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Missouri Freight and Passenger Rail Capacity Analysis

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16. Abstract The MoDOT Tracker performance measure "Number of Rail Passengers" is directly correlated with the level of passenger train delays. Therefore, the objective of this study was to develop a prioritized list of rail enhancements that addresses current passenger and freight rail performance on the Union Pacific line from St. Louis to Kansas City in order to improve on-time passenger service and reduce freight delays. An integrated systems analysis and modeling approach was used in this study. Based on a Theory of Constraints analysis the core problem was identified as the high level (and increasing) train load, both from a quantity and weight of train perspective. Corresponding to this four issues were identified that impact the overall delay in the system: geographic conditions, maintenance processes, crew scheduling, and Amtrak dispatching priority. Finally, based on the analysis conducted a set of six primary rail enhancement alternatives (with some having multiple options) were generated, together with potential alternative combinations. The alternatives were generated with respect to minimizing congestion, and therefore delay, within and between freight and passenger trains. The rail alternatives were analyzed by simulating the reduction in overall time for a train to cross the state of Missouri, then a set of recommendations were generated with respect to delay reduction and capital investment.			
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FINAL REPORT

R105-053

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Prepared for the
Missouri Department of Transportation
Organizational Results

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The opinions, findings, and conclusions expressed in this publication are those of the principal investigators and the Missouri Department of Transportation; Research, Development and Technology. They are not necessarily those of the U.S. Department of Transportation, Federal Highway Administration. This report does not constitute a standard or regulation.

Executive Summary

Missouri Freight and Passenger Rail Capacity Analysis

Study Objective

The primary objective of this study was to develop a prioritized list of rail enhancements that addresses current passenger and freight rail performance on the Union Pacific line between St. Louis and Kansas City in order to improve on-time passenger service and reduce freight delays. The MoDOT Tracker performance measure related to this project is the “Number of Rail Passengers” within the performance objective of “Easily Accessible Modal Choices”. In this study the key analysis issue is the delay encountered by both Amtrak for passenger and Union Pacific for freight operations. This issue directly impacts the MoDOT Tracker performance measure “Number of Rail Passengers” since it has been found that passenger train delays are directly correlated with the number of passengers utilizing rail service.

Study Approach and Scope

A four step approach was used in this study. First, the St. Louis-Kansas City Union Pacific rail line was assessed using a Theory of Constraints (TOC) approach to determine key capacity restrictions and congestion factors. Second, a simulation model was developed to examine candidate improvement alternatives. Third, a set of rail enhancement alternatives were generated. Fourth, alternatives were analyzed and prioritized with respect to system performance improvement and capital investment requirements.

The Union Pacific rail corridor between Saint Louis and Kansas City is comprised of three Subdivisions. The Jefferson City subdivision between Saint Louis and Jefferson City is mostly two tracks with bi-directional travel (except where the railway has two-way travel on single track bridges over the Osage and Gasconade Rivers). The Sedalia subdivision is single track (with sidings) with bidirectional flow of traffic when there is an eastbound passenger train which currently occurs twice per day. The River Subdivision is a single track (with sidings) with unidirectional flow of several different types of freight traffic.

Study Results and Analysis

The Theory of Constraints analysis identified the core problem as the high level (and increasing) train load, both from a quantity and weight of train perspective. From a train quantity perspective this corridor is handling between 50-60 trains per day which is at the upper limits of capacity for a double track line handling the types of freight that it does. From a train weight perspective this corridor handles a large percentage (roughly 50%) of heavy coal trains. As a result of this core problem there are four issues that ultimately impact the overall level of delay on the corridor.

1. Geographic Conditions – The double track in the Jefferson City Subdivision follows the Missouri River. The sub-grade in this Subdivision requires a substantial amount of maintenance in order to handle the heavy axle loads of a full coal train. Prior to maintenance there are an increased number of slow orders and during major maintenance activities all train traffic is affected due to reduced hours of operation.
2. Maintenance Processes – As a result of the geographic conditions and the high train load level on the corridor, the task of scheduling both routine and major maintenance windows is non-trivial. This is further complicated when combined with the scheduling of signal and track inspections.
3. Crew Scheduling – Increased train load increases the crew scheduling task complexity and has the potential to increase corridor congestion when crews exceed their 12 hours of allowed service and become "dead on hours" before reaching their crew change locations.
4. Amtrak Dispatching Priority – Increased freight load within a high maintenance and partially single track (with limited sidings) rail corridor makes it increasingly difficult to provide passenger train priority.

An analysis of the 2005 Amtrak Delay Reports reveals that the majority of train delay is caused by Freight Train Interference (FTI = 53.38%), Temporary Speed Restrictions (DSR = 15.09%), and Passenger Train Interference (PTI = 9.7%). Figure 1 shows the track segment contribution to overall passenger train delay.

Based on the Theory of Constraint analysis and the delay analysis a set of six primary rail enhancement alternatives (with some having multiple options) were generated, together with potential alternative combinations. The alternatives were generated with respect to minimizing congestion, and therefore delay, within and between freight and passenger trains (i.e. sidings and additional track). This approach is in contrast to improvement alternatives that specifically focus on improving overall train speed (i.e. sealed corridors, track curvature, etc.). However, as congestion and delay is minimized there is a corresponding increase in average train speed. Figure 1 shows the location of these enhancement alternatives.

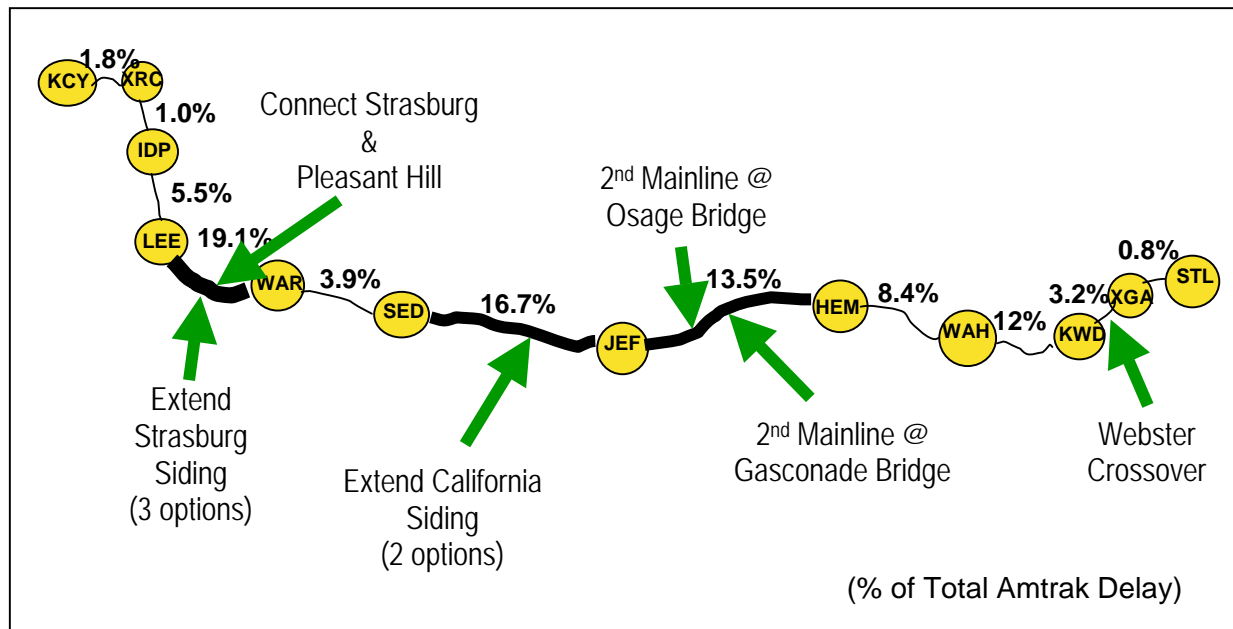


Figure 1: Primary delay locations and associated rail enhancement alternatives

The rail alternatives were analyzed by simulating the reduction in overall time for a train to cross the state of Missouri. The 2005 train volume (approximately 53 freight trains and 4 passenger trains per day) and mix (approximately 7% passenger, 43% commodity, and 50% inter-modal / manifest) was used as the basis of the analysis. The model was developed using Rockwell Automation's Arena simulation modeling software. For this study a performance baseline is assumed based on a scenario where all track from St. Louis to Kansas City is double track (implying that the Sedalia subdivision is double tracked and both the Gasconade and Osage bridges are double track) and then an alternative's overall percentage delay reduction with respect to the baseline scenario for both freight and passenger trains is calculated.

Examining the simulation results revealed two major trends: 1) the Sedalia subdivision alternatives provide more relative benefit with respect to reducing overall delay for Amtrak passenger trains (average benefit of Sedalia subdivision alternatives for Amtrak is 14.4% vs. 6.8% for UP), and 2) the Jefferson City subdivision alternatives provide more relative benefit for UP freight trains (average benefit of Jeff City subdivision alternatives for UP is 20.9% vs. 5.0% for Amtrak). Table 1 presents an analysis of each of the rail enhancement alternatives for both Union Pacific freight and Amtrak passenger rail service with respect to the percentage of delay reduction per million dollars of estimated project cost. Note that the

cost used in the analysis is the underlined cost for each alternative (multiple costs for each alternative reflect different implementation options that are detailed in the full project report).

Table 1 - Comparison of Alternatives with respect to % Delay Saved per \$M invested

	% UP Delay Savings / \$M	% Amtrak Delay Savings / \$M	Cost in Millions
Sedalia Subdivision Alternatives			
S1 - Extend California Siding	1.48	3.97	<u>4</u> or 2.5
S2 - Extend Strasburg Siding Freight	0.83	0.85	<u>10</u> or 8 or 2
S3 - Connect Strasburg & Pleasant Hill Sidings	0.01	1.12	<u>10.5</u>
S4 - Both Extend California Siding & Extend Strasburg Siding for Freight	0.90	0.88	<u>14</u> or 12.5 or 12 or 10.5 or 6.5 or 4.5
S5 - Both Extend California Siding & Connect Strasburg & Pleasant Hill Sidings	0.50	1.62	<u>14.5</u> or 13
Double Track LEE_JEF (130 miles)	0.08	0.11	260
Jefferson City Subdivision Alternatives			
J1 - Osage Bridge	1.16	0.60	<u>15</u> or 28
J2 - Gasconade Bridge	0.89	0.26	<u>21</u>
J3 - Gasconade/Osage Bridges	0.76	0.11	<u>36</u> or 49
J4 - Webster Crossover	8.00	0.56	<u>2.5</u>

The following discussion is based on the objective to maximize the Delay Savings / \$M obtained in Table 1. In the Sedalia subdivision alternative S1 (Extend California Siding) clearly dominates all other alternatives as it provides significant benefit with respect to the project cost for both freight and passenger operations. Alternatives S4 and S5 also merit further consideration as they both provide relatively strong benefit; however, S5 tends to provide more benefit to passenger rail service. In the Jefferson City subdivision alternative J4 (Webster Crossover) clearly dominates all other alternatives as it provides a very significant benefit for freight rail operations and a moderate benefit for passenger rail operations. Based on the fact that J4 has already been implemented by Union Pacific and J2 is in process of implementation, alternative J1 (Osage Bridge) should also be considered as it provides a significant benefit for both freight and passenger rail operations.

Recommendations

Based on the analysis conducted this study makes the following recommendations to be implemented in the order listed below:

- 1) Alternative S1 - Extend California Siding - option 2; Estimated cost = \$4 million
- 2) Alternative S3 - Connect Strasburg and Pleasant Hill Sidings; Estimated cost = \$10.5 million
- 3) Alternative J1 - 2nd Mainline on Osage Bridge; Estimated cost = \$15-28 million

Additionally, the current Union Pacific Maintenance processes warrant further analysis as they could provide reduction in overall passenger train delay performance without significant investment. Therefore, it is recommended that the scheduling of routine and major maintenance windows, and the scheduling of signal and track inspections, be further analyzed with respect to overall system delay performance.

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1.0 INTRODUCTION

A key performance measure for MoDOT is to provide expanded opportunities in Multi-Modal Access and Mobility. A specific performance outcome related to this proposal that is addressed in the MoDOT Tracker system is “Easily Accessible Modal Choices” and the specific performance measure related to this project is the “Number of Rail Passengers”. In general, this measure has increased slightly over the past 4 years, however, due to a major Union Pacific track work program in 2007, that has resulted in increased congestion on the St. Louis to Kansas City rail corridor, passenger ridership is expected to significantly drop. This project seeks to examine the issues that impact both freight and passenger delay on the St. Louis to Kansas City corridor from a systems perspective in order to improve the service of both.

2.0 STUDY OBJECTIVES

To develop a prioritized list of rail enhancements that address current passenger and freight rail performance on the Union Pacific line from St. Louis to Kansas City in order to improve on-time passenger service and reduce freight delays.

This objective is pursued with respect to the following research questions:

- What is the passenger / freight capacity of the Kansas City to St. Louis rail corridor?
- What rail system improvements are needed to ensure adequate current and future capacity?
- What relatively low-to-medium-cost solutions can significantly improve existing capacity?
- In the long term, what major improvements will be needed to accommodate growth of both passenger and freight rail?

3.0 STUDY APPROACH AND PROCEDURES

The general approach for this project consisted of the following four steps:

1) Assessment

Assessed Kansas City – St. Louis Union Pacific rail line constraints / variability associated with passenger / freight flow. A Theory of Constraints (TOC) approach was used to determine key capacity restrictions and congestion factors.

2) Model Development

Developed a capacity / variability analysis model to explore constraints. The modeling approach utilized a simulation-based candidate analysis to examine alternatives to improving overall capacity and reducing system congestion.

3) Generation of Alternatives

Generated set of rail enhancements that had potential to reduce overall rail congestion.

4) Alternative Analysis

Conducted capacity enhancement / delay reduction analysis respect to performance and economic criteria and generated a prioritized list with respect to economic objectives.

4.0 PROJECT SCOPE

The focus of this study is the Union Pacific rail corridor between Saint Louis and Kansas City (figure 1), both eastbound and westbound. The Jefferson City subdivision between Saint Louis and Jefferson City is mostly two-track with bi-directional travel. There are two points along the Jefferson City subdivision (JC sub) where the railway becomes one-track with two-way travel due to single track bridge over the Osage and Gasconade rivers. For the most part main track #1 is for westbound traffic and main track #2 is for eastbound traffic. Situated on the main tracks of the JC sub are three Amtrak depots for passenger trains (Kirkwood, Washington, Herman). The Amtrak depot locations result in short periods of time where passenger trains move against directional flow, which naturally creates train conflicts.

In Jefferson City, there is a yard operation with five tracks, with two being main tracks used for through traffic. The Amtrak depot is located on main track #2. West of Jefferson City is River Junction, the point of intersection between two rail subdivisions, the Sedalia subdivision and River subdivision. The westbound traffic coming from Saint Louis originating on main track #1 switches main track in the Jefferson City area in order to continue westbound on the Sedalia subdivision. Traffic traveling eastbound from Kansas City travels along the River subdivision (which is a single track with single direction traffic flow) and switches onto main track #2 in the Jefferson City area, and continues on to Saint Louis. The meeting and switching operations in the Jefferson City area is a potential point of congestion.

The Sedalia subdivision is single track with bidirectional flow of traffic in the case of eastbound passenger rail traffic, which currently occurs twice per day. The single track is supplemented by sidings that are used for meeting and passing of opposing directional trains. Sidings are also used for overtaking like-directional trains. There are four Amtrak depots along the Sedalia subdivision (Sedalia, Warrensburg, Lee's Summit, and Independence). The River subdivision is a single track with unidirectional flow of several different types of freight traffic, including coal, grain, automobile, inter-modal, manifest, etc. This railway also includes sidings, which are used primarily for mechanical failures or hold-ups for train sequencing prior to the Jefferson City area.

There are many activities occurring within the terminal operations of both Saint Louis and Kansas City. Based on several factors such as importance of loads, allowed service time of train crews, or destination of train, trains are sequenced before entering the terminal areas or held for long periods of time within terminal yards.



Figure 1 – Union Pacific System Map

5.0 RESULTS AND DISCUSSION

5.1 Amtrak On-time Performance and Delay Analysis

Table 1 presents the 2005 Amtrak on-time performance for all westbound trains (301/311/303/313). As can be seen from this data the majority of the westbound train lateness occurs between STL and JEF (31.3 – 5.6 = 25.7 minutes). The distribution of on-time performance shows that for 90% of the trains, the STL departure is within 30 minutes, JEF departure is within approximately 90 minutes and KCY arrival is within 120 minutes.

Table 1 - Westbound 2005 Amtrak On-time Performance

301/311/303/313 (Westbound)			
	STL Departure	JEF Departure	KCY Arrival
On-time 0 min	79%	10%	27%
On-time 15 min	86%	44%	50%
On-time 30 min	90%	70%	65%
On-time 60 min	95%	86%	76%
On-time 120 min	99%	96%	89%
Later 120 min	1%	4%	11%
Average Lateness	5.6	31.3	33.1
Min Lateness	0	0	-20
Max Lateness	317	312	405

Table 2 presents the 2005 Amtrak on-time performance for all eastbound trains (304/314/306/316). As can be seen from this data the majority of the eastbound train lateness occurs between KCY and JEF (42.7 – 4.5 = 38.2 minutes). The distribution of on-time performance shows that for 90% of the trains, the KCY departure is within 15 minutes, JEF departure is within approximately 120 minutes and STL arrival is within 120 minutes.

Table 2 - Eastbound 2005 Amtrak On-time Performance

304/314/306/316 (Eastbound)			
	KCY Departure	JEF Departure	STL Arrival
On-time 0 min	86%	8%	15%
On-time 15 min	94%	29%	30%
On-time 30 min	96%	50%	43%
On-time 60 min	97%	78%	68%
On-time 120 min	99%	94%	90%
Later 120 min	1%	6%	10%
Average Lateness	4.5	42.7	53.1
Min Lateness	0	0	-23
Max Lateness	185	358	570

Table 3 provides a summary of the assigned cause of Amtrak delays for 2005 and the total minutes attributed to this delay cause. This data is based on train engineer delay reports that are filed for each train. As can be seen the majority of the delay is caused by Freight Train Interference (FTI = 53.38%), Temporary Speed Restrictions (DSR = 15.09%), and Passenger Train Interference (PTI = 9.7%). Figure 2 illustrates the relative percentage of each delay type. A complete listing and description of the different delay codes can be found in Appendix B.

Table 3 – 2005 Amtrak Delay Sources

Delay Code	Total Delay Minutes	% of Total Delay	# of Delay Occurrences	Average Delay	Std Dev Delay
FTI	57272	53.38%	4022	14.2	18.2
DSR	16190	15.09%	4196	3.9	3.6
PTI	10411	9.70%	816	12.8	11.3
DCS	5206	4.85%	611	8.5	9.2
HLD	3840	3.58%	1400	2.7	2.5
DMW	3477	3.24%	189	18.4	30.8
ITI	3077	2.87%	90	34.2	38.3
RTE	1594	1.49%	324	4.9	6.7
ENG	1526	1.42%	53	28.8	57.4
NOD	867	0.81%	193	4.5	10.8
SYS	867	0.81%	95	9.1	17.9
OTH	539	0.50%	52	10.4	13.7
TRS	488	0.45%	27	18.1	35.4
SVS	434	0.40%	25	17.4	28.3
ITT	345	0.32%	22	15.7	24.0
CAR	223	0.21%	24	9.3	8.0
POL	218	0.20%	7	31.1	59.9
CON	201	0.19%	11	18.3	37.6
ITM	161	0.15%	6	26.8	29.6
INJ	133	0.12%	5	26.6	20.4
DTR	108	0.10%	6	18.0	40.7
DBS	34	0.03%	4	8.5	9.3
WTR	29	0.03%	5	5.8	5.3

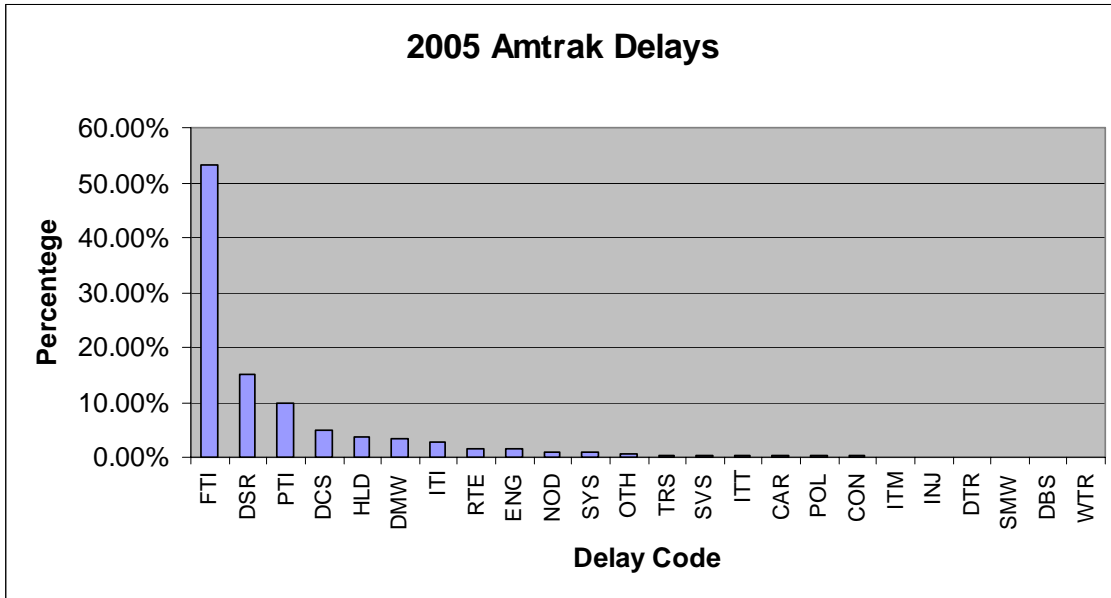


Figure 2 – Pareto Diagram of 2005 Amtrak Delay Sources

Figure 3 illustrates the aggregate delay on each segment of the line between stations (in green) and at stations (in red). Appendix C presents a summary of all delays both between stations (From-To based upon direction) and at stations, as well as the portion of delay that is caused by train congestion (FTI and PTI) for each From-To link in the route (with overall 69% of all From-To delay caused by FTI and PTI). From this delay data it is possible to highlight where the majority of Amtrak delay occurs. The track segment that contributes the most to the overall delay is between Lee’s Summit (LEE) and Warrensburg (WAR) (19.1% of which 73% is FTI/PTI delay), followed by the track segment between Sedalia (SED) and Jefferson City (JEF) (16.7% of which 92% is FTI/PTI delay), followed by the segment between Jefferson City (JEF) and Herman (HEM) (13.5% of which 63% is FTI/PTI delay), followed by the segment between Washington (WAH) and Kirkwood (KWD) (12.0% of which 43% is FTI/PTI delay).

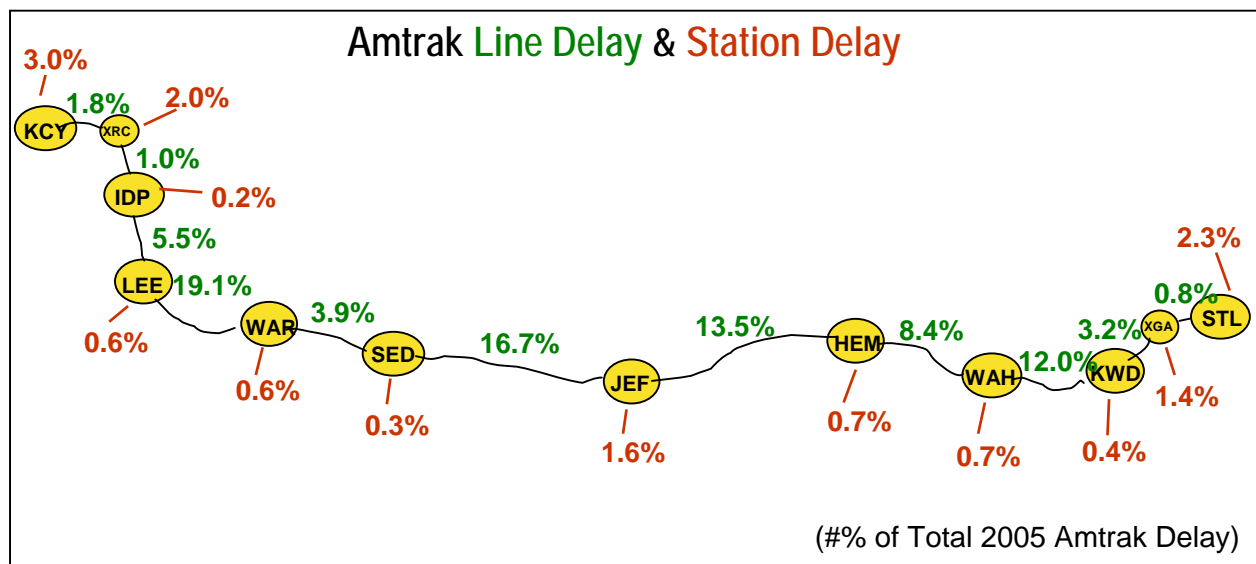


Figure 3 – 2005 Amtrak Line and Station Delay

5.2 Current Reality Tree – Root Causes

Figure 4 illustrates the general form of a current reality tree (CRT) which is a representation of an underlying core problem (CP) and the symptoms or undesirable effects (UDE) that arise from it. A CRT maps out a sequence of cause and effects from the core problem to the symptoms or undesirable effects (Youngman, 2006).

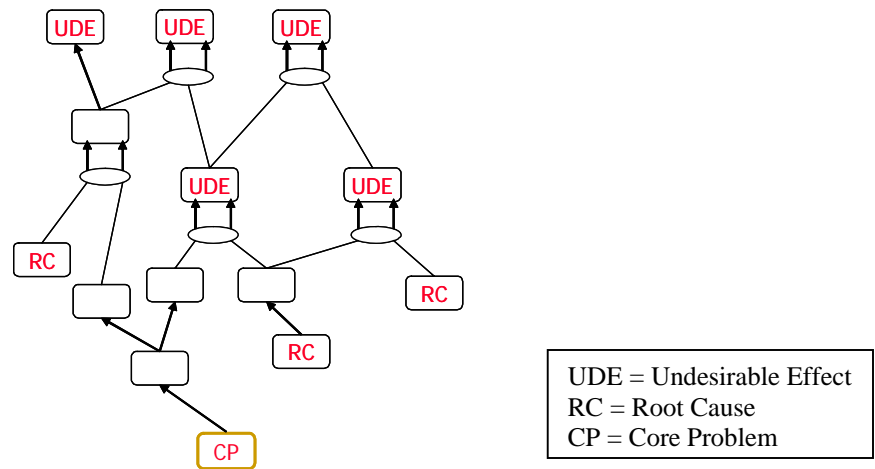


Figure 4 - CRT: Identify the Core Problem Source

In this project a current reality tree was constructed after extensive interviews with key rail personnel from Amtrak, Union Pacific, and Kansas City Terminal, together with supporting data they supplied. The resulting current reality tree is given in figure 5.

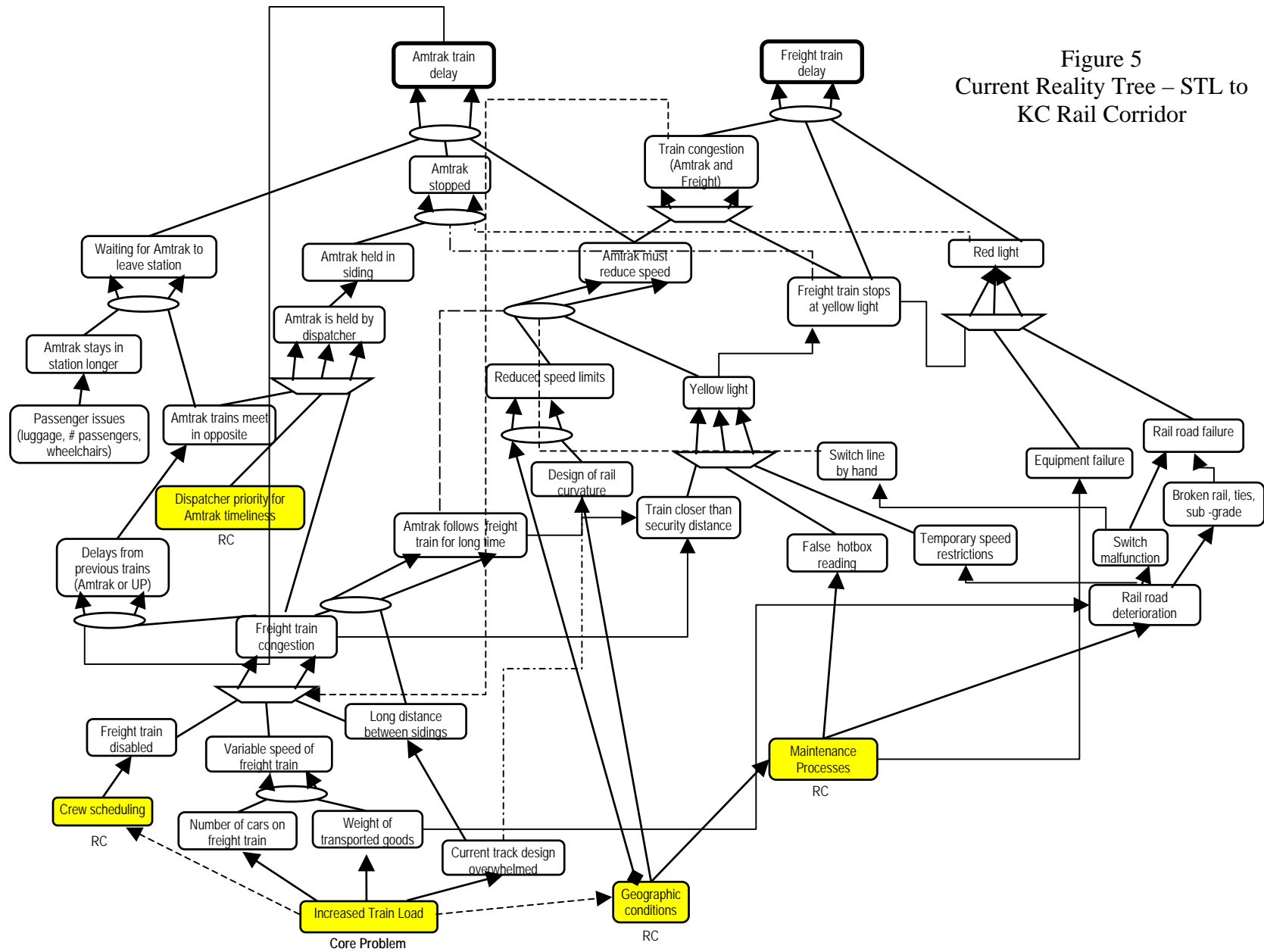
In this analysis the primary undesirable effects are the delays encountered by both Amtrak for passenger operations and Union Pacific for freight operations. This undesirable effect directly impacts the MoDOT Tracker performance for “Number of Rail Passengers” since as delays increase the advantages of train travel decrease and as a result the number of passengers decreases as well.

The core problem (CP) was identified as the high level (and increasing) of train load, both from a quantity of trains and weight of trains perspective. From a train quantity perspective this corridor is handling between 50-60 trains per day which is at the upper limits of capacity for a double track line handling the types of freight that it does. From a train weight perspective this corridor handling a large percentage (roughly 50% of total trains) of heavy coal trains. As a result this core problem either directly or indirectly impacts four root causes (RC) that impact the overall undesirable effects associated with this system.

The following will discuss how each of the four root causes identified (Geographic Conditions, Maintenance Processes, Crew Scheduling and Dispatching Priority) are a result of the core problem (Train Load) and ultimately impact the overall level of delay in the system.

1. Geographic Conditions – The double track in the Jefferson City subdivision follows along the side of the Missouri River. The sub-grade in this area is particularly unsuited to handle the heavy axle loads of a full coal train. The degradation of the sub-grade is further compounded by the number of heavy coal trains that traverse the track. In order to maintain the track in useable condition a substantial amount of maintenance is required. As a result of the sub-grade deterioration, prior to maintenance there can be a increased number of slow orders and during major maintenance activities all train traffic is affected due to reduce hours of operation.
2. Maintenance Processes – As a result of the geographic conditions and the high train load level on the corridor, the task of scheduling both routine and major maintenance windows is non-trivial. This is further complicated when combined with the scheduling of both signal and track inspections. Therefore, both the planning and scheduling associated with maintenance significantly affects the congestion and overall level of train delays.
3. Crew Scheduling – Due to the increased train load the crew scheduling task becomes more complicated and has the potential to add to the overall corridor congestion when crews exceed their allowed 12 hours of service and become “dead on hours” before reaching their crew change locations.
4. Amtrak Dispatching Priority – Increased freight load within both a high maintenance and partially single track (with limited sidings) rail corridor makes it increasingly difficult to provide passenger train priority and requires increased scheduling/control efforts to reduce overall system delays.

Figure 5
Current Reality Tree – STL to
KC Rail Corridor



5.3 Rail Enhancement Alternative Specifications and Estimated Cost

Based on the delay analysis and current reality tree a set of six primary rail enhancement alternatives (with some having multiple options) have been generated, together with potential alternative combinations. The alternatives were generated with respect to minimizing congestion, and therefore delay, within and between freight and passenger trains (i.e. the addition of sidings and double track). This approach is in contrast to improvement alternatives that specifically focus on improving overall train speed (i.e. sealed corridors, track curvature, etc.). However, as congestion and delay is minimized there is a corresponding increase in average train speed. Figure 6 shows the location of these alternatives.

The following section provides the specifications for each enhancement alternative and the estimated cost. (Note all cost estimates were developed by Hanson-Wilson unless noted otherwise). The performance characteristics will be given separately in the results section of the report.

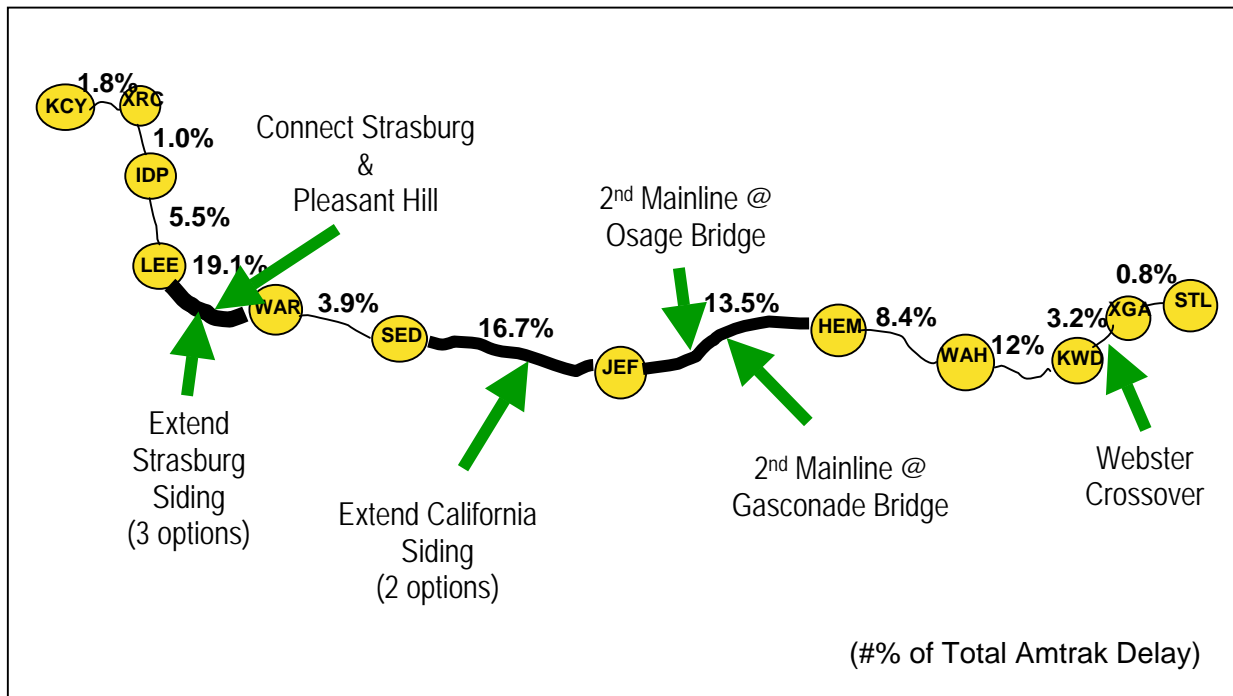
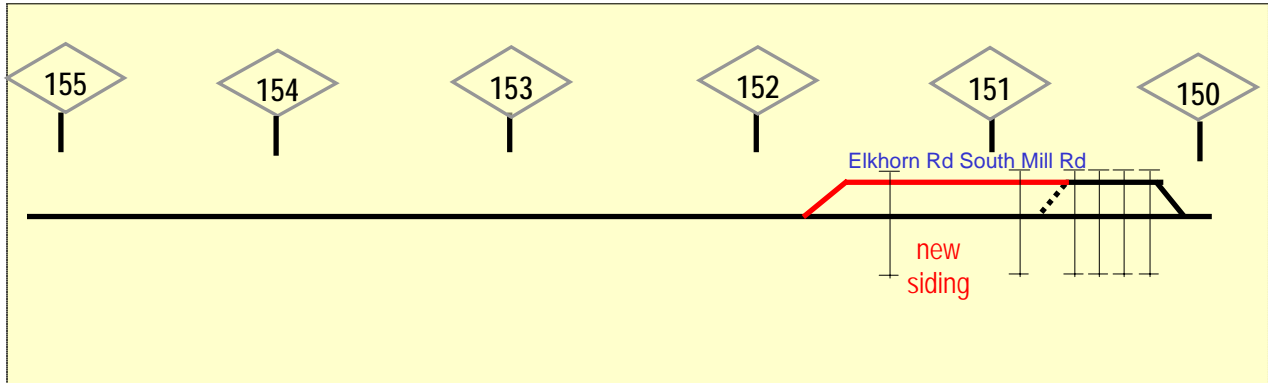


Figure 6: Rail Enhancement Alternatives

S1.1 Extension of Existing California, MO Siding – Alternate #1 (Extension of Siding to West)



Description of Site: The existing siding located at California, MO is located mostly within the city limits. The existing turnouts at each end of the siding are hand thrown #10 turnouts. The existing siding currently crosses three of the five north-south roads located within the main part of the City. These three roads are Williams Street, Oak Street/Missouri Route 87, and East Street. Based on available information, it appears the siding is only about 3,500 foot long total. Other major north-south roads in the vicinity of Oak Street/Missouri Route 87 are South Industrial Drive, located about 0.5 miles to the east, and South Mill Street, located about 0.25 miles to the west. Any extension of the siding in either direction would cross one of these roads.

Scope of Work: Extend existing siding to the west to provide an 8,500 foot long siding.

- Assumptions:
1. The existing hand thrown #10 turnouts are in inadequate and require replacement.
 2. The existing signals are either inadequate or in the wrong location and require replacement.
 3. Assume 25 foot spacing between the siding and the mainline (for the purpose of computing preliminary quantities of work).
 4. Since no information is available regarding the limits of existing right-of-way, assume that new right-of-way will be required for the limits of work.

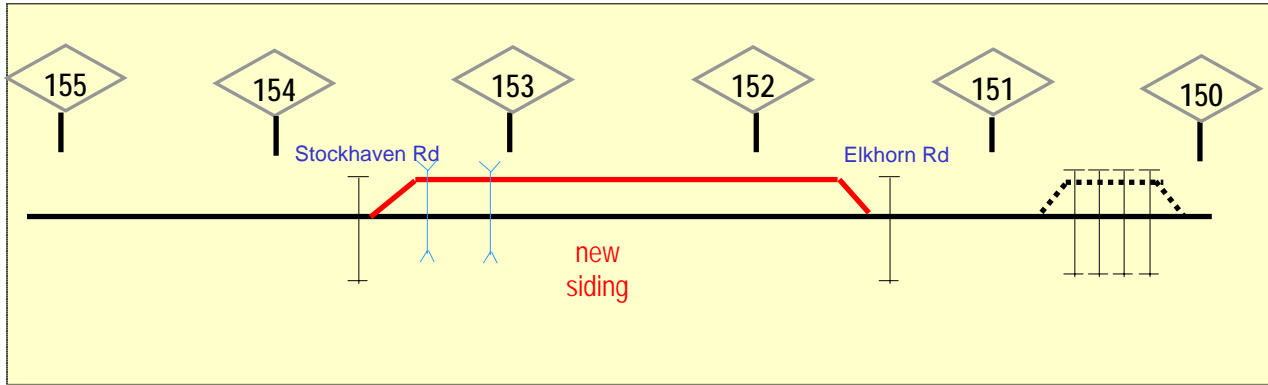
Advantages:

1. Potentially cheaper construction cost.

- Disadvantages:
1. Additional grade crossings at South Mill Street and Elkhorn Road could adversely impact traffic flows and emergency response.
 2. More potential for land acquisition problems due to the urban nature of the proposed site.

Estimated Project Cost: \$2,500,000

S1.2 California, MO Siding – Alternate #2 (New Siding Location)



Description of Site: The existing siding located at California, MO is located mostly within the city limits. The existing turnouts at each end of the siding are hand thrown #10 turnouts. The existing siding currently crosses three of the five north-south roads located within the main part of the City. These three roads are Williams Street, Oak Street/Missouri Route 87, and East Street. Based on available information, it appears the siding is only about 3,500 foot long total. Other major north-south roads in the vicinity of Oak Street/Missouri Route 87 are South Industrial Drive, located about 0.5 miles to the east, and South Mill Street, located about 0.25 miles to the west. Any extension of the siding in either direction would cross one of these roads.

Scope of Work: Because any extension of the existing siding will result in an additional road crossing which would be blocked by a parked train, we recommend a new siding located west of town between Elkhorn Road and Stockhaven Road.

Assumptions:

1. New signals will be required.
2. Assume 25 foot spacing between the siding and the mainline (for the purpose of computing preliminary quantities of work).
3. Since no information is available regarding the limits of existing right-of-way, assume that new right-of-way will be required for the limits of work.

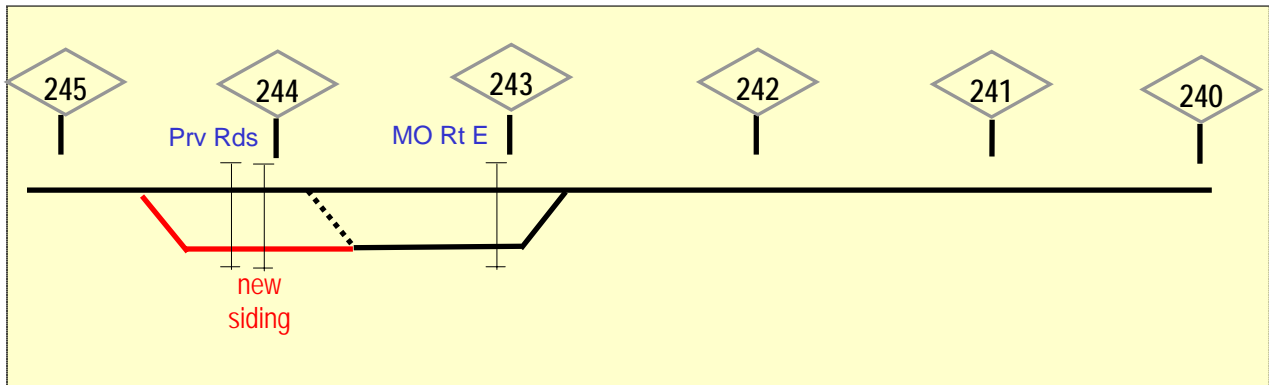
Advantages:

1. The proposed siding will be located between two existing roadways and will not block any roadways.
2. Proposed siding will not adversely impact traffic flow or emergency response. It may actually result in improvements in the City due to the fact that the shorter existing siding likely won't be used that often.

Disadvantages: 1. Since this siding will be an entirely new siding, construction costs will likely be higher than extending the existing siding.

Estimated Project Cost: \$4,000,000

S2.1 Extension of Existing Strasburg, MO Siding – Alternate #1 (Extension of Siding to West)



Description of Site: The existing siding located at Strasburg, MO begins within the city limits and extends approximately 5,000 feet to the west. The existing turnouts at each end of the siding are powered #16 turnouts. The existing siding crosses Missouri Route E near the east end of the existing siding. Based on available information, it appears the siding can only hold about a 4,000 foot long train clear of Missouri Route E. Since this is the only north-south road crossing the tracks in Strasburg, it would be desirable to avoid blocking this crossing with a train parked in the siding.

Scope of Work: Based on the stated desire to have a siding that can hold an 8,500 foot long train, one alternative would be to extend the existing siding to the west to provide an 8,500 foot clear storage length between the proposed west end of the siding and the crossing at Missouri Route E.

Assumptions:

1. Both existing power-operated #16 turnouts are in good condition and are suitable for re-use.
2. The existing signals are in good condition and can be relocated.
3. Assume a 25 foot spacing between the siding and the mainline (for the purpose of computing preliminary quantities of work).
4. Since no information is available regarding the limits of existing right-of-way, assume that new right-of-way will be required for the limits of work.

Advantages:

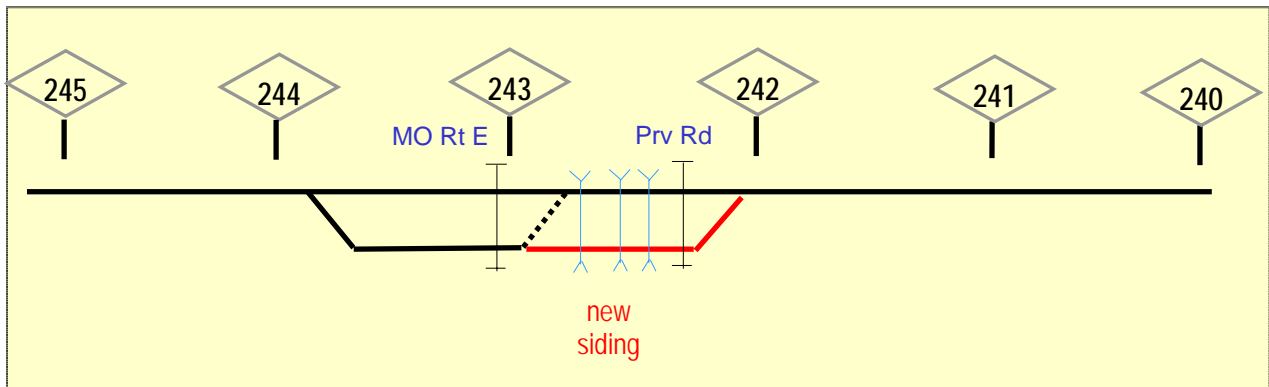
1. Extension of the siding to the west should minimize the cost of the siding extension by utilizing a majority of the existing siding length.
2. If the siding were extended as described above, it would allow an 8,500 foot long train to be parked in the siding without blocking traffic on Missouri Route E, the only north-south road through Strasburg. This would provide significant advantages in terms of traffic flow and emergency response.

Disadvantages:

1. If the siding were extended as described above, it would extend across two private residential access roads. This would likely inhibit the on demand use of their driveway by these residents and could have an impact on emergency response to these residences. (Note that other north-south roads exist and are located 1.3 miles east and 2.1 miles to the west of the crossing at Missouri Route E).

Estimated Project Cost: \$2,000,000

S2.2 Extension of Existing Strasburg, MO Siding – Alternate #2A – 8500’ Total Length Siding



Description of Site:

The existing siding located at Strasburg, MO begins within the city limits and extends approximately 5,000 feet to the west. The existing turnouts at each end of the siding are powered #16 turnouts. The existing siding crosses Missouri Route E near the east end of the existing siding. Based on available information, it appears the siding can only hold about a 4,000 foot long train clear of Missouri Route E. Since this is the only north-south road crossing the tracks in Strasburg, it would be desirable to avoid blocking this crossing with a train parked in the siding.

Scope of Work: Based on the stated desire to have a siding that can hold an 8,500 foot long train, one alternative would be to extend the existing siding to the east to provide an 8,500 foot clear storage length.

Assumptions:

1. Both existing power-operated #16 turnouts are in good condition and are suitable for re-use.
2. The existing signals are in good condition and can be relocated.
3. Assume 25 foot spacing between the siding and the mainline (for the purpose of computing preliminary quantities of work).
4. Since no information is available regarding the limits of existing right-of-way, assume that new right-of-way will be required for the limits of work.

Advantages:

1. If the siding were extended as described above, only one residence (farm) would be affected versus two residences affected by Alternate #1.

Disadvantages:

1. If the siding were extended as described above, it would extend across one private residential access road. This would likely inhibit the on demand use of their driveway by this resident and could have an impact on emergency response to this residence.
2. This alternative would likely result in the crossing at Missouri Route E being blocked more frequently and for longer durations than it is now. This could have a significant impact on emergency response within the Strasburg. (Note that other north-south roads are located about 1.3 miles east and 2.1 miles west of the crossing at Missouri Route E).
3. This alternative would require the construction of three new bridges across Crawford Creek, the West Branch of Crawford Creek, and another unnamed waterway.
4. This alternative will cost more to construct than Alternative #1, primarily due to the three bridges required for this alternative.

Estimated Project Cost: \$8,000,000

