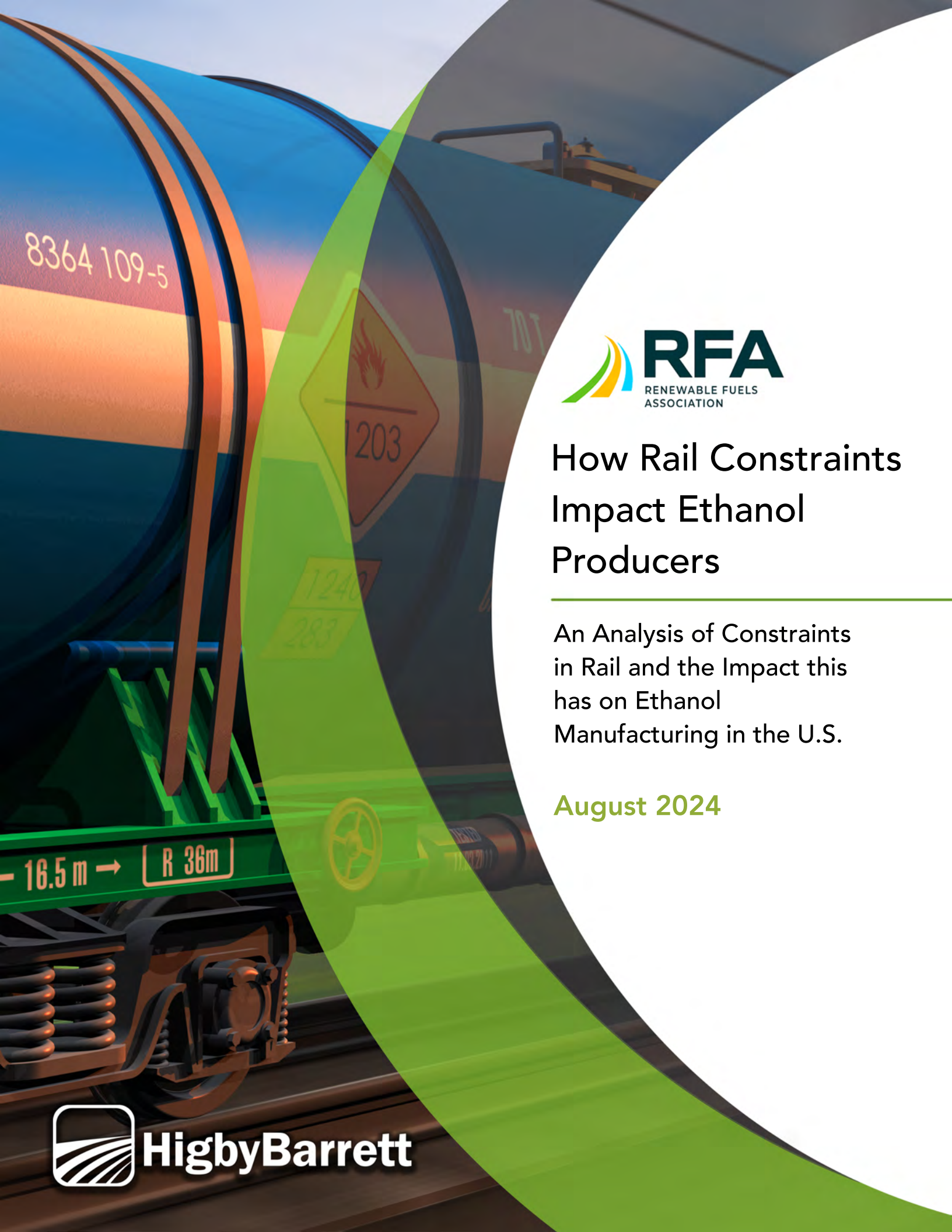

RFA
RENEWABLE FUELS ASSOCIATION

How Rail Constraints Impact Ethanol Producers

An Analysis of Constraints in Rail and the Impact this has on Ethanol Manufacturing in the U.S.

August 2024

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Executive Summary

This analysis of U.S. Class I railroad performance provides overwhelming evidence that Class I railroads differentiate service levels to their customers. And during periods of capacity constraints, whether due to equipment, weather or labor challenges, the differentiation in service levels across different types of rail customers becomes much wider and those adversely impacted are primarily ethanol and grain shippers. The service levels to crude oil, coal and intermodal customers remain consistent and dependable throughout, but not for ethanol and grain shippers. This is particularly egregious between crude oil and ethanol shippers, since equipment and crew requirements are essentially identical, yet service levels are vastly different. And unlike other rail freight shippers, the adverse economic impact resulting from poor rail service to the ethanol industry is more severe given the dependance on both inbound (grain into ethanol plants) and outbound (processed fuel and dried distillers grain) service. The unique operating conditions of ethanol plants places greater significance on efficient inbound (grain) and outbound (ethanol) rail service, particularly since ethanol plants have limited storage capacities for grain or ethanol fuel. Transportation service impediments directly impact their ability to keep processing, either from reduced rates (speed) of processing or to shut down. Both increase operating costs per unit and if service impacts last long enough, can ultimately close plants.

The analysis utilizes the publicly available weekly performance reports that the Surface Transportation Board requires each Class I railroad to submit. Service levels are primarily evaluated through dwell times at terminals, average train speeds and volumes by commodity type. The analyses are provided at both the industry (all Class I railroads) and individual railroad (each Class I) level. The information provided spans the years 2017 to fall 2023 and should support oversight by the STB to ensure service compliance by all Class I railroad providers. The resulting service level differentiation across shipping customer type is consistent across all Class I railroads, reflecting the economic pressure of the industry overall to prioritize service to the highest value customer from the railroads perspective. Grain and ethanol shippers represent significant proportions of railroad activity (volumes), but relative to other commodity shippers (coal, crude oil, intermodal) are likely lower margin business to the railroad and certainly more seasonally variable. Consistency and predictability allow the railroad to manage equipment and labor more effectively and efficiently, leading to lower costs and higher margins.

Railroads face equipment and labor constraints that do make it difficult to quickly adjust to operational changes, whether initiated by fluctuating freight demand or weather. Adding or reducing equipment or labor takes time, which is why the railroads have preferred long horizon contracts to plan effectively. Grain and ethanol shippers, due to the nature of the product being shipped, experience seasonal fluctuations that often contribute to service challenges,

It is recommended that the Renewable Fuels Association continue to monitor rail service levels ongoing and update reporting frequently. This information can be provided to their membership and the public on their web site with geographic data visualization capability to specifically identify affected customers. Encouraging other agricultural industry shippers (corn, soybeans and wheat) to likewise monitor rail service levels may also result in more effective rail performance. This collectively could be included into USDA reporting, given the overall agricultural industry representation. Appealing to the STB in real-time, as the RFA has done in the past, would greatly improve industry Class I rail performance. The STB has increasingly become more responsive to shipper complaints regarding Class I rail performance and more active in monitoring railroads' performance.

Introduction: Class I Railroad Performance Challenges Post Covid

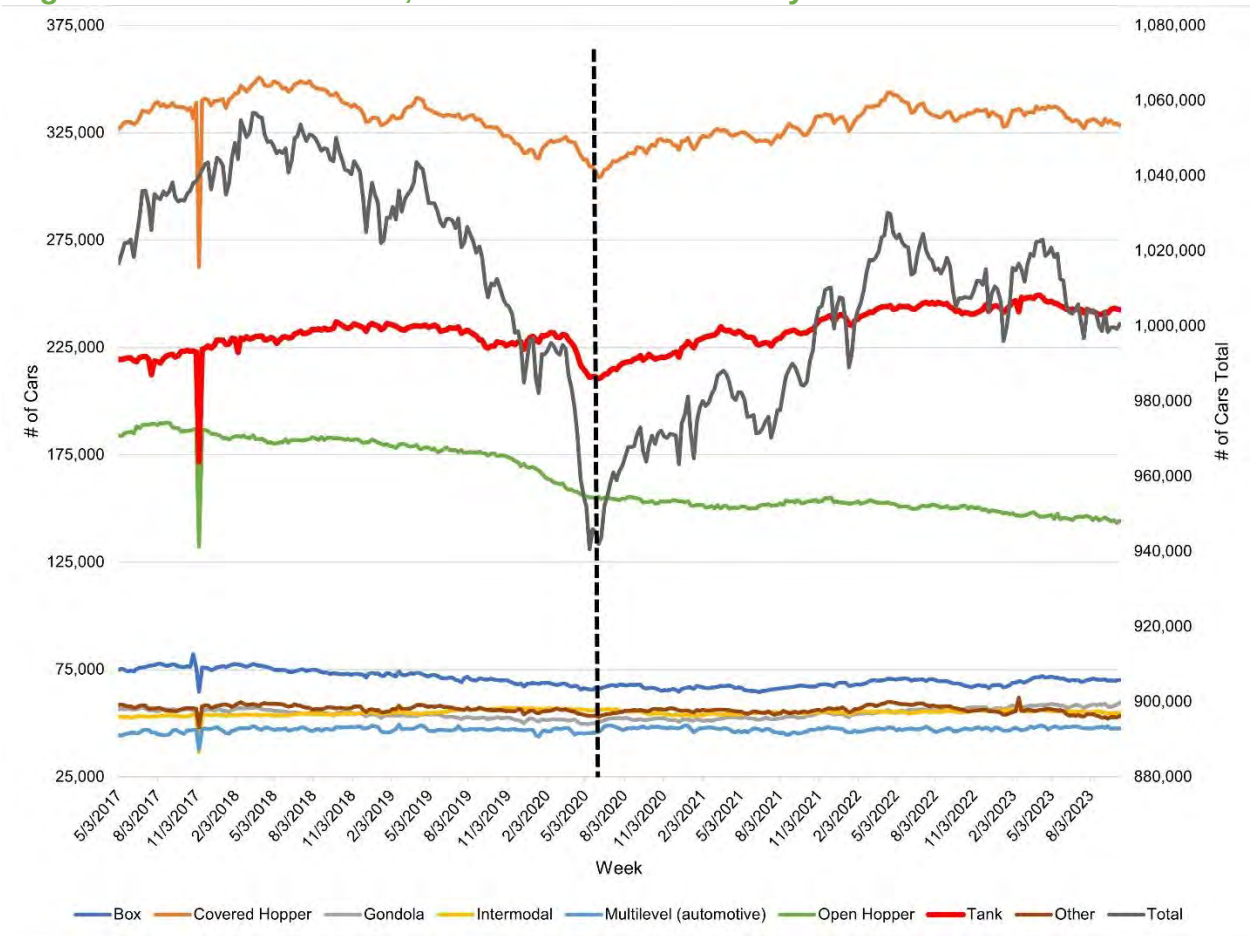
The U.S. Ethanol industry depends on efficient, reliable, consistent, and cost-effective transportation, both for grain moving into ethanol plants and more importantly for fuel leaving plants. Any service or cost disruptions for inbound and outbound transportation dramatically impedes plant operating margins and economic viability. Ethanol plants typically have limited storage capacity, both for corn and processed fuel, thereby placing far greater importance on reliable and dependable rail service. Two or three days past scheduled rail delivery service could result in ceasing operations. Over the past three years, the U.S. Ethanol industry has experienced severe challenges from the services provided by Class I railroads which most ethanol plants depend upon for moving ethanol fuel to blenders. This detailed analysis of the weekly rail performance data (provided by the Surface Transportation Board and required of all Class I railroads), reveals that ethanol shippers have been adversely impacted from the decreased rail service since the post-covid recovery. The following graphs and figures illustrate weekly rail performance, extending from 2017 to late fall of 2023 and depict how Class I railroad responded to the challenges faced by the pandemic.

Initially, going into the spring and summer of 2020, freight volumes across all Class I railroads plummeted to below 950,000 cars as illustrated in Figure 1 below. Total cars online had peaked above 1,060,000 cars in late 2017 with approximately 75 percent of those cars being covered hopper (35 percent), tank (22 percent) and open hopper (18 percent). But those volumes bottomed out in May/June 2020 and began growing substantially over the next two years. The Class I railroads had labor challenges getting crews back online during this time, but managed to maintain service to some customers, but not all Class I rail customers. As the rail volumes grew and the labor challenges more acute, the average terminal dwell times also began increasing for some rail customers (primarily grain and ethanol shippers), but automotive, coal and crude oil shippers of unit trains did not experience increases in terminal dwell times.

This is evident in Figure 2 below, comparing terminal dwell times before and after June 2020. Historically, dwell times for grain, ethanol and all other unit trains are significantly above automotive, coal and crude oil unit trains, even prior to June 2020. But as overall rail volumes plummeted toward the end of 2019 and early 2020, dwell times for ethanol and grain shippers approached service levels for the other commodities, falling below 15 hours across all unit trains. But once volumes picked up again after June 2020, terminal dwell times increased the most for ethanol and grain shippers while remaining unchanged (even decreasing slightly) for automotive, crude oil and coal shippers. The comparison between ethanol and crude oil is revealing since both products are moved in similar equipment (tank cars) and require similar crew (labor) demands. And even though many ethanol plants receive corn via truck, those plants which purchase unit trains of corn for inbound processing were caught with double the impact being unable to receive and send product, drastically impeding plant operations and economic viability. This is particularly problematic since ethanol plants have limited storage capacity, both for grain and ethanol. Rail service delays for both inbound and outbound deliveries can dramatically impede operations if extended long enough.

The challenges surrounding the pandemic (and subsequent labor) are not the only events that affect rail service and terminal dwell times. Weather events are likely the greatest contributor, including flooding (as was the case in 2019 throughout the Midwest), extreme cold or snow as has occurred throughout the upper Midwest during many winters.

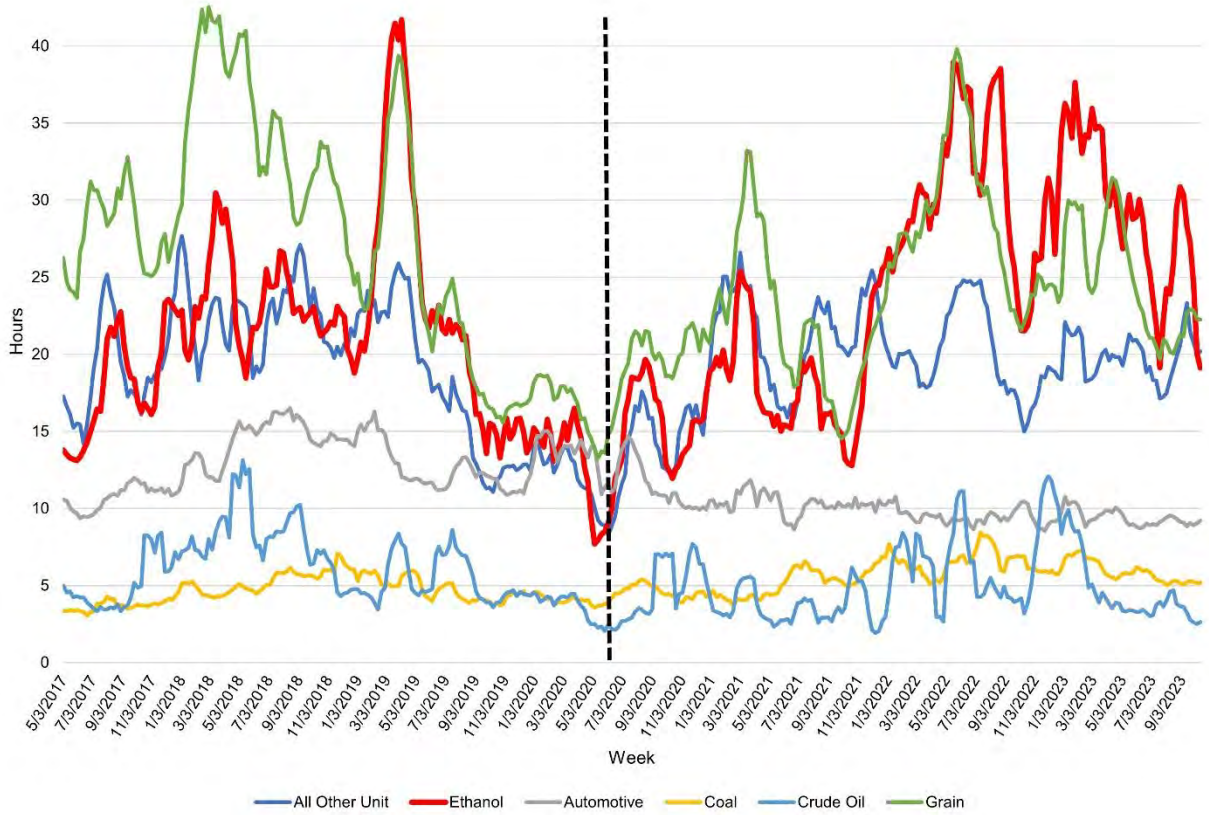
Figure 1: Class I Railroad, Total Cars Online Weekly



Source: Surface Transportation Board

Average train speed is another indicator of Class I rail service and the comparison across different commodity types is provided in Figure 3 below. The speed of trains revealed identical patterns going into and out of the pandemic, except for crude oil. Average train speeds increased as volumes declined, hitting the peak speeds in June 2020, and then declining precipitously once volumes began increasing after June 2020. The average speed of crude oil trains initially declined, but then increased significantly by early 2021 and clearly separated from average speeds revealed before the pandemic. This is important because the average speed of ethanol and crude oil trains was almost identical before June 2020, but not after. Ethanol train speeds remained around 20 mph while crude oil trains averaged above 25 mph for several months.

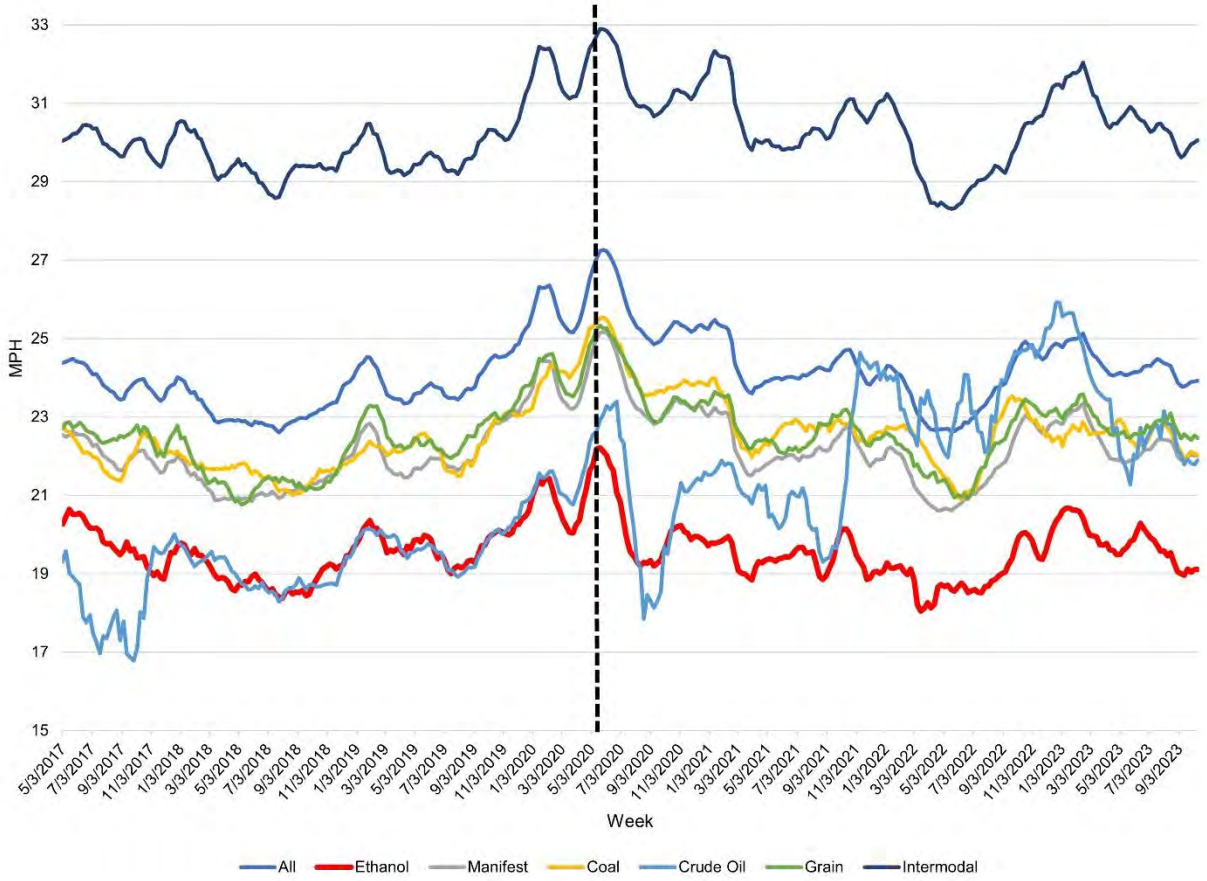
Figure 2: Class I Railroad Average Terminal Dwell Time, Hours



Source: Surface Transportation Board

The differences in train speeds also illustrate how intermodal trains maintain the fastest speeds, both before and after the pandemic, followed by grain and coal and with crude oil and ethanol being the slowest speeds. This is primarily due to the differences in weight density of the products and the hazardous nature of crude oil and ethanol.

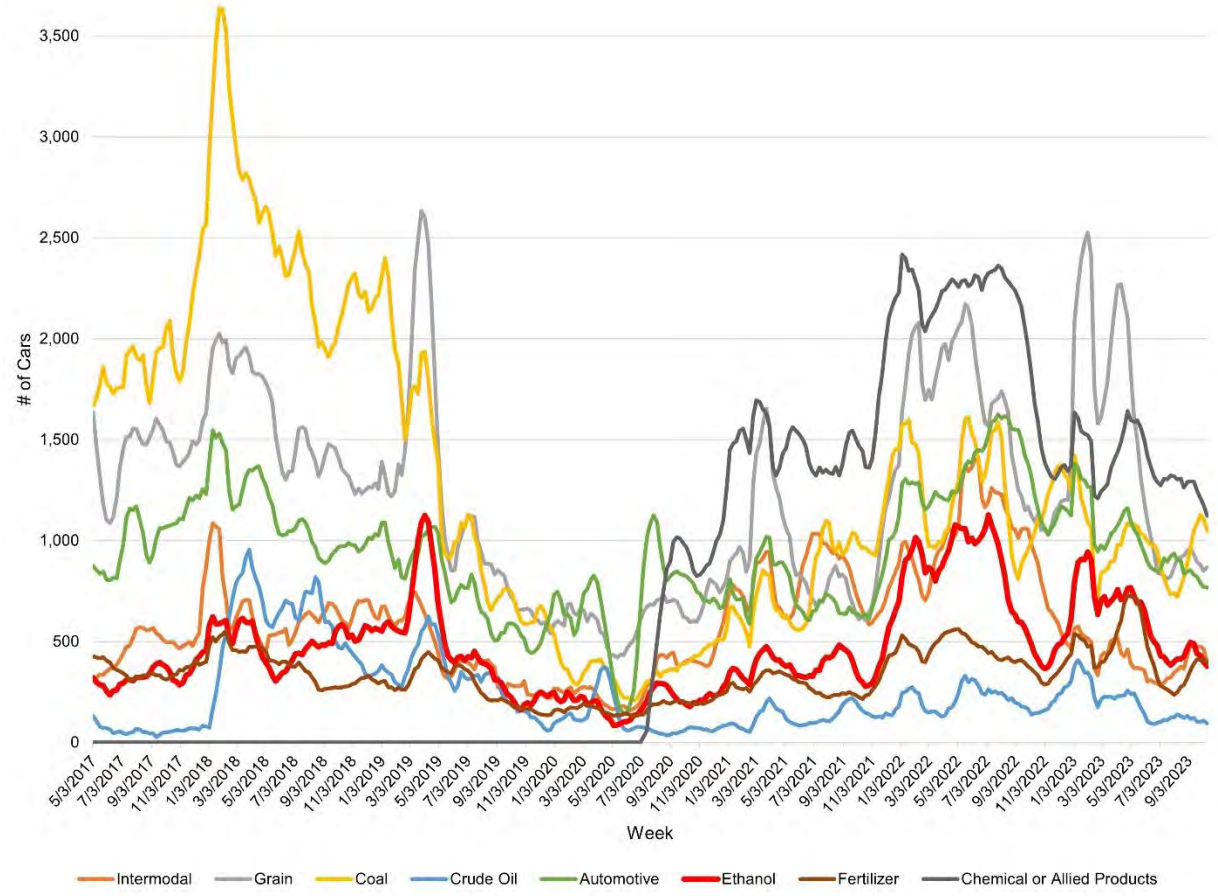
Figure 3: Class I Railroad Average Train Speed, MPH



Source: Surface Transportation Board

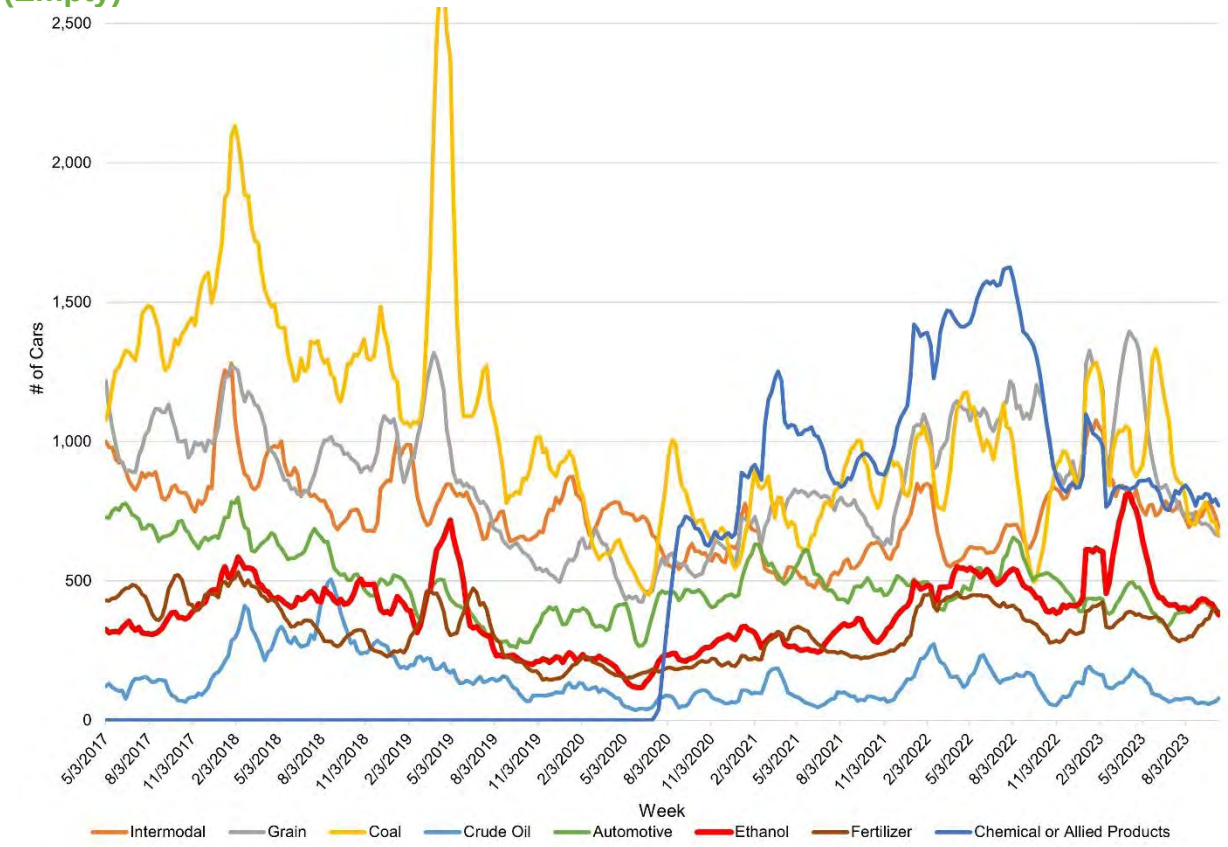
The last comparison at the Class I railroad industry level is the average number of cars in service that have not moved in more than 48 hours, those that are both loaded and empty. This measure is indicative of those shippers most disadvantaged from service challenges. As you can see from Figure 2 above, even in the most extreme terminal dwell times, they did not exceed more than 40 hours across all train types. The ethanol industry did have sizeable volumes of cars sitting more than 48 hours after June 2020, but not as severely as some other commodity types, most notably grain, chemicals, coal and automotive (loaded, Figure 4). The Class I railroads collectively maintained good service to the crude oil and fertilizer industries, as the number of loaded cars sitting more than 48 hours remained low after June 2020. The ethanol industry was mostly impacted between November 2021 and July 2023, as the number of loaded ethanol cars waiting longer than 48 hours more than doubled, going from below 500 to over 1,000 cars. A very similar scenario occurred for those empty cars waiting more than 48 hours. The number of crude oil cars not moved within 48 hours remained low for both loaded and empty crude oil cars, both before and after the pandemic.

Figure 4: Average Number of Cars in Service that have not moved in 48 hrs. (Loaded)



Source: Surface Transportation Board

Figure 5: Average Number of Cars in Service that have not moved in 48 hrs. (Empty)



Source: Surface Transportation Board

Class I Individual Railroad Performance Challenges Post Covid

The STB weekly performance reports offer limited information related to site specific operations, particularly by shipper or commodity type. But given that there are seven Class I railroads and each possessing a unique rail network and service to customers, this section allows a deeper focus within each Class I railroad to help identify geographical impacts and how service to ethanol shippers varied across different Class I railroads. The data provided for each railroad is terminal dwell times across different ***unit*** train types (rolling 12-week average for smoothing) and a map depicting the location of ethanol producing facilities, the primary terminal dwell times (since June 2020 and unique to each railroad), the railroad lines and aggregate estimated alcohol rail volumes across all railroads. The terminal dwell times for the maps include all train types but allows for comparison of how services varied geographically for each Class I railroad.

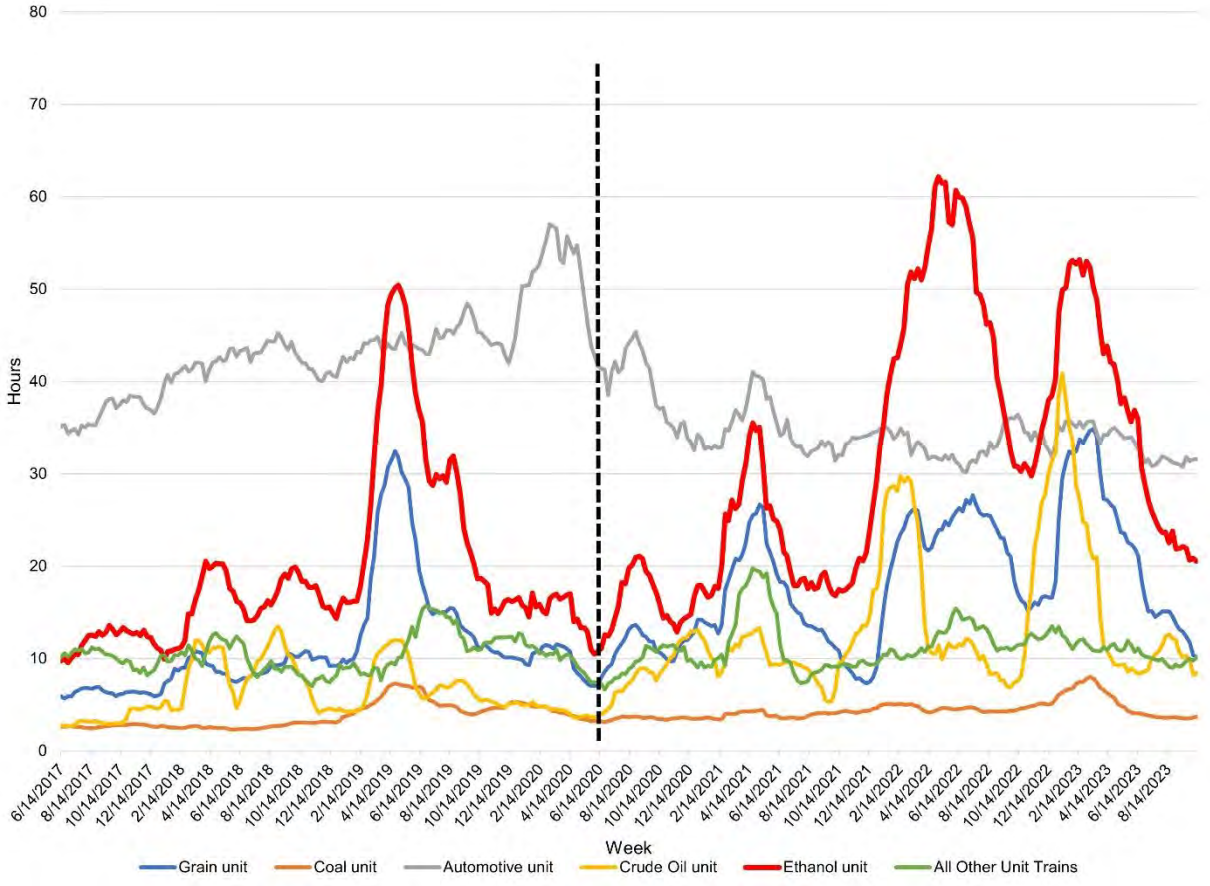
It is important to note that Class I railroads, like any transportation service provider, are focused on long term profitability. These railroads are optimizing long-term profitability over national networks and many different shipper and freight commodities which intrinsically can lead to difficult choices of providing optimal service across the breadth of customers. Infrastructure, equipment, and labor investments are long term decisions and cannot be quickly modified due to volatile or fluctuating freight demand. This is particularly true with labor, given the labor union agreements that Class I railroads must adhere to which limit their operating flexibility. The national Class I railroad trackage network was reduced by more than 30 percent following passage of the Staggers Act in 1980, as low volume lines with high operating costs were eliminated. This led to significant improvements in the ability of railroads to operate more efficiently, but also reduced network redundancy/resiliency which poses greater challenges when weather or accidents closes part of the network.

In addition, the Surface Transportation Board began requiring all Class I railroads to provide weekly performance reports in 2014. This information, publicly provided, has been critical to helping shippers highlight service problems and allowing the STB to be more responsive.

BNSF Performance

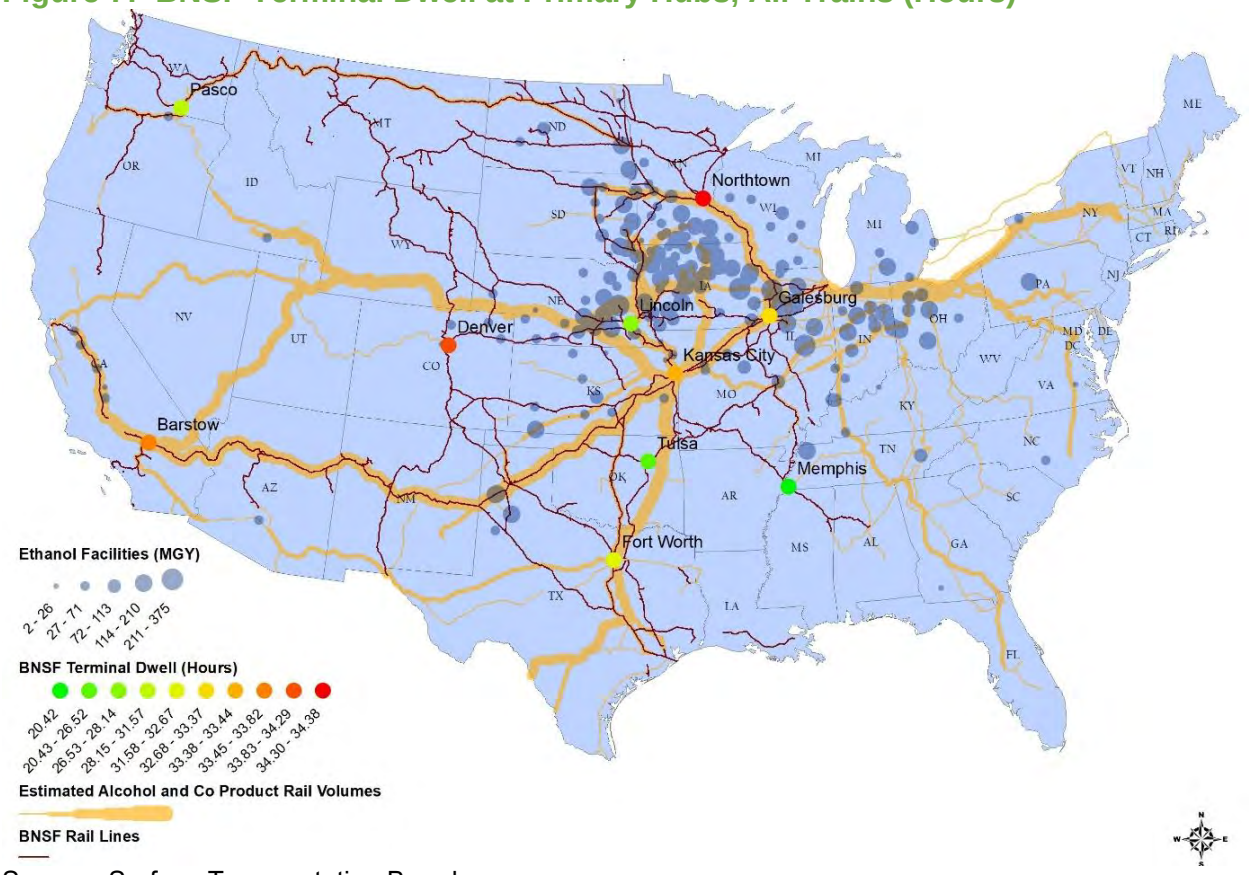
The average dwell times for BNSF trains is presented in Figure 6, and it illustrates how ethanol shippers faced the greatest dwell times after June 2020, even remaining high into May/June 2023. BNSF did a good job maintaining service to the coal shippers and all other unit trains, but service to ethanol, grain and even automotive suffered significantly. Even crude oil dwell times peaked twice, once in February 2022 and again in February 2023, most likely weather-related impacts. But ethanol shippers for BNSF saw terminal dwell times increase from below 20 hours in June 2020 to above 60 hours in May 2022. No other industry came close to this level of impact. The BNSF rail network is illustrated in red in Figure 7, along with the average terminal dwell times for all trains at primary BNSF terminals/hubs. The terminals with the highest dwell times for BNSF were Denver and Northtown, but significant service challenges at Galesburg, Kansas City, Barstow, and Fort Worth.

Figure 6: BNSF Dwell Time at Origin for Unit Trains (Hours)



Source: Surface Transportation Board

Figure 7: BNSF Terminal Dwell at Primary Hubs, All Trains (Hours)



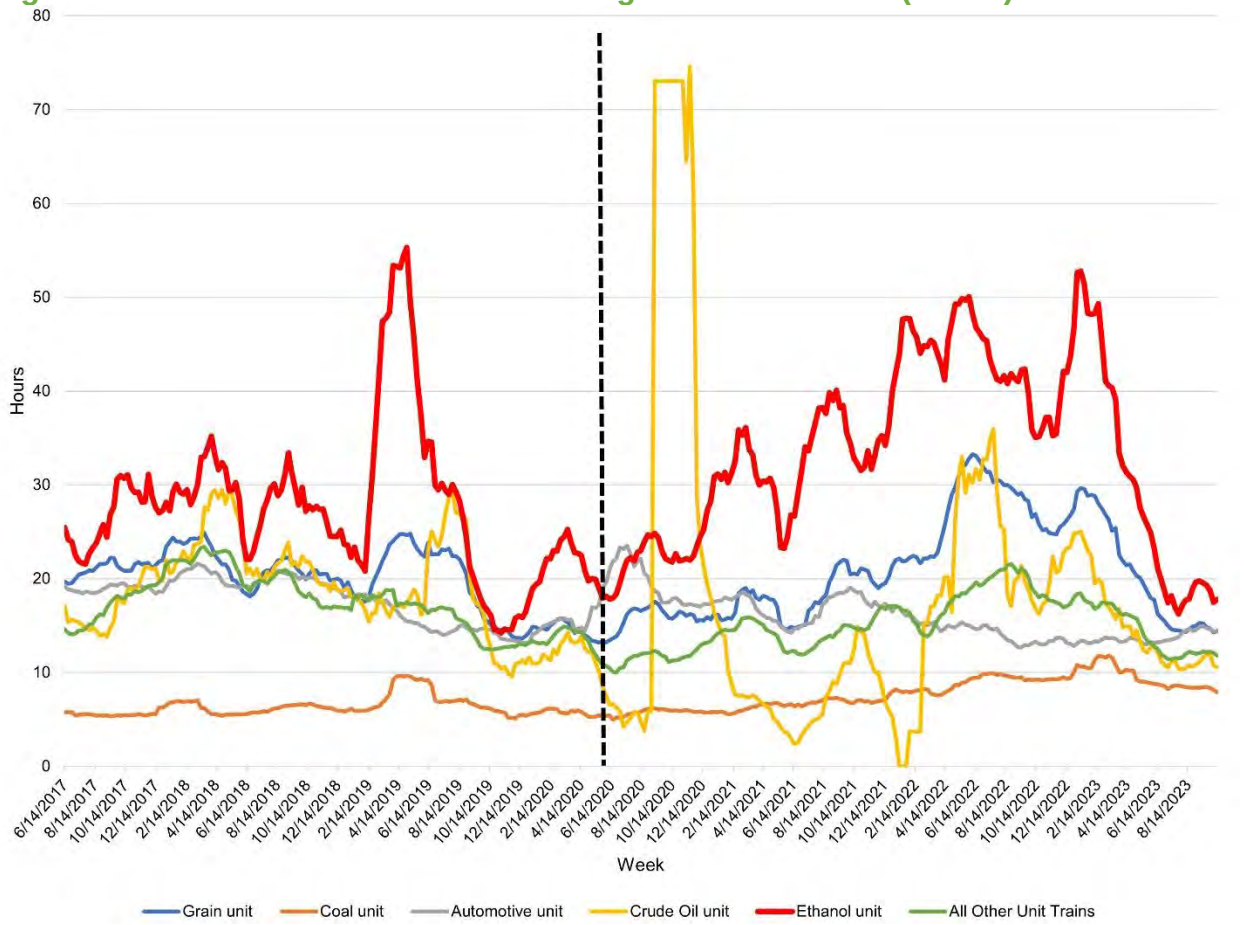
Source: Surface Transportation Board

Service in Lincoln, Tulsa and Memphis has remained quite good for BNSF, but those are not areas moving large volumes of ethanol. The two areas most adversely impacted from high terminal dwell times are ethanol shippers moving between Northtown and Galesburg and between California and Chicago.

Union Pacific Performance

The other western Class I railroad, Union Pacific, likewise has the highest terminal dwell times for ethanol unit trains, with those times increasing significantly since June 2020, as illustrated in Figure 8. There is greater variability on crude oil trains, given that dwell times exceeded 70 hours for UP in September/October 2020. But those dwell times for crude oil dropped within a few weeks, and while UP has had weeks where crude oil dwell times have increased substantially, those times are less than half the dwell times for UP ethanol shippers. Coal unit trains for UP have not been adversely impacted, like BNSF, with terminal dwell times remaining under 10 hours before and after June 2020. But UP ethanol shippers experienced dwell times increasing from near 20 hours to above 50 hours after June 2020.

Figure 8: Union Pacific Dwell Time at Origin for Unit Trains (Hours)

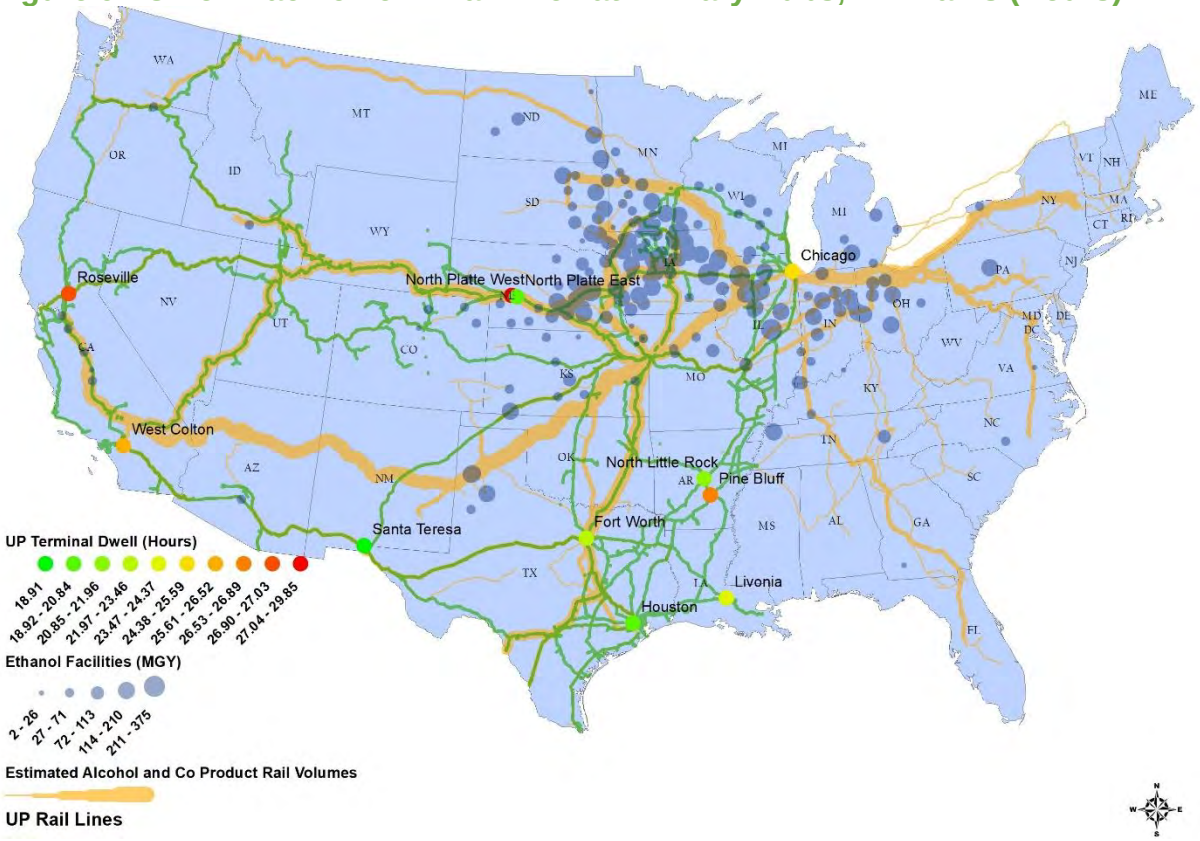


Source: Surface Transportation Board

The geographic location of Union Pacific's rail network is provided in Figure 9, along with terminal dwell times at key terminals and ethanol facilities illustrated. Generally, those terminals not handling much ethanol kept terminal dwell times relatively low, including Houston, North Little Rock, Santa Teresa and Fort Worth. Average terminal dwell times were high in Chicago, North Platte West, West Colton and Roseville. The pipeline for alcohol and ethanol products to the western U.S. is either on BNSF or Union Pacific, and both of those avenues have experienced high terminal dwell times accessing those markets. Also, where's BNSF services primarily ethanol facilities along the northern edge of the corn belt (Dakotas,

Minnesota, Wisconsin, and northern Iowa), Union Pacific pulls ethanol volumes out of central Iowa, eastern Nebraska and northern Illinois. Regardless of whether the ethanol plant was being serviced by BNSF or Union Pacific, customers were adversely impacted. This includes products moving west or south.

Figure 9: Union Pacific Terminal Dwell at Primary Hubs, All Trains (Hours)

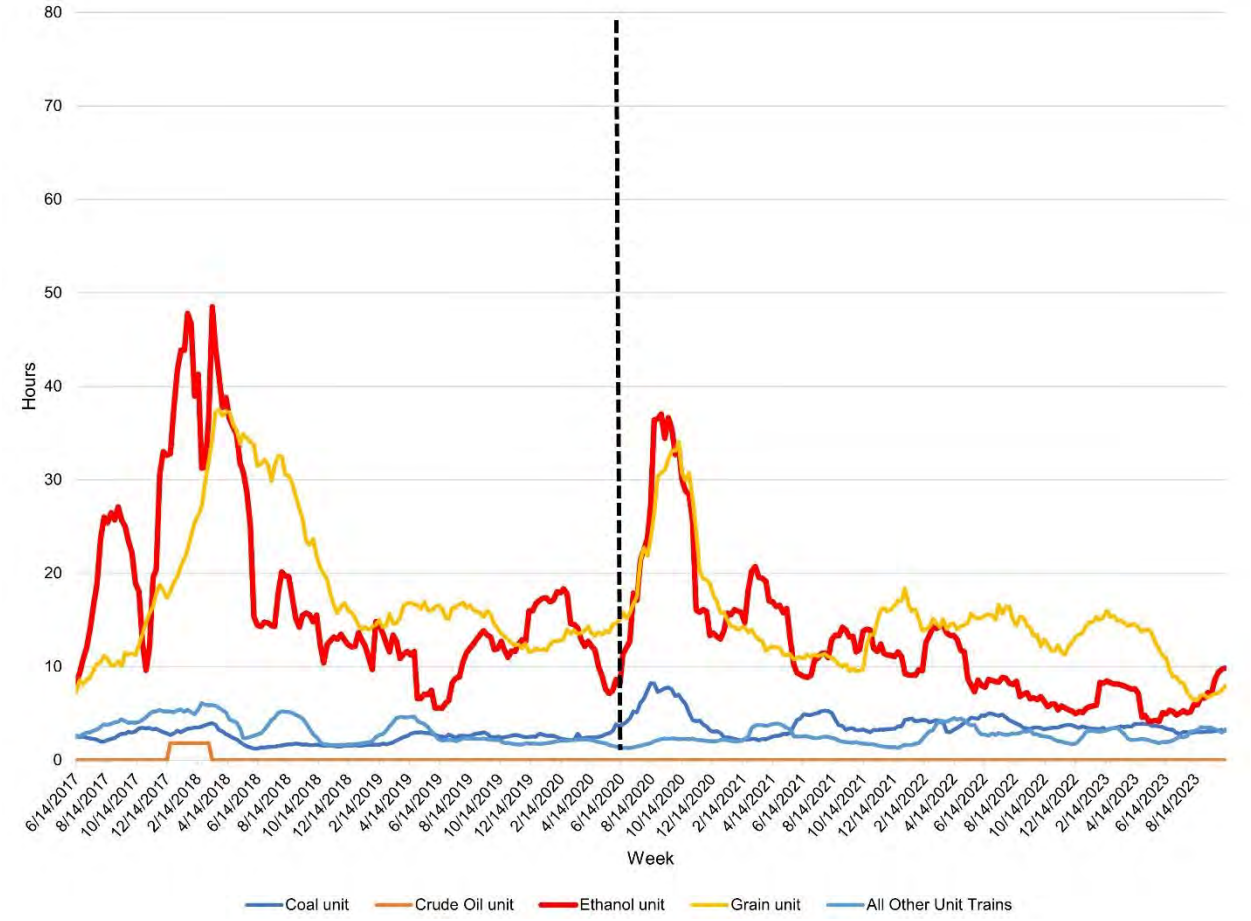


Source: Surface Transportation Board

Canadian National Performance

Canadian National rail service after June 2020, as measured in terminal dwell times, was significantly better than BNSF and UP, as illustrated in Figure 12. Average terminal dwell times for ethanol and grain trains at CN were still the highest across all unit trains, but lower as compared to other Class I railroads. Also, the periods when dwell times peaked were not sustained high. Average terminal dwell times for ethanol and grain trains remain mostly under 20 hours until January 2022, rising to near 38 hours and again in January 2023, this time peaking at 55 hours. Dwell times for coal and crude oil trains are consistently below all other unit trains, as is the case at BNSF and UP.

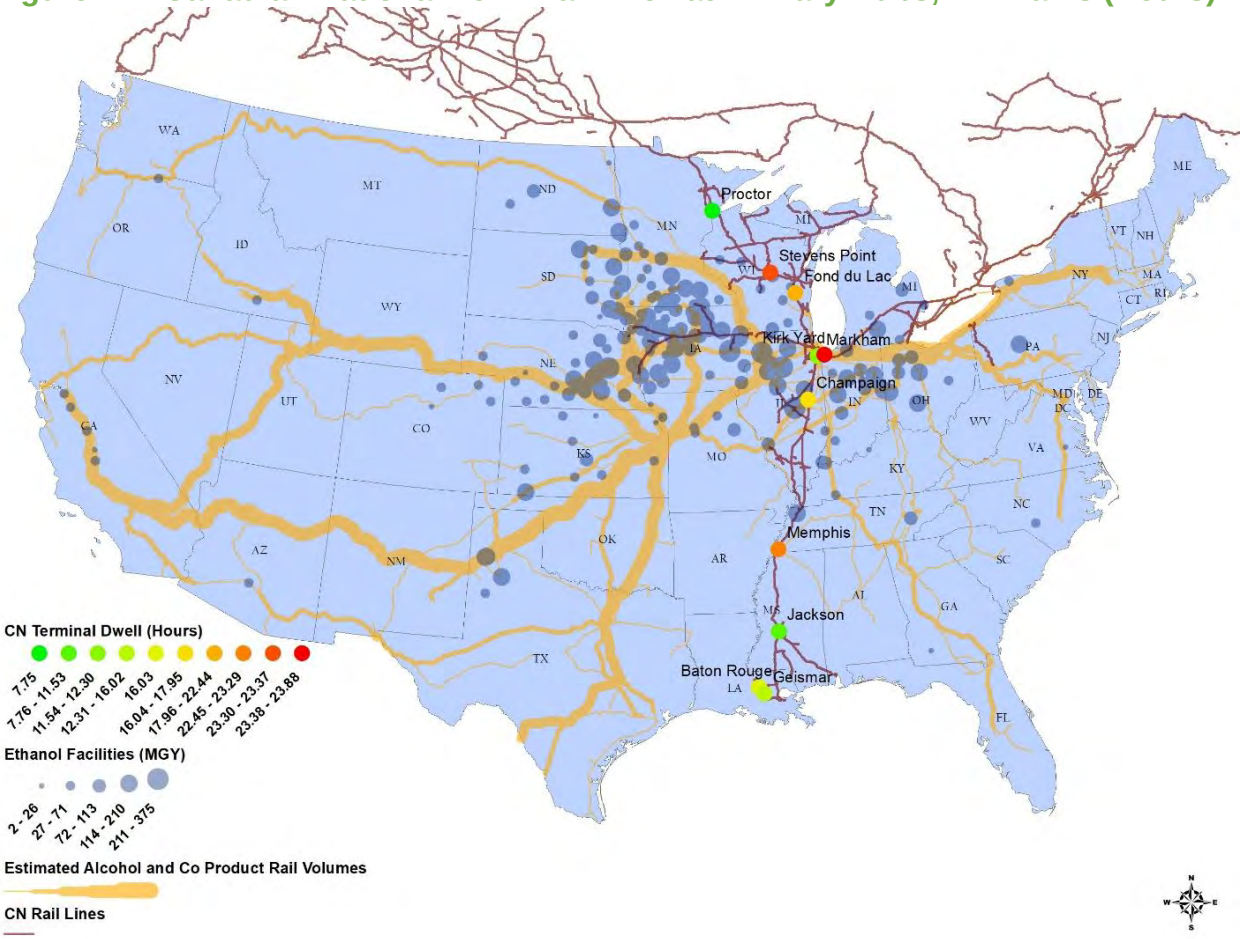
Figure 10: Canadian National Dwell Time at Origin for Unit Trains (Hours)



Source: Surface Transportation Board

Canadian National's rail network within the U.S. is limited, primarily serving a north/south corridor between Chicago, IL and New Orleans, LA. CN experienced the highest terminal dwell times at Stevens Point, Markham and Memphis, but relatively small volumes of ethanol moved on that corridor. That corridor does move significant volumes of crude oil coming out of Canada for refining operations in the center gulf region. But as Figure 10 illustrates, no terminal delays impacted crude oil unit trains for CN. The ethanol shippers that would have been adversely impacted would have been served on the line that runs west out of Markham (Chicago) through central Iowa and connecting with southern Minnesota and eastern Nebraska.

Figure 11: Canadian National Terminal Dwell at Primary Hubs, All Trains (Hours)

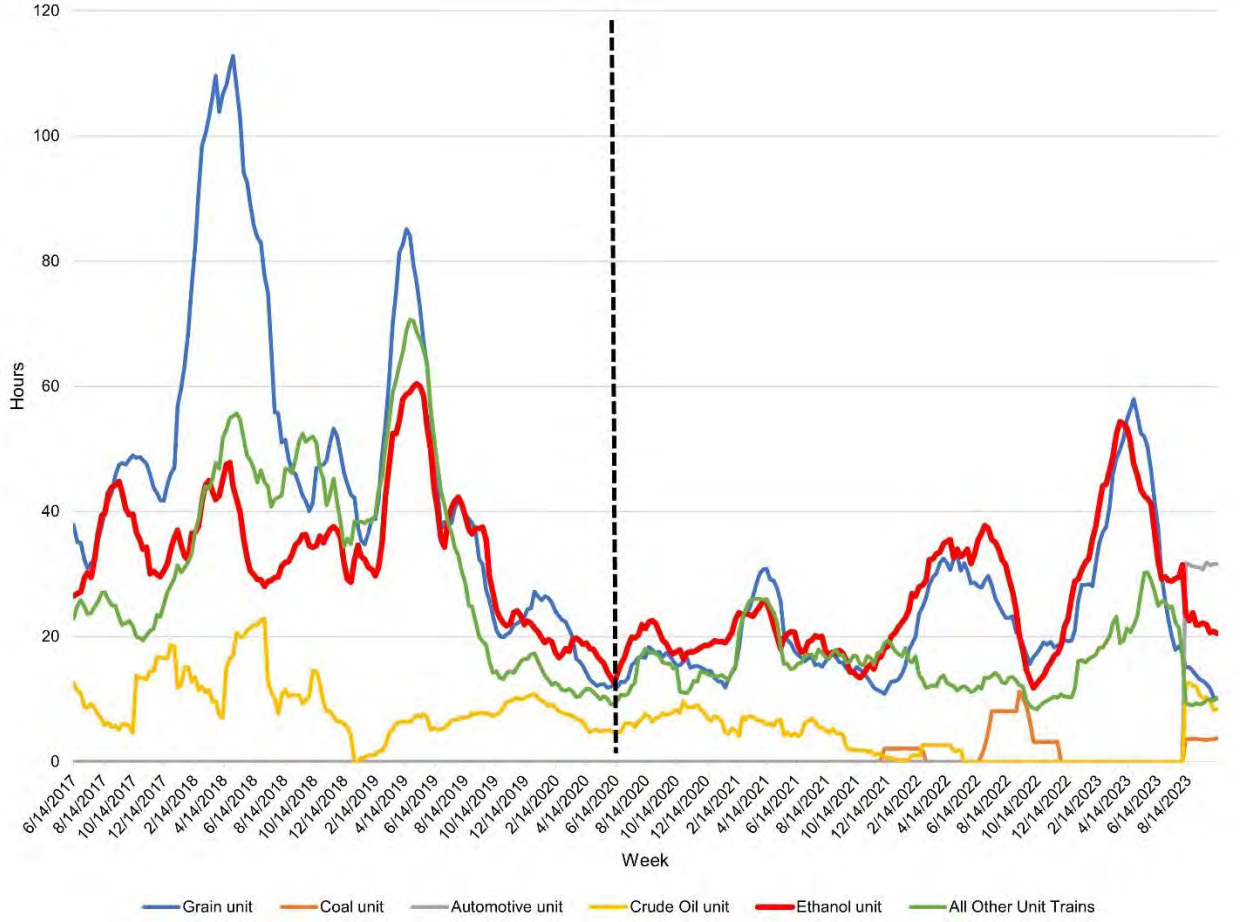


Source: Surface Transportation Board

Canadian Pacific Performance

Canadian Pacific and Kansas City Southern have merged operations but reporting to the Surface Transportation Board remains separate and therefore their performance is separated here. Both Canadian railroads exhibit similar patterns in the timing of when terminal dwell times peaked after June 2020, both occurring in the heart of winter and likely exacerbated due to weather effects. What is evident in Figure 12 is that Canadian Pacific was experiencing severe terminal dwell times for ethanol shippers in the winters of 2017/2018 and spring of 2019. Terminal delays for ethanol unit trains exceeded 100 hours and 80 hours respectively. But service at Canadian Pacific was very good throughout 2020 and most of 2021, predominately remaining below 20 hours for that two-year period. Like each of the previous Class I railroads, when service challenges occur, it is ethanol and grain shippers that bear the brunt, not coal or crude oil shippers.

Figure 12: Canadian Pacific Dwell Time at Origin for Unit Trains (Hours)

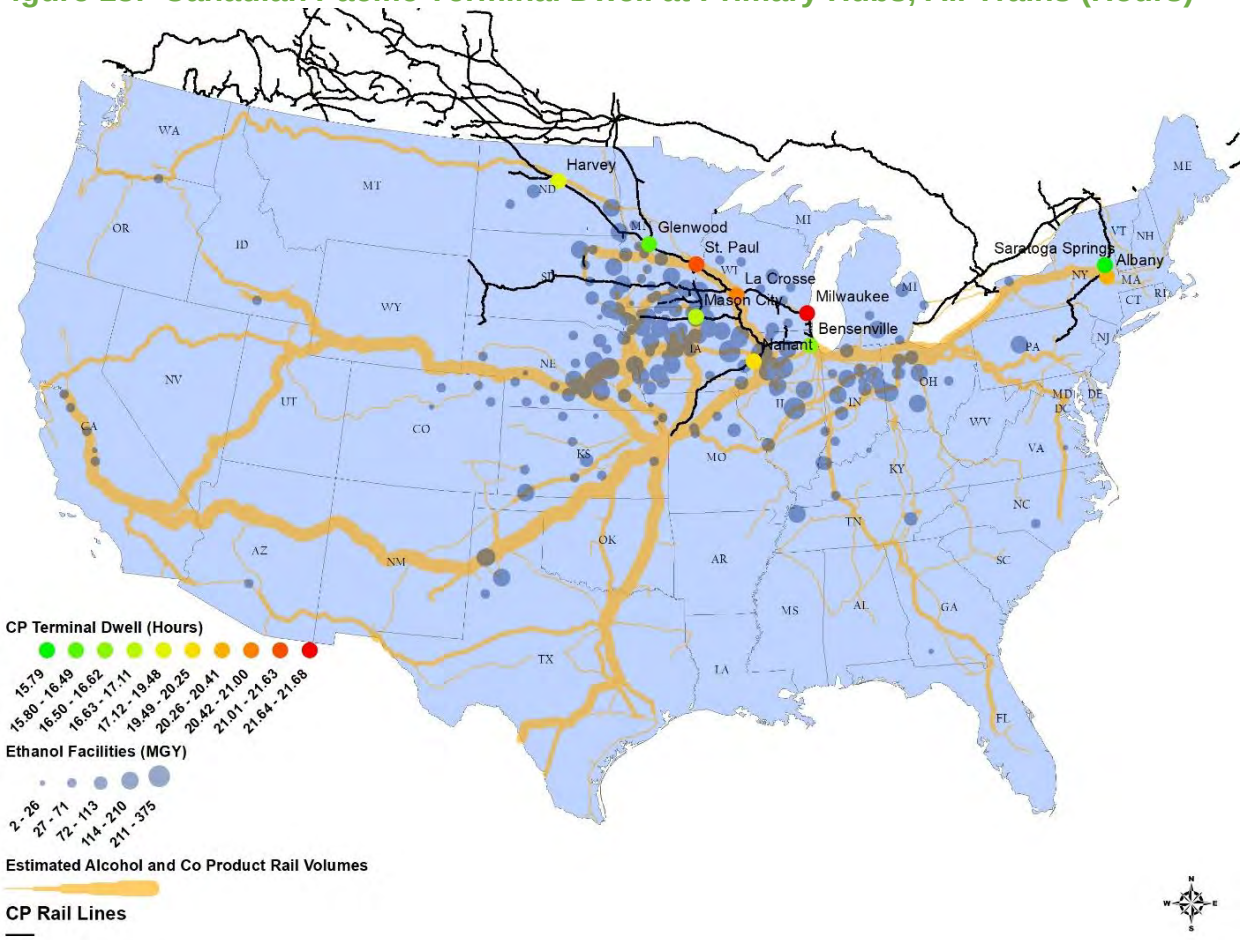


Source: Surface Transportation Board

Canadian Pacific's rail footprint in the U.S. is also geographically constrained, compared to BNSF and UP, as illustrated in Figure 13. One thing to notice is that the performance (as measured in terminal dwell across all product types) of CN and CP is overall much better than BNSF and UP. The scale/distribution for both Canadian railroads never exceeds 24 hours for the red areas on the map. BNSF had terminals exceeding delays of 34 hours and UP delays of 30 hours. On the lower end of the scale, those delay times

are also much lower for both Canadian railroads. Amongst CP terminals, the Milwaukee, St. Paul and La Crosse terminals had the highest dwell times with Glenwood, Mason City, Albany and Bensenville having the lowest terminal dwell times. Given that CP as rail track that comes into La Crosse from South Dakota, ethanol shippers served across South Dakota and southern Minnesota would have been adversely impacted from high terminal dwell times.

Figure 13: Canadian Pacific Terminal Dwell at Primary Hubs, All Trains (Hours)

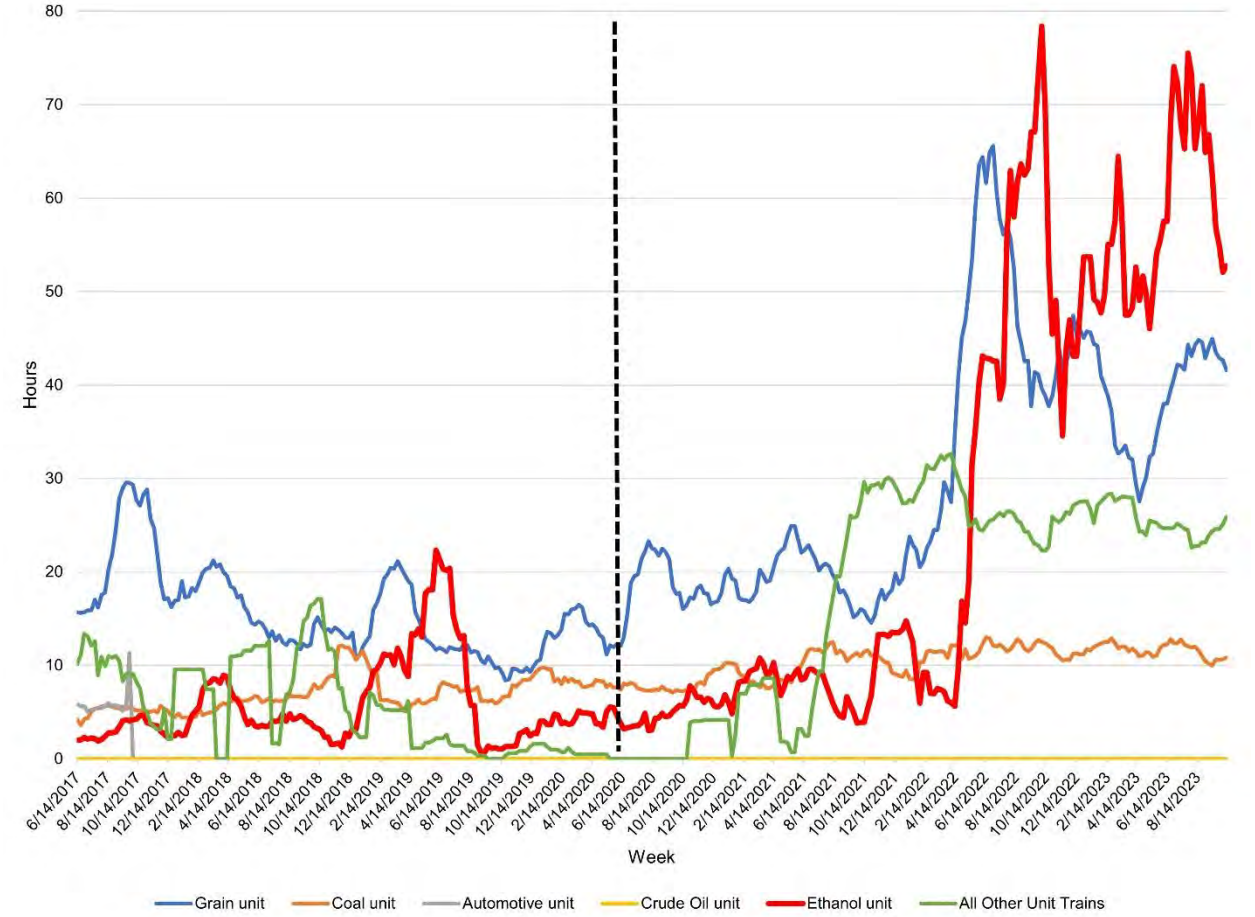


Source: Surface Transportation Board

CSX Performance

Ethanol producers moving product to eastern markets were most severely impacted by CSX service challenges, as illustrated in Figure 14. CSX had been maintaining very low terminal dwell times for all unit trains since the beginning of 2017, far better than any other Class I railroad. But after June 2020 those terminal dwell times climbed to record levels for grain and ethanol shippers. Terminal dwell times for ethanol unit trains increased from below 10 hours to above 70 hours and for grain unit trains from near 20 hours to above 60 hours. Those high terminal dwell times have persisted for CSX even today. Terminal dwell times on their coal unit trains have creeped up slightly, going from just below 10 hours to slightly above 10 hours, but no delays on crude oil unit trains.

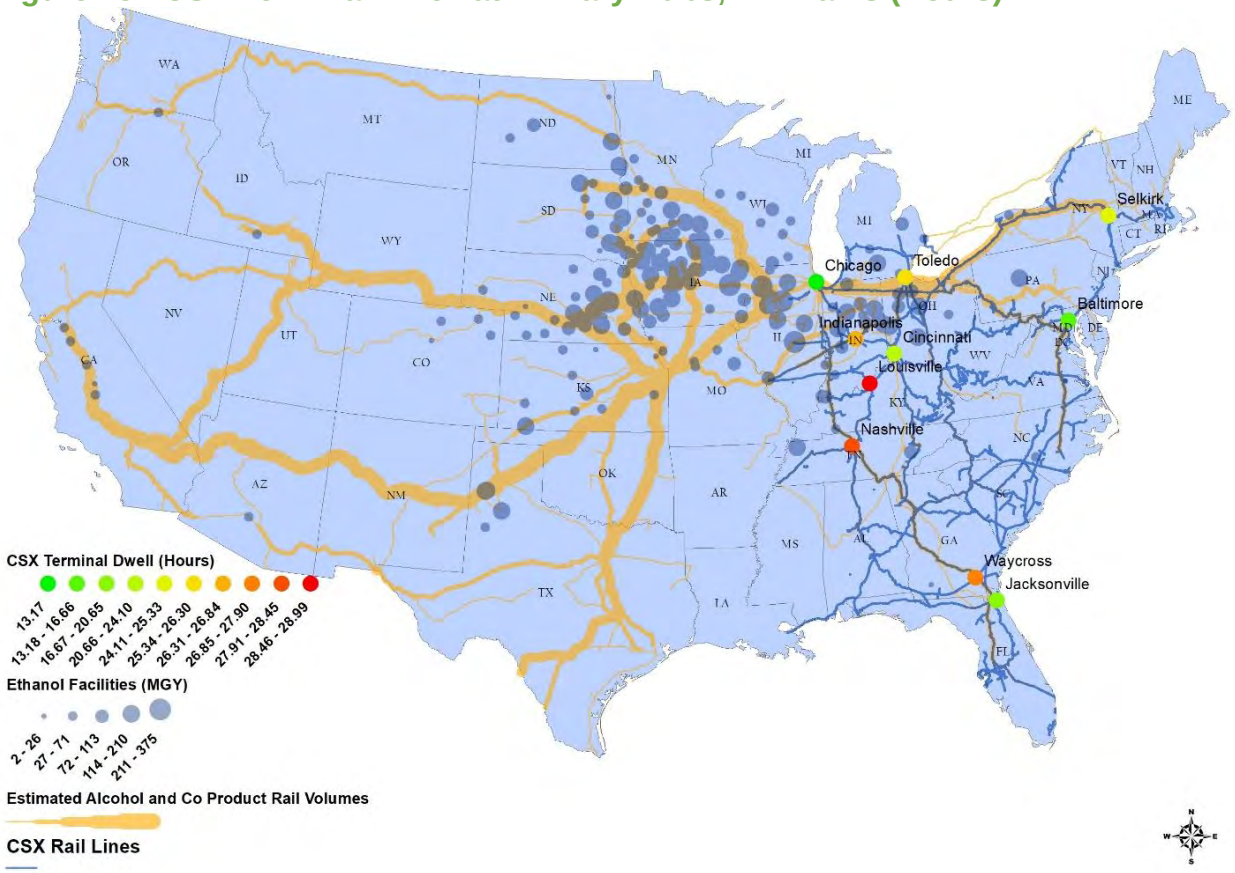
Figure 14: CSX Dwell Time at Origin for Unit Trains (Hours)



Source: Surface Transportation Board

The CSX rail network is displayed in Figure 15 and services markets east and south of Chicago, particularly central New York, Baltimore, and Jacksonville. Ethanol producers in Indiana, Ohio and Kentucky are those most disadvantaged by poor CSX service and high terminal delays. The Louisville and Nashville terminals have the highest terminal delays, exceeding 27 hours. This is followed by Indianapolis, Toledo and Waycross. Terminal operations for CSX in Chicago, Baltimore, Cincinnati, and Jacksonville is relatively good.

Figure 15: CSX Terminal Dwell at Primary Hubs, All Trains (Hours)

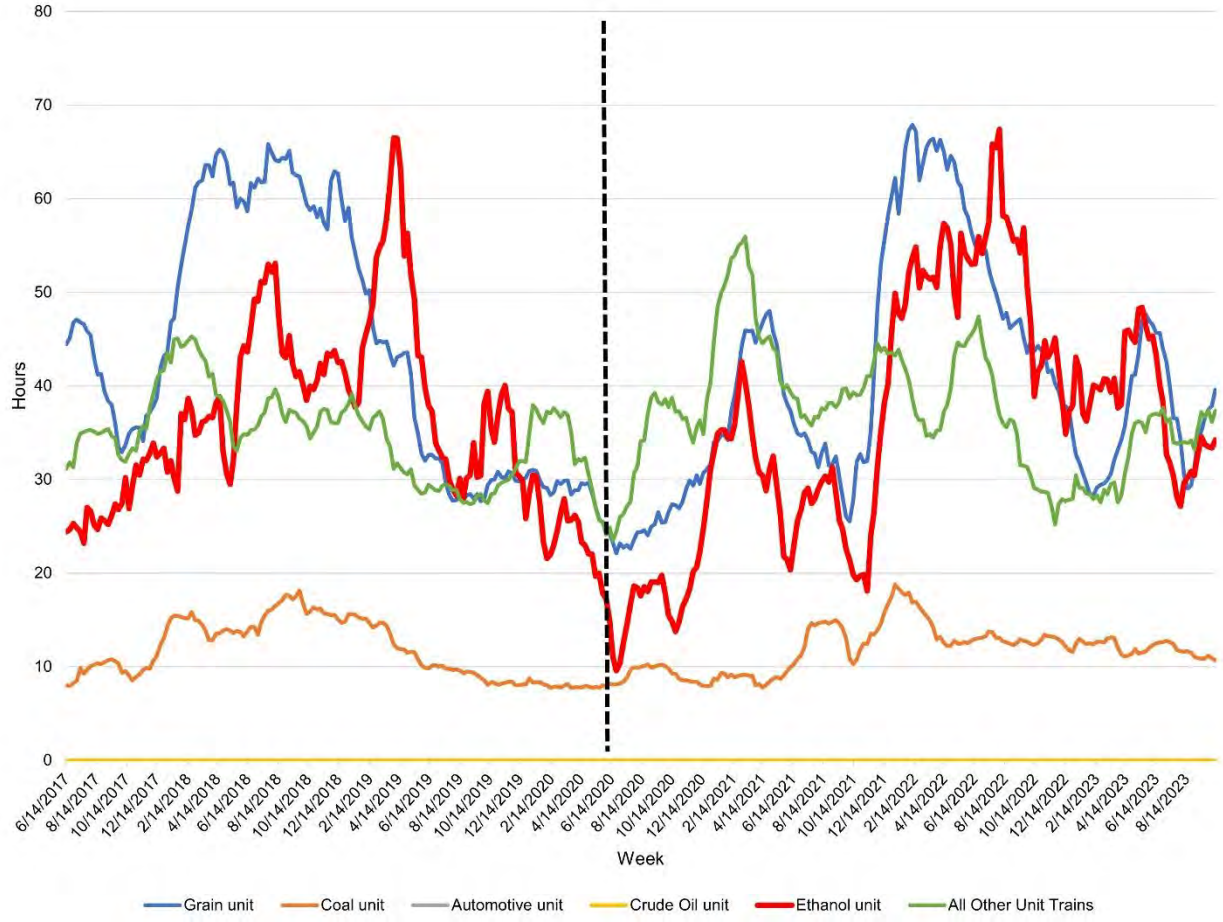


Source: Surface Transportation Board

Norfolk Southern Performance

The one constant with Norfolk Southern railroad is that service was bad before June 2020 and remained bad afterwards. Terminal dwell times for grain and ethanol unit trains reached 65 hours between January 2018 and March 2019 before declining below 25 hours in June 2020. But those dwell times jumped back to the 65-hour range between December 2021 and September 2022. Norfolk Southern doesn't report any delays for crude oil trains and coal trains have maintained consistent terminal dwell times since 2017. This is a similar pattern across all Class I railroads, between 10 to 15 hours delay.

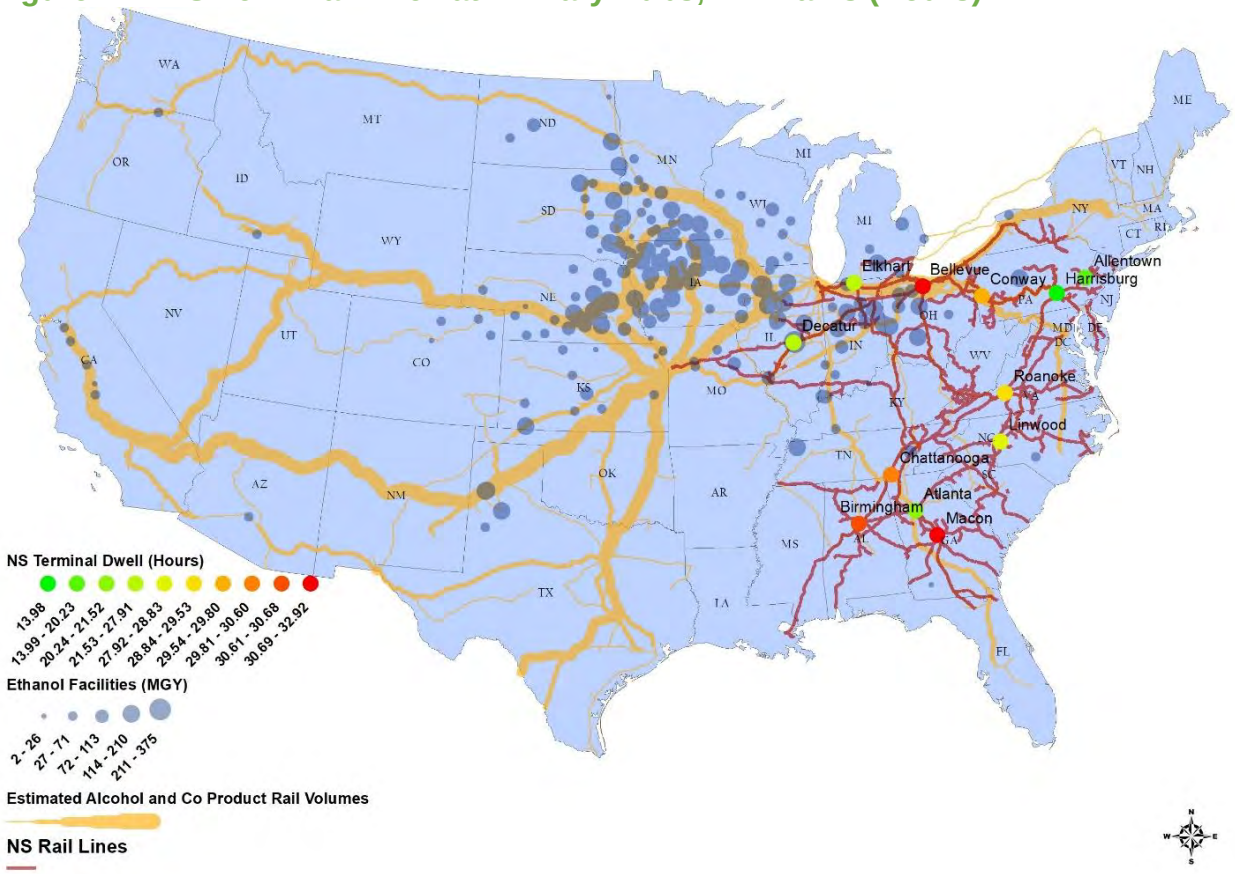
Figure 16: NS Dwell Time at Origin for Unit Trains (Hours)



Source: Surface Transportation Board

Ethanol shippers moving product east primarily rely on either CSX of Norfolk Southern. The rail network for Norfolk Southern is displayed in Figure 17 and covers comparable geography as CSX, albeit not identical. Norfolk Southern terminals experiencing the highest dwell times included Macon, Bellevue, Birmingham, Conway, and Chattanooga. These terminals have all averaged above 30 hours delay since June 2020, impacting any freight moving through them. Relatively low dwell times have been experienced at Decatur, Elkhart, Allentown, Harrisburg, and Atlanta.

Figure 17: NS Terminal Dwell at Primary Hubs, All Trains (Hours)

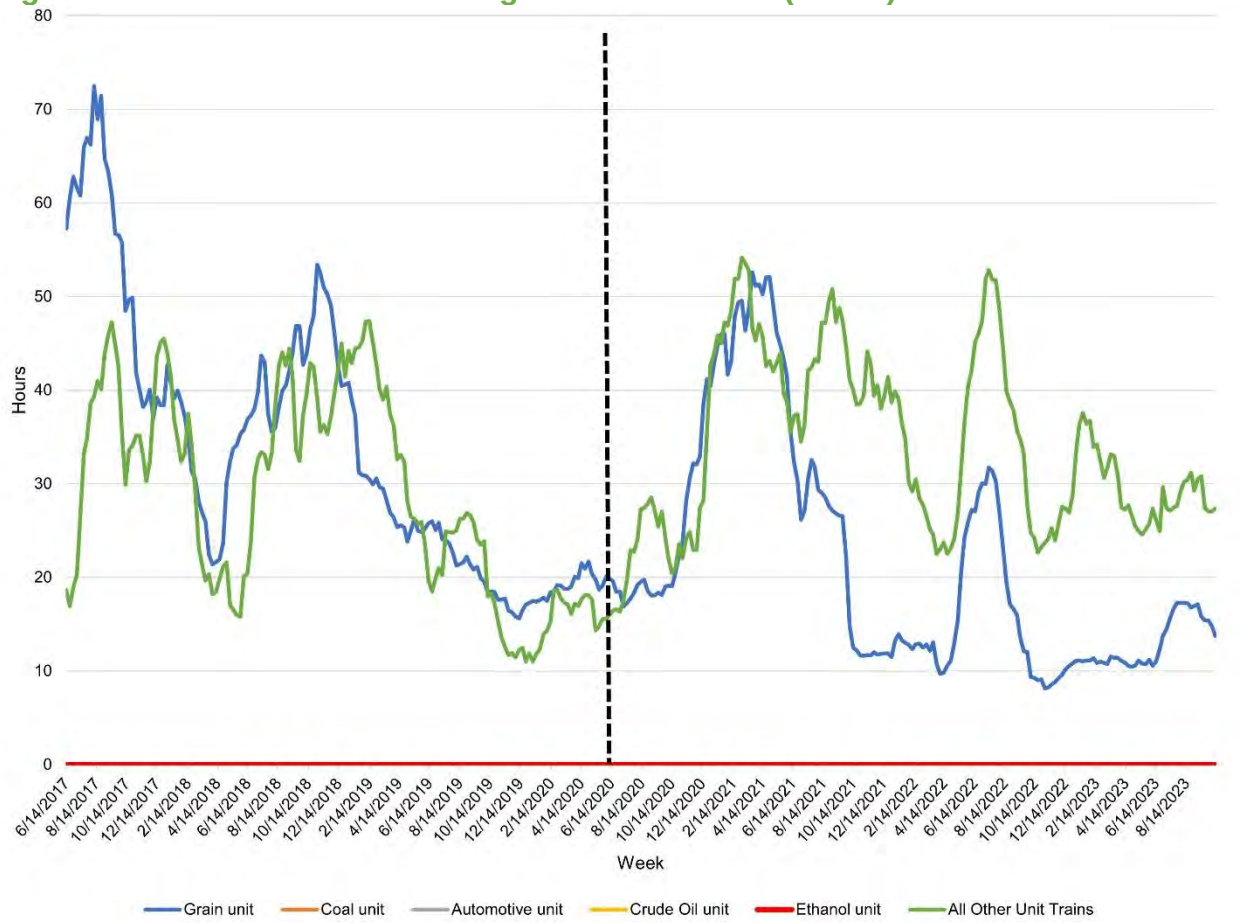


Source: Surface Transportation Board

Kansas City Southern Performance

Kansas City Southern is the final Class I railroad and report no delays for ethanol unit trains in their weekly performance reports to the STB. This is likely a reporting omission (error), given that KCS does move ethanol into the Mexico market and would have at least some terminal dwell times for ethanol shipments. KCS did report terminal delays for grain and all other unit trains, and those delays have fluctuated widely since 2017. Those delays reached a peak in June 22017 with grain unit trains experiencing delays above 70 hours and all other unit trains about 45 hours. Those delays dropped to below 20 hours by June 2020, but then climbed back to above 45 hours by March 2021. Those delays have since receded to below 30 hours for all unit trains and below 15 hours for grain trains.

Figure 18: KCS Dwell Time at Origin for Unit Trains (Hours)



Source: Surface Transportation Board

The combined entity of Canadian Pacific and Kansas City Southern will like have opportunities to move significant volumes of grain and ethanol in the future, given the advantageous geographical coverage of origination opportunities for both products. But prior to the merger, KCS is likely the smallest of Class I rail shippers of ethanol given location of trackage (Figure 19). The high terminal dwell times at KCS facilities may have adversely impacted grain and other unit trains but are unlikely to have had much impact on ethanol shipments. Those terminals with the highest delays included Shreveport, Beaumont, Leesville, and Jackson. Those terminals with the lowest delays included Meridian, Latanier, Wylie and Heavener.

Figure 19: KCS Terminal Dwell at Primary Hubs, All Trains (Hours)

Source: Surface Transportation Board

Economic Impact of Rail Service Challenges

Estimating the direct economic impact of rail service challenges to the ethanol industry, or specific ethanol plant locations is difficult given that historical data is aggregated to the national level and the limited data availability at the site-specific location. Additionally, there are many factors at play that impact ethanol operations and profitability over time, including grain prices, fuel demand, access to truck transportation and natural gas prices. Attributing specific impacts to the ethanol industry solely on reduced rail service varies widely depending on existing conditions, and mostly, existing conditions at the localized level. We offer two approaches that utilize existing data on impacts to operating cost and economic impacts associated with carrying higher inventories (stocks) and the lost market value realized. These impacts can be gleaned from comparison of railroad performance against ethanol production, stocks, returns above operating cost and corn prices, which is provided below in Figure 20.

Economic Impact of Lost Market Value Realized

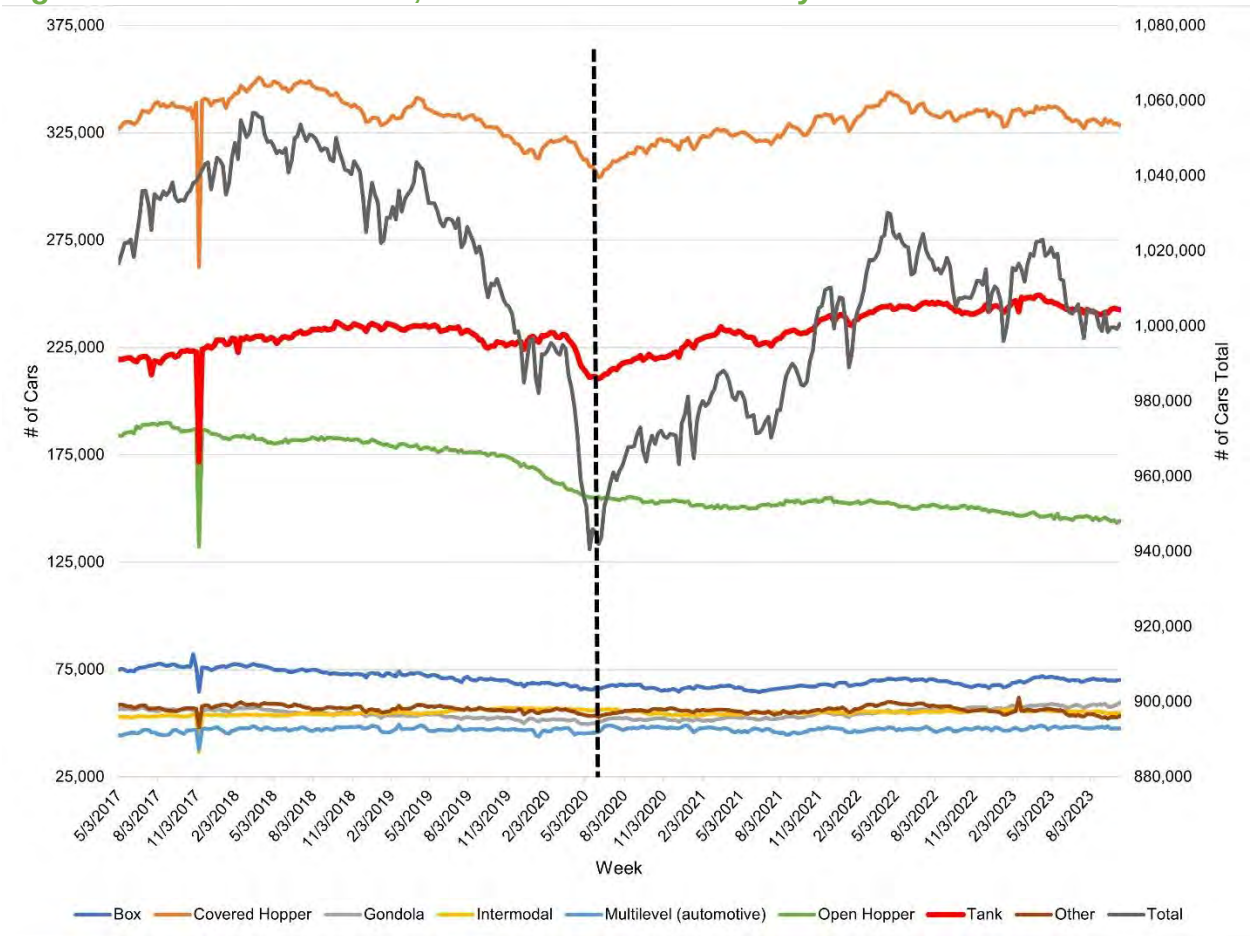
The time horizon on the graphs below is identical, spanning from March 2017 until October 2023, with the black dotted vertical line indicating when Covid-19 impacted all operations. The top figure displays weekly ethanol production (thousand barrels per day) and ethanol stocks (million barrels) against the weekly number of ethanol rail cars (both loaded and empty) for all Class I railroads scheduled to be moved but have not moved in more than 48 hours. This performance metric may be considered the most severe service limitations, adversely impacting ethanol plant operations far more than the earlier dwell time delays presented above. Comparing how the metric changes over time and relative to the ethanol operating metrics reveals how operations change as rail performance decreases. The bottom figure displays the average price of corn (dollars per bushel) and ethanol production returns above operating costs (dollars per gallon).

Class I railroad service challenges impacting ethanol shippers were pronounced over two distinct periods, the first period being between August 2017-July 2019 and the second period after Covid-19, between late 2020 and through the fall 2023. During the first period, ethanol production returns over operating cost decline precipitously from near $.40 per gallon to near zero. This coincides with a period when corn prices were generally increasing, being driven by steady increases to both domestic and export demand.

Ethanol stocks, while varying widely week to week, generally increased over this period with production relatively constant. But a quick inspection of Figure 20 reveals that intermodal and grain cars were the only rail car types experiencing increases in volumes during this period, likely pulling equipment and labor away from ethanol shippers and thereby resulting in service delays beyond 48 hours.

During this period, the number of ethanol rail cars left sitting for 48 hours or more increased from a low of 600 to above 1,800, or between 18 million gallons to-54 million gallons of ethanol (assuming each ethanol rail car holds 30,000 gallons). Applying the $.40 reduction in production returns above operating costs on those ethanol shippers impacted would place the value between $7.2 million and $21.6 million, per week. If we applied the decrease in returns to all ethanol production, the value would be much larger (about $18 million per day or $126 million per week).

Figure 20: Class I Railroad, Total Cars Online Weekly



Source: Surface Transportation Board

The circumstances over the second time were different, an unrealized opportunity for the ethanol industry to significantly increase production to take advantage of fuel demand was prevented by rail service challenges. Entering Covid-19, intermodal demand had already started declining some 6 months before, allowing the railroads capacity to address service challenges to the ethanol shippers, as we see the number of ethanol cars sitting for greater than 48 hours decreases below 200. But once demand for fuel and grain increased, the railroads could not react quickly. Because of favorable pricing on ethanol fuel relative to corn and natural gas cost, production returns over operating costs exceeded $.40 per gallon and steadily climbed to near $.80 per gallon by October 2023 with margins peaking one week above $1.5 per gallon.

Unlike the first period, the Class I railroads were dealing with labor shortages, in addition to surge demand for transportation services across intermodal, grain and ethanol. Thus, grain and ethanol service challenges returned, with the number of ethanol cars sitting more than 48 hours climbing from below 200 to above 2,200 cars and driving down returns over operating costs. Ethanol production does exhibit an increase over this period, but stocks also increased despite the very high ethanol margins. The opposite should have occurred.

The lack of granularity on the location of the stocks prevents determining the real impact. In this situation, ethanol plants that had access to transportation should have pulled their stocks to extremely low levels.

Since overall stocks increased, the ethanol plants without access to transportation had stocks increase much more than a statistical average overall plants. In addition, some ethanol plants reportedly stopped production due to lack of storage during a period of very high ethanol margins. This is the last result action that should not have occurred.

This reality has severe consequences for ethanol producers from a lost revenue standpoint. A 100-million-gallon plant or a production of 350 thousand gallons per day that shuts down when ethanol margins are $.80 cents per gallon represents an additional $280 thousand lost opportunity per plant per day on top of the cost of storing the ethanol. For an ethanol plant that maintained transportation service, that plant made more money than normal.

It should also be noted that ethanol plants are designed to operate at maximum efficiency, within a relatively narrow production band based upon size. Reducing production, even temporarily, significantly increases costs and lowers margins. The typical plant size of 100 million gallons to 110 million gallons generates about 350 thousand gallons of ethanol or 12 rail cars per day and most plants have approximately ten days of storage capacity. These plants are generally running unit trains (100-110 rail cars), so a unit train is produced about every 9 to 10 days. This is about three unit trains per month that are required for the ethanol plant to deliver the ethanol. Time to load and a day or two of delay should the cars not arrive as expected are factored into the calculation. If the cars are held up, for weather, congestion, or any reason, it only takes a day or so before plant operations and output must be slowed. And depending on how long the delay occurs, at some point production will be stopped entirely and the cost and time of scaling production back up is large.

Applying an $.80 reduction in production returns above operating costs on those ethanol shippers impacted would place the value between $14.2 and $43.2 million, per week. If we applied the decrease in opportunity cost to all ethanol production, the value would be much larger (about $36 million per day or $252 million per week).

Operational Cost Increase

An efficient ethanol plant utilizes a 50-hour to 55-hour burn process that will produce three gallons per bushel. The process utilizes yeast and there will still be living yeast in what is referred to as the beer after the 55-hour point in time. The plant has approximately 10 days of beer storage. One way to extend the storage is to let the burn process continue past 55 hours. Because some yeast is still alive, additional ethanol will be produced but at a much lower rate than three gallons per bushel. The additional ethanol production does not offset the cost to produce the extra volume. After 80 hours, no extra ethanol is being produced but the costs are still occurring. Even at lower marginal production gain levels, there is an adverse impact on margins because all the ethanol must be kept above 90 degrees to prevent the product from breaking down and this heating is costly, especially when the yeast has died off.

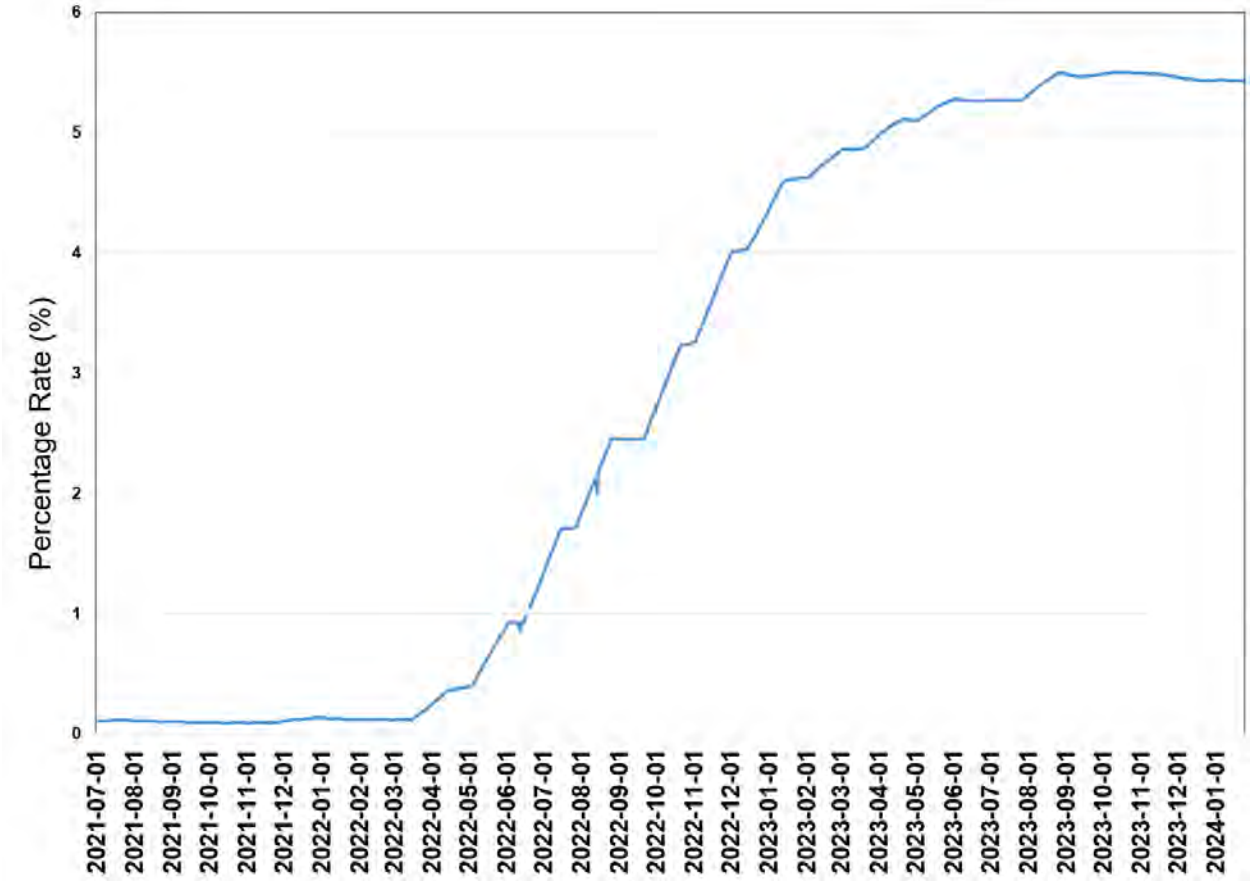
Once the ethanol plant is shut down, the cost and effort to restart the plant and optimize the plant for peak efficiency is intensive. The idea that the plant can be shut down and restarted like a truck is wrong. The reason given for not providing a cost is the actual cost is unknown. Sometime the restarting process goes smoothly and sometimes shutting the plant down created a chain reaction of problems.

Economic Impact from Carrying Costs

When ethanol plants are forced to hold on to inventories longer than expected there are real explicit carrying costs associated with the inventories. This carrying cost includes the additional heat required to keep the goods from breaking down. These costs can also come in the form of the financial outlay in terms of interest

from holding onto finished goods longer than expected. One way to measure carrying costs from interest on borrowed working capital is using short-term interest rates, which have increased in recent years. Analyzing interest rates from 2017 to 2023 provides a view of how carrying costs change from differing levels of adverse service and different interest rates. The interest rate used is a combination of short-term rates published by the St. Louis Federal Reserve plus an estimated premium of three percent to arrive at the rate banks charge their best clients for short term money. The short-term rate used is the AMERIBOR and its increase in the last three years is shown in Figure 21.

Figure 21: AMERIBOR Rates (Three Years)



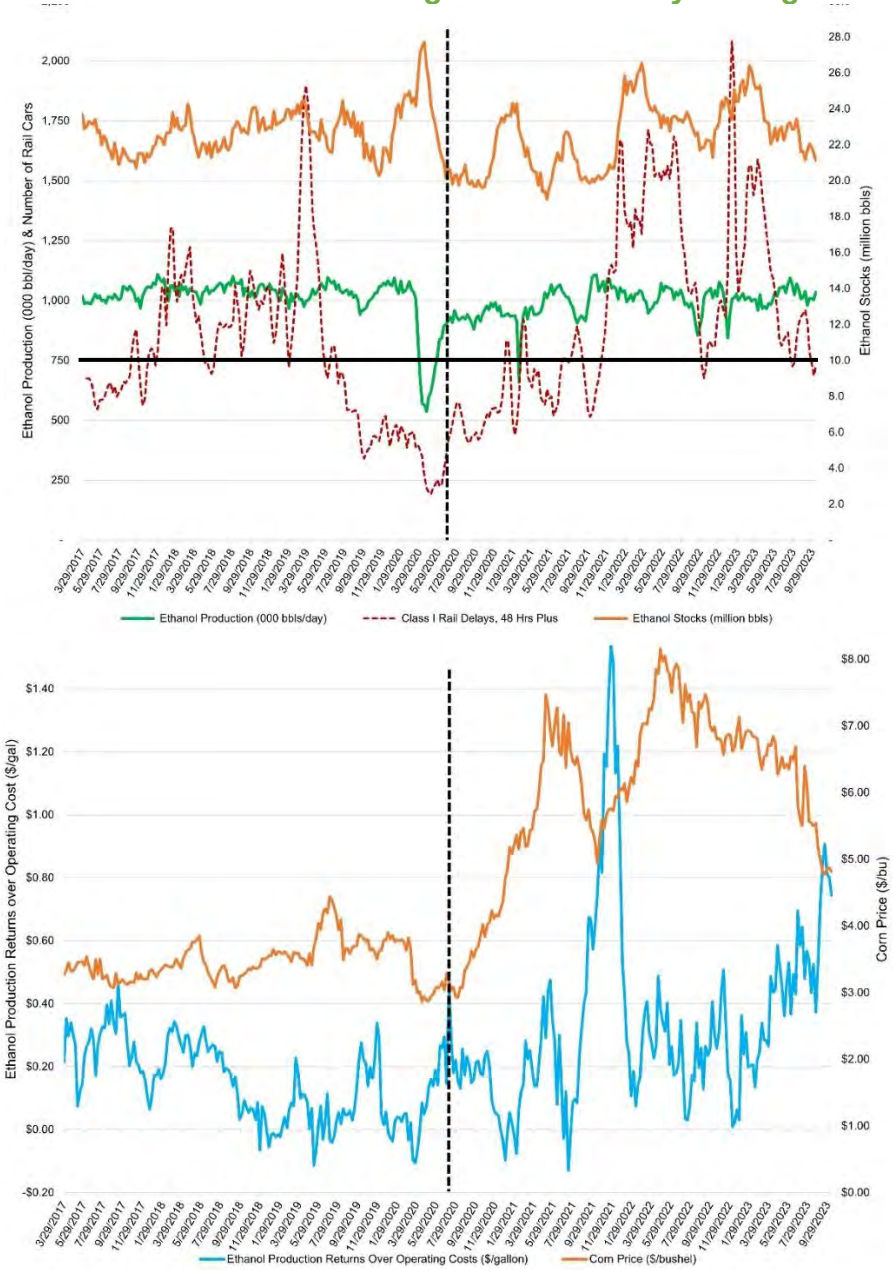
Source: St. Louis Federal Reserve

Using the rates shown in Figure 21 and the premium of three percent, carrying costs increased from 3.1 percent in 2020 to 8.2 percent in 2023. Today's rates (2024) are slightly higher at around 8.5 percent. The carrying cost analysis only looked at weeks where train delays exceeded 48 hours and amounted to more than 750 tank cars, as shown in Figure 22. Using this approach the average carrying costs during lower interest rates from 2017 to 2021 was $3.2 million per year. During periods of higher interest rates, from 2022 to 2023, the average carrying costs were estimated at $26.1 million.

An important distinction of the approaches used to measure the economic impact to ethanol from disruptions in rail service is that they are all profit measures. The lost market value approach impacts both revenue and profit as it measures the additional value of the ethanol that was lost, and that amount flows straight to the bottom-line of the profit and loss statement. The increased costs of slowing or shutting down

a plant are expenses that could have been avoided, and while these are difficult to measure, they have an adverse impact on profit. The economic impact from interest on borrowed short-term capital represents either increased expenses on the same output that impact profit or, if a plant is self-financed, a measure of lost opportunity cost on that plant's equity.

Figure 22: Ethanol Production, Stocks, Return Over Operating Cost, Corn Price and Class 1 Ethanol Rail Cars Exceeding 48 hrs. of Delay at Origination



Source: Surface Transportation Board and Renewable Fuels Association

Summary & Conclusion

The U.S. ethanol industry provides renewable fuels for transportation markets, both domestic and international. There are approximately 200 ethanol plants throughout the U.S., providing a valuable market for corn producers and significantly contributing to economic opportunities from employment at processing plants, largely in rural America. A recent economic impact study (N. Sonnichsen, August 2023) estimated that the U.S. ethanol industry contributed 57 billion dollars to the U.S. gross domestic product, with over 78 thousand direct jobs and over 340 thousand indirect or induced jobs. This industry depends heavily upon efficient, reliable, and effective transportation services for both inbound product (grain) and outbound fuel (ethanol). Depending on plant location, truck, rail, and barge transportation may be utilized. But the overall industry relies increasingly upon rail transportation at most plants throughout the U.S. due to the efficiency associated with bulk rail shipping.

The railroad industry has faced significant service challenges since the pandemic and over the last 10 years from a variety of weather events that created labor/staffing challenges, equipment utilization and allocation across all railroad customers. By utilizing the U.S. Surface Transportation Board's required weekly performance reports of all Class I railroads, this analysis has shown that the Class I railroads prioritize service differently, depending on the customer type. During these periods of railroad service challenges, some high value railroad customers maintain consistently high levels of service as revealed through terminal dwell times and average train speeds. Grain and ethanol shippers experience the lowest service levels during these adverse periods for railroads, exhibiting higher than normal terminal dwell times and lower train speeds.

Delays in transportation service has an opportunity cost from lost market sales, increased operational costs, and increased stock carrying costs. With interest rates much higher than in recent history, if the transportation issues were to occur now, the direct cost would be dramatically higher. With the general increase in the cost of everything, the cost of unscheduled closures will also be much higher. The direct impact of train disruption to the ethanol sector was estimated to be:

- Lost Market Value: $.80 reduction in production returns above operating costs, or $36 million per day across all ethanol producers.
- Carrying Costs: In the last two years, $26 million in increased carrying costs from increased inventories.
- Cost of Slowing Production: This cost wasn't estimated as it varies greatly, but there is a cost of keeping the beer in process at 90 degrees while the plant is idled plus the cost of plant breakdowns that occur during plant idling.

The Renewable Fuels Association may improve rail response and performance throughout the ethanol industry by continuing the monitoring of rail service levels weekly. This information can be provided on their web site with geographic data visualization capability to specifically identify affected customers. Encouraging other agricultural industry shippers (corn, soybeans, wheat) to likewise monitor rail service levels may also result in more effective rail performance. This collectively could be included into USDA, given the overall agricultural industry representation. Appealing to the STB in real-time, as the RFA has done in the past, will greatly improve industry performance and mitigate adverse economic impacts to this critical industry.