From: Stopplecamp, Henry
Sent: Friday, December 14, 2018 7:15 PM
To: 'Lauby, Robert (FRA)' <robert.lauby@dot.gov>
Cc: Genova, David <David.Genova@rtd-denver.com>; Christie, Joseph <Joe.Christie@RTD-Denver.com>; Miller, Allen <Allen.Miller@RTD-Denver.com>; 'Hayward-Williams, Carolyn (FRA)' <c.hayward-williams@dot.gov>; John Thompson (john.thompson@dtpjv.com) <john.thompson@dtpjv.com>; 'Peter Strange' <Peter.Strange@dtpjv.com>; 'Anne Herzenberg' <anne.herzenberg@rtdcrail.com>
Subject: RTD CR crossing warning time action plan 12-14-18

Dear Mr. Lauby,

Please see the attached action plan addressing your November 15, 2018 letter (letter attached). In addition to the joint plan, RTD is also submitting our "RTD Eagle Project Oversight Commitment" document to FRA as part of our response as the Railroad owner of record. This document details RTD's current and future commitment to the FRA.

I would request that your Team review the attached plan and give us the opportunity to meet in DC to go over any questions or concerns that might arise before you make your final determination on the plan. RTD's Team is available to meet with your Team at your earliest convenience.

Thank you in advance for your help on the project.

Have a safe day

Henry

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REGIONAL TRANSPORTATION DISTRICT COMMUTER RAIL (RTDC)

CROSSING WARNING TIME ACTION PLAN

In Response to FRA Letter Dated November 15, 2018

Douglas M. Tisdale Chair, Regional Transportation District Board	David J. Rushton Chair, Denver Transit Partners
David A. Genova GM & CEO Regional Transportation District	John F. Thompson Executive Project Director, Denver Transit Partners
Henry J. Stopplecamp AGM Capital Programs Regional Transportation District	Peter D. Strange Project Director, Denver Transit Systems
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Revision 0
(December 14, 2018)

Revision No.	Date	Revision Notes
0	December 14, 2018	

Contents

INTRODUCTION

FRA issued a letter dated November 15, 2018, which asserted concerns with respect to the grade crossing warning times being experienced on the RTDC University of Colorado A Line (A Line) B Line and G Line. The FRA letter requires the submission of "*an action plan for correcting the identified noncompliance and ensuring that its grade crossing warning systems meet the conditions of the waiver granted in this docket, and, overall, its signal system and operations meet all other applicable Federal regulatory safety requirements*." More specifically, the letter requires the plan to include: *"(a) detailed procedures for correcting the identified non-compliance; (b) a schedule demonstrating RTD's commitment to bring its grade crossing warning systems on the A, B, and G Lines into compliance within one year; (c) detailed procedures, methods, milestones, and timelines for completion; and, (d) a description of the technical resources to be employed*." This action plan (Plan) is intended to satisfy FRA's requirements set out in its November 15, 2018 letter, while also providing a more detailed explanation of technical and operational factors affecting warning times.

EXECUTIVE SUMMARY

This Action Plan:

- Articulates the issues being addressed in respect of crossing warning times and documents the actions implemented since testing and commissioning
- Commits to a process of continuous improvement throughout the remainder of the Concession
- Confirms areas for immediate focus and action to make grade crossing warning times as experienced by highway users more consistent
- Prioritizes the areas of immediate focus to ensure early gains and create momentum in the Plan's actions
- Describes robust and innovative planning and implementation processes to ensure that the results are sustained and sustainable
- Describes the depth of capability that RTDC will bring to bear on this Plan

1. PLAN SUMMARY

The objective of this Plan is to present activities and milestones to address the issues raised in the FRA letter with respect to grade crossing warning times. FRA requires that, within one year, warning times unaffected by exclusions specifically allowed by FRA be within -5 and +15 seconds of the Programmed Warning Time (PWT).[1] Matters other than crossing warning times raised in the FRA's letter will be addressed separately with the FRA.

This Plan includes a detailed description of responsibilities for various aspects of the action plan, an overview of improvements to date, and a detailed description of additional initiatives, which include the following:

Current and Future Initiatives

- Development of an analytical data tool to automate data reviews
- Approach Condition Adjustment Factor (ACAF) adjustments at selected crossings
- Improvements to wireless activation algorithms
- Continuous review of passenger behavior (e.g. increased passenger loading, pedestrians on or near tracks)
- Collaboration with other railroads for shared improvements
- Targeted operator training and mentoring
- GPS improvements at the DUS terminal to improve PTC initialization

System Upgrades

- Upgrade to Data Model 8, which is expected to achieve various improvements including a reduction in PTC cutouts
- Potential Human-Machine Interface (HMI) improvements

In Depth Analysis

- Station specific analysis (in particular for stations in close proximity to crossings)
- Dwell times
- Operating schedule for impacts and optimization
- Express train operations
- Optimal train speeds
- Signal or train failures
- Location based analysis to assist Operators in optimal train handling
- Speed smoothing to assist in train handling
- Review of integration of crossings with overlapping approaches to identify ways of reducing impact of Form Cs

[1] Understandably, RTD and DTP cannot agree that RTDC is in any manner noncompliant with regulations while facing alleged violations. Nothing in this plan is intended as an admission against interest, or an expression of anything less than RTD and DTP's steadfast commitment to public safety. This Plan is provided in the spirit of cooperation for the advancement of safety.

Potential Future Enhancements

- CTWS evaluation for emerging, improved and new technologies; pilot projects/demonstrations where applicable
- PTC on board software integration with the operating schedule
- Elimination of select crossings

The Plan employs a variety of methods and approaches to address the FRA's concerns, including enhanced monitoring, software enhancements, analytical studies with specific end dates and commitments to evaluate additional data. The Plan includes detailed procedures, methods, milestones, and timelines for completion, and descriptions of the technical resources to be employed. If FRA has any questions or concerns after reviewing this document, both RTD and DTP respectfully request an opportunity to meet with FRA to allow us to respond to all concerns.

2. BACKGROUND ON RTDC CROSSING WARNING TIMES

This section is included to frame and clarify the issue for the benefit of stakeholders who may consult this public document.

Warning time is the time from activation of the crossing warning devices (lights, sound and gates) until the train arrives at the crossing. Each crossing has its own design warning time based on such factors as track speed limits (referred to as Maximum Authorized Speeds or "MAS"), the width of the crossing, and the time needed for motorists, cyclists and pedestrians to clear the crossing after the lights, bells and gates have been activated. Some safety experts believe that crossings are safer where warning times are as short as reasonably possible and relatively consistent so that the public does not distrust active warning devices and does not attempt to cross the tracks with a mistaken belief that the train is not really coming.

Most of the crossings used by RTDC have multiple railroad users, including Amtrak, Union Pacific and/or BNSF. Each type of train and type of service travels at different speeds and performs different types of operations/stops within the vicinity of the grade crossings. RTDC commuter rail trains, for example, make frequent station stops and are often accelerating and decelerating. Amtrak, Union Pacific and BNSF perform switching operations at or near crossings and also run through trains, such as the trains out of Golden that are long and slow.

Regulations regarding crossing warning times are the same for all trains. Warning time expectations are the same for all trains. It does not matter if the train is carrying passengers or transporting goods. The objective is to assure that road traffic experiences relatively uniform warning times, and is otherwise protected by adequate safety measures, regardless of the type or speed of the oncoming train. In some cases, multiple trains traverse or approach a crossing at the same time on different tracks. In these cases, the warning times are long because the gates remain down from the time the first train activates the crossing until the last train has passed through the crossing.

The technologies used to activate crossing warning devices attempt to predict when each specific train will arrive at a particular crossing, taking into account the speed at the time of detection and activating the warning devices when the train is a fixed time away from the crossing. In this manner, the warning time for a high-speed train carrying passengers will be approximately the same as the warning time for a slow-moving freight train. If the expected warning time is, for example, 30 seconds, a train advancing at 30mph will activate the crossing when it is ¼ mile from the crossing, while a train traveling at 60mph will activate the crossing when it is ½ mile away.

The example above is overly simplified. The crossings in question are located in densely developed urban territory with multiple crossings within very short distances of each other and with switching yards and train stations within the crossing activation zones. The technology used by each of the railroads using the crossings must take many variables into account to predict when the train will arrive at the crossing. The accuracy of the prediction is affected by known factors, such as the actual speed of the train at the point of activation. Accuracy is also affected by factors not known or controllable by the system, for example an unanticipated decision by the train operator to slow down after the crossing has already been activated based on his/her judgment approaching the crossing. Human operators have the freedom and responsibility to adjust train speeds for conditions. One freight operator may take more time to conduct a particular switching movement than another operator, and a passenger train operator may allow more time at a station stop for passengers to board than is typically needed. Railroads attempt to run on schedule but trains are not fully automated or driverless.

The integrated Positive Train Control (PTC) and Wireless Crossing Activation System (WCAS) employed on the RTDC system was manufactured by Wabtec, an industry leading provider of train control and advanced crossing warning systems. Xorail, which is part of Wabtec's organization, integrated the Wabtec PTC and WCAS systems with signaling and grade crossing activation systems from other leading suppliers (i.e. GE, Alstom and Siemens) to provide an integrated and safe grade crossing activation and warning system that uniquely enforces and protects the FRA mandated minimum warning time of twenty (20) seconds. Older forms of technology used by the other railroads are not available for RTDC because RTDC is an electrified railroad, whereas the others are diesel. An electrified railroad uses the track as a ground circuit. Traditional grade crossing prediction or constant warning time detection equipment cannot be used to operate grade crossings in the way that diesel railroad tracks can. The Wabtec system uses a wireless/GPS application to adjust for actual train speed up to the point that signals must activate, which is when the train is 30 seconds away from the crossing in the example above. In case of an interruption in wireless connectivity, the crossing will activate based on train occupancy of a simple track circuit, as is traditional on other electrified railroads. The simple fall back track circuit device cannot adjust for actual train speed. RTDC is the first electrified railroad to use the new Wabtec system. RTDC is the only railroad using the crossings in question with a system that can automatically apply the brakes if the train is approaching the crossing too quickly.

Railroad grade crossings experience occasional warning times that are as long as a minute or more. Following FRA guidance on requirements for quiet zones, the RTDC grade crossings are all equipped with safety devices such as four-quadrant gates. With a gate on the entrance and exit of each traffic lane, impatient motorists are unable to weave around the crossing arms and place themselves in harm's way. RTDC also improved road layouts, added raised medians where possible, channelized pedestrian railings, upgraded traffic signals, added and improved signage, and installed CCTV surveillance in addition to providing the WCAS. These improvements enhance the safety of the RTDC system and other railroads using the same crossings. RTDC records the warning times for all of the railroads using the crossings. Currently the data for RTDC consistently shows that an average of approximately 90% of all warning times are within -5 to +15 seconds of the design-warning times for all crossings (excluded event applied and shown in Appendix C). This is reflected in Table 1 below for a representative three day period in November 2018.

RTDC is committed to doing whatever is possible to meet the FRA objective stated in the 15th November letter, through the potential system and operational improvements described in this Plan. Recognizing that trains have human operators and can face variable conditions that cannot always be addressed with technology and no system on North American railroads can control warning time variations after warning time devices have been activated, since speed variations are under the operator's control.

3. BASELINE

3.1 A Line

The A Line has eleven (11) at grade crossings. Ten (10) of the at-grade crossings are shared with the Union Pacific Railroad (UPRR). Table 1 below provides the current performance as a baseline for observing future improvement. The chart reflects operations from November 27th to November 29th 2018, which were relatively free of poor weather or other known operating anomalies.

Crossing Name	Total Activations at crossing	RTDC			UPRR		
		# Activations	% Over target range (+15 Sec)	# Over target range (+15 Sec)	# Activations	% Over target range (+15 Sec)	# Over target range (+15 Sec)
York	414	414	5.3%	23	N/A	N/A	N/A
Clayton	417	401	4.5%	18	16	18.8%	3
Steele	420	404	2.2%	9	16	12.5%	2
Dahlia	381	362	5.0%	18	19	26.3%	5
Holly	421	402	3.5%	14	19	15.8%	3
Monaco	410	378	11.6%	44	32	40.6%	13
Quebec	422	395	4.3%	17	27	44.4%	12
Ulster	428	398	6.5%	26	30	23.3%	7
Havana	381	364	6.3%	23	17	17.6%	3
Sable	418	398	1.5%	6	20	50.0%	10
Chambers	427	400	1.8%	7	27	14.8%	4

Table 1 – All activations at A Line corridor crossings with warning times outside of 15 second limit (over a 3 day period).
Note train meets excluded from activation

3.2 G Line

The G Line has sixteen (16) at grade crossings. Fifteen of the crossings are shared with BNSF and two of the crossings are shared with UPRR, including Amtrak. The G Line has been operating on a partial schedule without passengers since August of 2018. FRA has required that RTDC provide data demonstrating good performance for each individual G Line crossing for five consecutive days. The report with the five days of performance data was submitted to the FRA on Tuesday 11th December 2018. For comparison, the chart below shows baseline data for the G Line crossings for the same days used for the chart above presenting A Line performance.

Crossing Name	Total Activations at crossing	RTDC			BNSF/UPRR		
		# Activations	% Over target range (+15 Sec)	# Over target range (+15 Sec)	# Activations	% Over target range (+15 Sec)	# Over target range (+15 Sec)
60th	302	302	1.7%	5	N/A	N/A	N/A
Lowell	334	287	2.1%	6	47	21.3%	10
Tennyson	317	273	6.6%	18	44	20.5%	9
Lamar	256	248	8.1%	20	8	25.0%	2
Saulsbury	286	278	6.8%	19	8	0.0%	0
Vance	246	238	2.9%	7	8	100.0%	8
OldeWads	270	262	5.3%	14	8	37.5%	3
Allison	256	248	5.2%	13	8	12.5%	1
Balsam	273	265	9.1%	24	8	0.0%	0
Carr	273	265	10.6%	28	8	12.5%	1
Garrison	301	293	2.7%	8	8	12.5%	1
Indy	292	284	7.7%	22	8	12.5%	1
Miller	277	263	13.3%	35	14	28.6%	4
Parfet	254	242	19.4%	47	12	41.7%	5
Robb	271	258	16.3%	42	13	23.1%	3
Tabor	256	244	24.2%	59	12	91.7%	11

Table 2 – All activations at G Line corridor crossings with warning times outside of 15 second limit (over a 5 day period).
Note train meets excluded from activation

G Line Operation

The continuous improvement program detailed in this document applies to the G Line crossings as well as the A Line crossings over the same timescales.

RTDC is prepared to commence Revenue Service on the G Line in the first quarter of 2019. RTDC is confident that revenue operations can be performed safely. The commencement of G Line revenue service in the first quarter of 2019 would require cooperation and coordination with multiple stakeholders. The commencement of G Line revenue operation would be subject to FRA approval to begin the Revenue Service Demonstration for PTC (the system that provides the braking function described above) within the G-Line territory.

4. IMPLEMENTATION TEAM

The Implementation Team for this Plan will be led by the following executives and subject matter experts. The résumé statement of each is contained in Attachment A. A brief summary of experience is provided below:

Role/ Responsibility	Name	Company/Title	Background	Rail Experience
Owner Executive Committee Member	David A. Genova	RTD CEO	Safety, Executive	24 years
Operator Executive Committee Member	Andrea Warfield	Fluor VP	Operations, Maintenance	38 years
Owner Sponsor	Henry Stopplecamp	RTD Capital Programs AGM	Civil Construction, Project Management	24 years
Oversight Owner	Allen Miller	Deputy AGM Commuter Rail	Rail Operations and Maintenance	40 years
Executive Sponsor	John Thompson	John Laing VP DTP Executive Project Director	Operations, Maintenance	40 years
Wabtec Executive Sponsor	Rajendra Khadev	Wabtec EVP	Signaling, Executive	28 years
Plan Consultant	Clifford Eby	FRA (Retired)	Civil Engineer	45 years
Operations Director	Anne Herzenberg	DTO General Manager	Operations, Maintenance	35 years
Operations Consultant	Michael Mulhern	ACI Chief Operating Officer	Rail Operations and Maintenance	30 years
Plan Director	Peter Strange	Fluor Project Director	Systems Engineer	25 years
Operations Deputy Director	Paul Kenney	Deputy General Manager O&M	Engineering Manager	3 years
Plan RTD Oversight	Joe Christie	RTD Project Director	Civil Engineer	12 years
Quality Assurance Director	Evariste Poissot	DTP Technical & Quality Director	Systems Project Manager	5 years
Engineering Review and Configuration Management	Luis Rivera	DTO Chief Engineer	Rail Systems and Infrastructure	18 years

Role/ Responsibility	Name	Company/Title	Background	Rail Experience
Engineering Review and Configuration Management	Kelly Abaray	DTO Engineering Program Manager	Design and Rail Project Manager	Over 19 years
Project Management and Design review	Jacob Seward	DTP Train Control & Signaling Manager	Rail Signaling Design and Construction	18 years
Technical Consultant	Jeff Whiteman	RTD Systems Project Manager	Rail Systems	9 years
DTP Train Control & Signaling Manager	Jacob Seward	Balfour Beatty TC&S Manager	Signaling and Rail Systems Construction	18 years
DTP Train Control & Signaling Engineer	Zachary Taylor	Balfour Beatty TC&S Manager	Signaling and Rail Systems Construction	12 years
Xorail Project Manager and System Testing Lead	Craig Inman	Xorail/Wabtec Project Manager	Signaling	20 years
Xorail Project Director	Nima Tehrani	Xorail/Wabtec VP	Signaling	17 years
Wabtec Executive Software Support and Consultant	Jeff Kernwein	Wabtec Electronics VP	Train Control & Signaling	25 years
Data Analyst and Technical Development	Timothy Schultz	Wabtec Senior Systems Engineer	Train Control and systems	6 years
Data Analysis and Signal System Technical Development	Van Fayler	Xorail Signaling Systems Director	Signaling	30 years
Data Analysis, Technical Development and Testing Lead	James Mitchell	Xorail Senior Signaling Systems Engineer	Signaling	19 years

Table 3 – Implementation Team

RTDC requests that the FRA assign specific personnel to participate in activities and reviews under the Plan.

5. TECHNICAL BACKGROUND AND NEED FOR WIRELESS/GPS SYSTEM

At the time planning for RTDC began, Congress had mandated Positive Train Control (PTC) for collision and over-speed protection. This was a major step for the industry and a bedrock requirement for RTD in opening a new commuter railroad. PTC utilizes GPS technology in a similar manner to advanced automotive technologies that are paving the way toward driverless cars. RTD was additionally required by environmental permits to have quiet zones (no train horns), and RTD desired to have an electrified railway for reliability and environmental reasons.

Quiet zones require the use of constant warning time detection. With the advent of PTC, it was now possible to use the wireless connectivity and GPS functionality provided for PTC as building blocks for a constant warning time device on an electrified railroad.[2] A design requirement of the project was to provide constant warning train detection capability to allow for quiet zones.

DTP, a consortium of experienced companies, submitted a bid for the project. They retained Xorail (later acquired by Wabtec) to provide the system description for the DTP Proposal. Xorail described its latest technology. Following award of the P3 Contract to DTP, DTP entered into a contract with Xorail/Wabtec for the system as described.

Wabtec (through Xorail) provided the Wabtec Interoperable-Electronic Train Management System (I-ETMS), which it had designed to meet the Congressional mandate for Positive Train Control (PTC). I-ETMS, as provided for RTDC, includes a Wireless Crossing Activation System (WCAS) which enabled constant warning train detection for the first time on a North American electrified railroad. An underlying Audio Frequency Overlay (AFO) track circuit design (also termed Conventional Track Warning System (CTWS))-provides the base crossing activation and traffic preemption technology. The overall system controls both the crossing warning devices and preempts traffic signals at adjacent intersections. CTWS can be thought of as the base fallback system. CTWS assures that crossing warning device will be activated no matter what conditions may be present. It assumes that the train is traveling at the maximum speed limit. WCAS is integrated with CTWS and operates to interject a delay in the signal activation when the train is actually traveling more slowly than the train speed limit. More specifically, CTWS will activate the crossing warning devices, subject to overriding messages from WCAS that adjust warning time up to the point that the predicted time of arrival at the crossing matches the programmed or designed warning time (30 seconds in the earlier example). The system reacts to messages from WCAS wireless communication, which while highly reliable, is subject to potential interference. If the WCAS signal is not refreshed every second, CTWS will activate the crossing warning devices based on the last message from WCAS as to the location and speed of the train. Crossings will always activate even if no WCAS message is received. Like any other crossing warning system, WCAS cannot correct for

[2] Constant Warning Time Devices definition is found in the MUTCD (2009 Edition) and the Federal Highway Administration Railroad-Highway Grade Crossing Handbook – Revised Second Edition August 2007.

unplanned changes in train velocity after activation (with the exception of braking enforcement in the event of a potential early arrival at the crossing, which is an advancement over trains without PTC).

One factor that causes variability of warning times is the variation in the time that trains stop in passenger stations (dwell time). RTDC will seek a method of reducing or eliminating the impact of dwell time variation on crossing warning times. Other railroads may use a manual button in the train cab to trigger crossing signals after a station stop, rather than activating the signals automatically based on an assumed dwell time. In either case, actual warning time can vary based on the actual start time and rate of acceleration. This is an alternative that will be further studied under the Plan. The use of a button would require a reinforcement measure to assure the operator cannot move forward until the button has been pushed. RTDC will evaluate this issue and other complications that may impose safety concerns.

In August of 2016, in response to FRA concerns about warning times, RTDC carried out an evaluation of the Eagle P3 grade crossing design with input from various consultants experienced in US railroad signaling systems and grade crossing warning systems. DTP also requested guidance from FRA inspectors regarding their expectation of warning time consistency.

In September and October of 2016, DTP engaged HNTB as an independent reviewer to provide specialist knowledge of PTC and grade crossing activation systems under development in the US. HNTB carried out an evaluation of the EAGLE grade crossing activation system and proposed modifications to both WCAS and CTWS to improve warning times. Subsequently, HNTB's role was expanded to guide implementation of its concepts.

The improvements proposed by HNTB (as detailed more fully in prior submissions) included the following:

1. PTC Configuration – Approach Condition Adjustment Factors (ACAF) adjustment and optimization. The ACAF was introduced to improve the accuracy of the predictions of the time that the train will arrive at the crossing based on experience available only from actual passenger operations. Initially, the system design assumed that the train's maximum acceleration or minimum deceleration rates would be in effect between the time of activation of the warning devices and arrival at the crossing. This was a conservative approach taken to assure that there would not be a short warning time or activation failure. This approach is indicative of prudent design. For example, if a station stop occurs just prior to the crossing, the system initially assumed that the train would accelerate at its maximum rate to attain the maximum authorized speed (MAS) even though in actual operation it was observed that every operator would accelerate more slowly (example crossing, Ulster Street travelling southbound). Thus, the train's actual arrival time at the crossing would be later than the system predicted and the warning time would be correspondingly longer than expected. An ACAF value was introduced to account for the typical variation. The ACAF in this instance is a revised assumption that decreases the assumed travel time to the crossing and delays the activation of

the warning devices to achieve a warning time closer to the design warning time. Even with ACAFs in effect, the system still protects the crossing by preventing trains from arriving at the crossing with less than the minimum 20 seconds warning time required by FRA regulations. Other ACAF examples apply to other crossings. This approach to crossing optimization was also followed on the G Line during testing, and will continue to be followed once the G Line is in actual passenger service and additional operational assumptions are validated.

2. Onboard PTC Software Upgrade to DE 1.0.8.0. I-ETMS On-Board software version 1.0.8.0 was developed to increase the railroad's flexibility to adjust ACAF values based on operating experience. The capability to utilize ACAFs for specific crossings was initially introduced in I-ETMS On-Board software Version 1.0.7.0. With that version, ACAF values were stored within the track database, and each change in an ACAF value required an update to the track database. Software version 1.0.8.0 made the ACAF a configurable value, allowing the railroad to make changes without updating the track database, thus expediting the process of refining ACAF values. As with all software updates, FRA approval was required and obtained for installation of the update.

3. WCAS Wayside Vital Logic change to decouple the crossing activation from the traffic preemption signal. This allowed the expected arrival time to the crossing time to be updated closer to the point of activation.

4. WCAS Wayside Vital Logic change based on warning time for the “whole” crossing, instead of the entry plane of the crossing.

5. CTWS Wayside Vital Logic Change to add Advanced Delay Timers that allow for speed changes rather than the assumption of maximum authorized speed. This change is possible due to the braking function of PTC. Railroads without PTC would be required to assume the speed limit.

6. CTWS Wayside Vital Logic Change – Investigation into using ATC Cab code enforcement of station stops in the absence of WCAS to distinguish between express and station stop modes.

The only HNTB proposal not implemented was item 6. Item 6 was investigated but not implemented because at the time it was determined that safety concerns outweighed the benefit of the improvement in warning time consistency expected to result from the change. Specifically, the change was expected to improve the consistency of warning times for infrequent CTWS only activations of crossings with stations in their approaches. The change would remove the possibility that a train could operate express through a station. Wabtec developed the methodology and a work plan, but the implementation process raised safety concerns with the ability to enforce the 20 second minimum warning time for a crossing versus the impact of unintended enforcements which in turn would cause longer warning times and was therefore rejected by the operations team. DTP has now asked Wabtec to continue to develop a method to enforce a train to restricted speed or stop before a crossing in the event that a train should fail to make a planned station stop. This will be examined further under the

Plan and implementation plans and procedures will be developed should the data analysis support this modification.

Changes 1-5 were also implemented on the G Line prior to and during grade crossing testing.

Further onboard software updates have been implemented across all lines, with prior FRA approval of each update. The updates reflect normal evolution and offered certain improvements relative to warning times:

DE 1.0.9.0 This version included revisions that reduced the occurrence of early arrival warning banners on the operator's control panel that may have unnecessarily caused the operator to slow the train.

DE 1.0.10.0 This version included certain revisions to the wireless crossing activation algorithm to reflect uncommon crossover moves ahead of certain crossings. Because these train moves are not part of normal operations, the change did not provide a significant improvement in warning times. Nonetheless, the test demonstrated that should such complex train moves take place, the wireless system would remain active and therefore adjust the time of crossing activation, improving the consistency of warning times.

DE 1.0.11.0 Improvement to the wireless crossing activation algorithm to eliminate the potential for certain short warning times (referred to in prior submissions as the triplexing issue). This change was not focused on warning time consistency as such, but rather corrected a rare circumstance that had not been anticipated originally. This issue was identified by DTP in the review of testing logs on the G Line and was an issue that could have affected other crossings.

6. PERFORMANCE SUMMARY

Current grade crossing activation results have been reported to the FRA monthly for the A and B Lines since the current waiver was approved in September of 2017[3]. Table 4 below shows the percentage of warning times inside and outside of the 15 seconds for each crossing for 27-29th November 2018. It also shows the percentage of warning times just outside the +15 range (additional 5 seconds). These dates were selected for this report because they followed two events that improved warning time consistency: 1). the triplexing issue was resolved, ending the need to mitigate risk by extending dwell times at three station stations; and 2). an ACAF adjustment was implemented for the approach to Monaco.

[3] Please note that the data shown in the table and previous tables reflect actual warning times, and do not differentiate between variations caused by controllable system factors and non-controllable factors.

Crossing	# of Activations	within Range	over range	5 seconds over range
York	414	94.7%	5.3%	97.6%
Clayton	401	95.5%	4.5%	97.8%
Steele	404	97.8%	2.2%	98.0%
Dahlia	362	95.0%	5.0%	97.0%
Holly	402	96.5%	3.5%	98.0%
Monaco	378	88.4%	11.6%	95.0%
Quebec	395	95.7%	4.3%	97.2%
Ulster	398	93.5%	6.5%	96.7%
Havana	364	93.7%	6.3%	96.2%
Sable	398	98.5%	1.5%	99.7%
Chambers	400	98.3%	1.8%	99.5%

Table 4 – Percentage of warning times within and outside of 15-second limit

Warning time data was recorded over the same three-day period for all of the A line crossings. Differences in the number of activations at each crossing are due to train meets, for which the crossing is activated by one train and a second train gets on the approach to the crossing from the opposite direction. In these cases there is only one activation and warning time for two moves and the data is excluded. This is detailed in Appendix C.

Further analysis will be conducted to investigate and determine the root causes of warning times outside of the 15 second target during the next month. Common causes, discussed in Section 8, are known but the investigation will not be limited and will look at the factors that influence train handling and station stops. RTDC will develop system improvements to adjust for these factors. Appendix C shows a summary of long warning times by number of occurrences for each crossing.

RTDC has initially identified Monaco, Holly, then York and Clayton crossings as priorities for analysis and improvement on the A line; and Tabor, Robb, Parfet, and Old Wadsworth on the G line.

7. HOLLY AND MONACO CROSSING IMPROVEMENTS

Holly and Monaco crossings were expressly identified as a concern by the FRA in the November 15, 2018 letter and in previous FRA inspection reports. These crossings are an example of how RTDC continues to analyze data and improve crossing warning time consistency. Efforts to implement revised ACAF values were already underway months before the FRA's letter was received.

RTDC analyzed these crossings and discovered that the acceleration and deceleration profile of trains approaching these crossings had evolved significantly with increased operator experience in train handling. The FRA approved new ACAF values for Monaco crossing, which were implemented on November 21, 2018. Data for both of the crossings since then has shown improvement in the warning times. Further improvement may also be possible with additional study of actual operations. For example, observed dwell times at the Central Park station, which is on the approach to these crossings,

are typically longer than the assumed 35 second minimum dwell time and may be a factor in lengthening the actual warning times experienced at Holly and Monaco. RTDC is working to determine the root cause of the long dwell times and may address the root cause with a change in operating practices or recognize the long dwell times in a further ACAF adjustment. As further described in the Plan below, RTDC will continue to study operations at the Central Park Station.

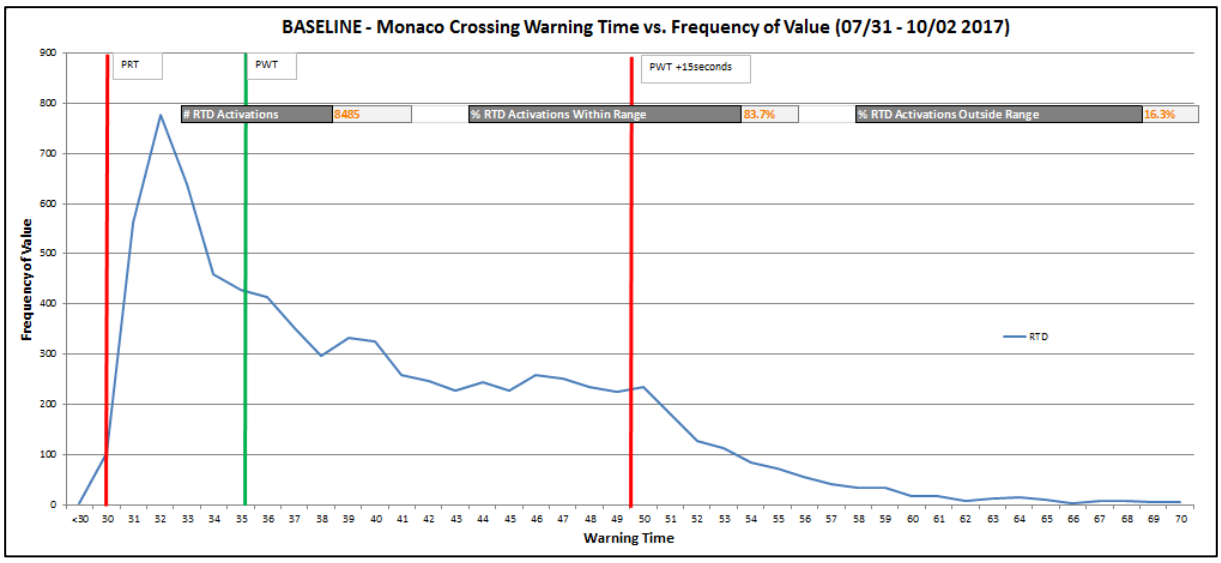
Before and after bell curves for the crossings are shown for Monaco and Holly crossings below. Table 5 below summarizes the change in WT performance.

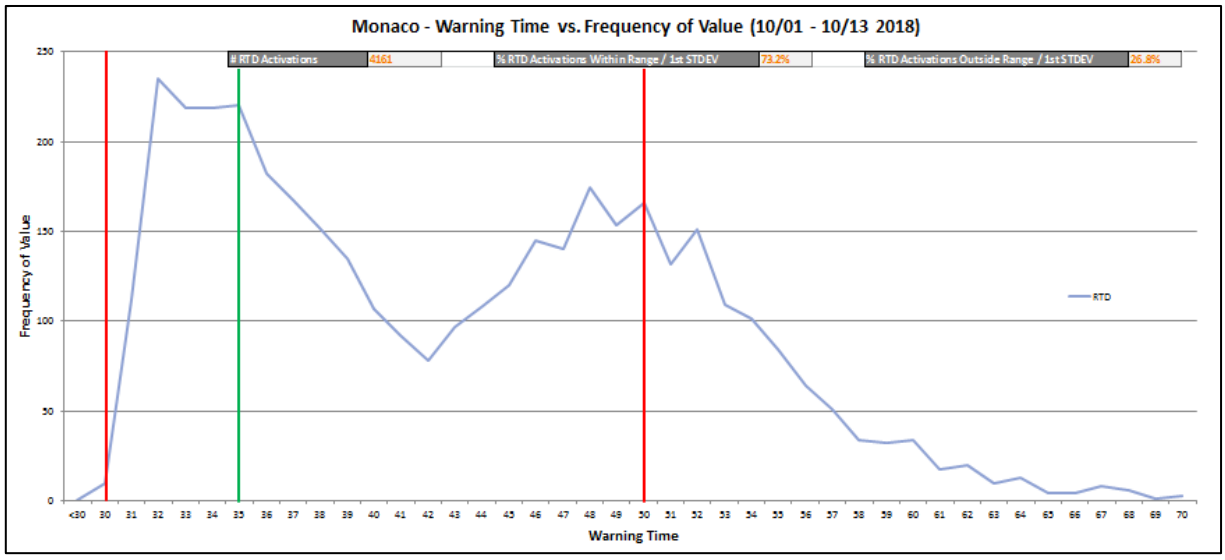
Crossing	Baseline Performance 7/31 to 10/02 2017 (-5 to +15 seconds of PWT	Pre November 2018 ACAF Adjustment 10/1 to 10/13 2018	Post November 21st ACAF Adjustment 11/27 to 11/29
Monaco	83.7%	73.2%	88.4%
Holly	83.0%	77.8%	96.5%

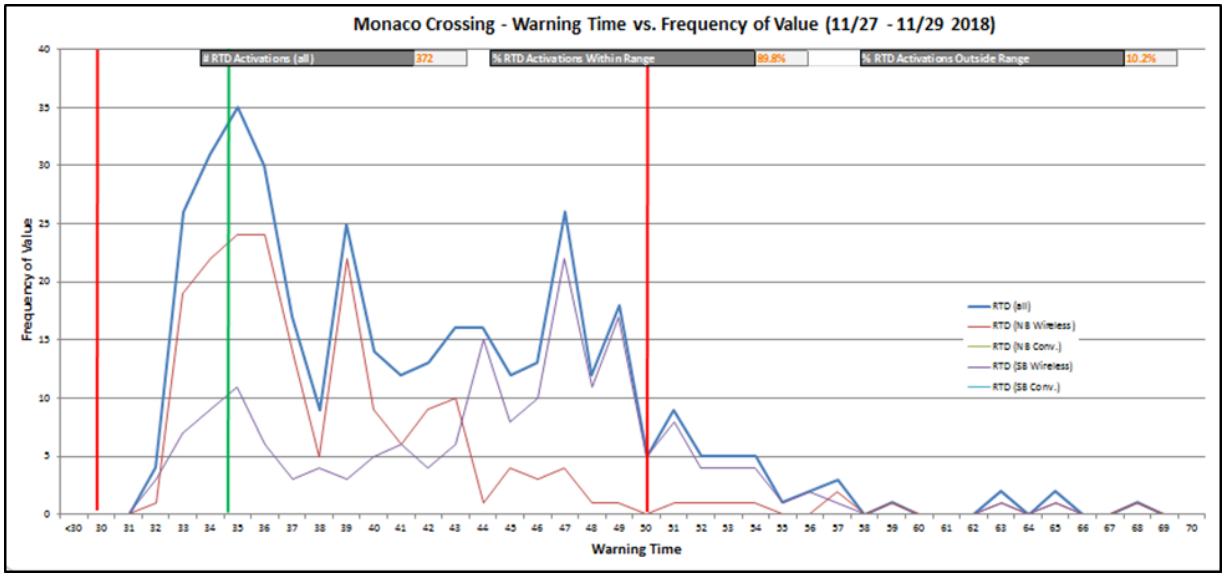
Table 5 – Change in warning time performance

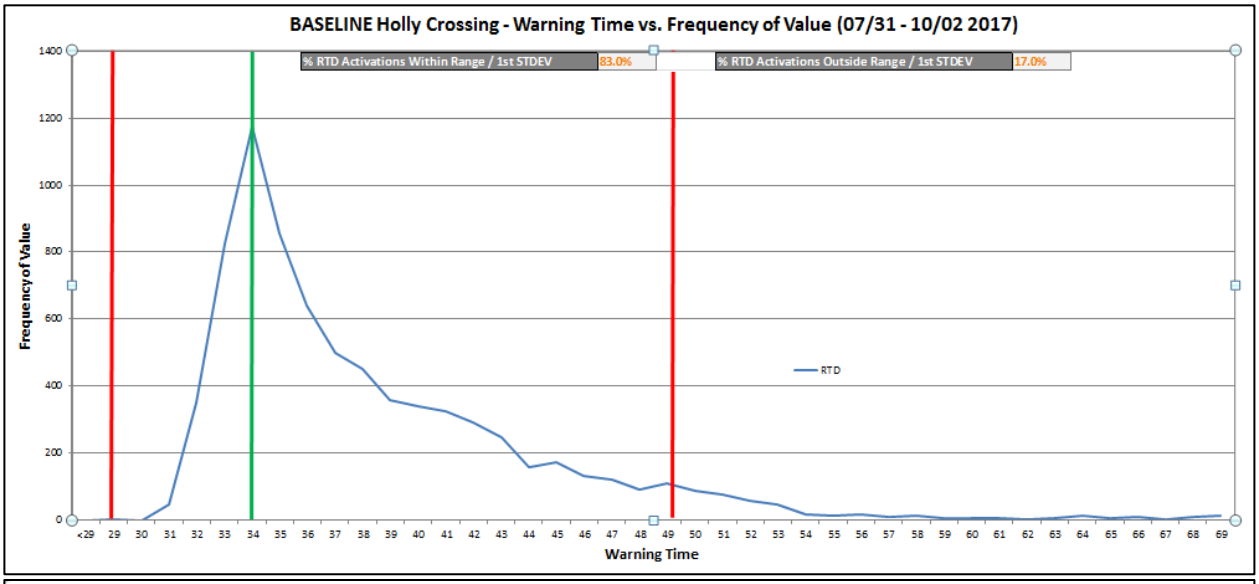
Further analysis of Monaco and Holly crossings shows that the southbound approach experiences a wide range of train operating speeds. Another ACAF adjustment is in review now and additional design work has started on eliminating the express train move, thereby allowing the conventional track circuit to be shortened significantly, possibly taking the station off of the southbound crossing approach.

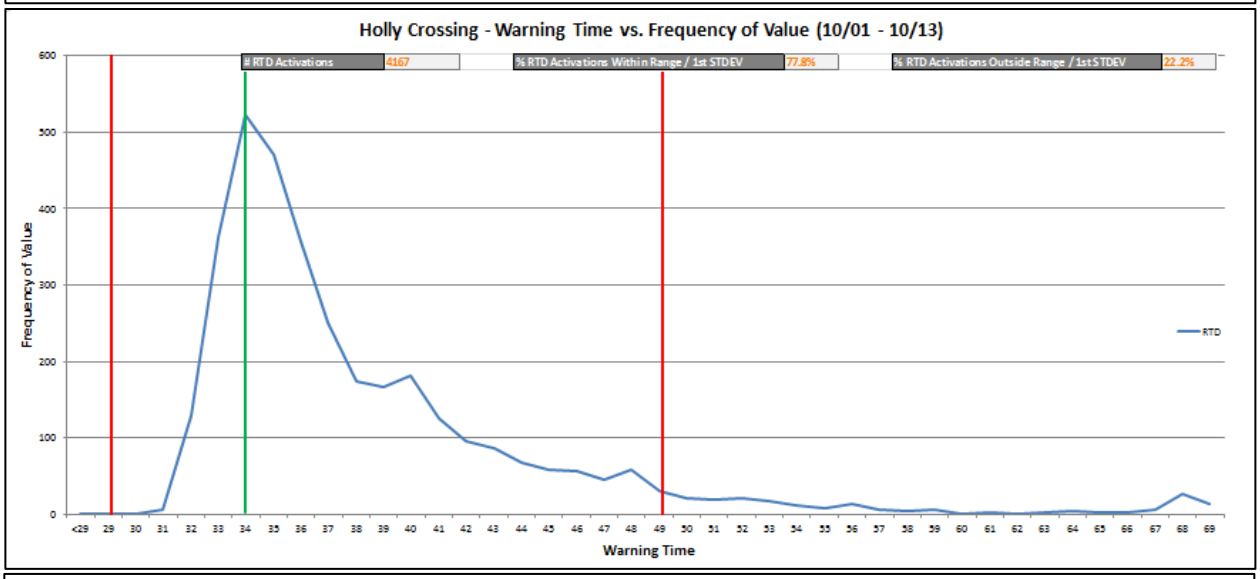
The team is also reviewing the timetable speeds along this approach to identify rationalization of the speed limits to improve consistency.

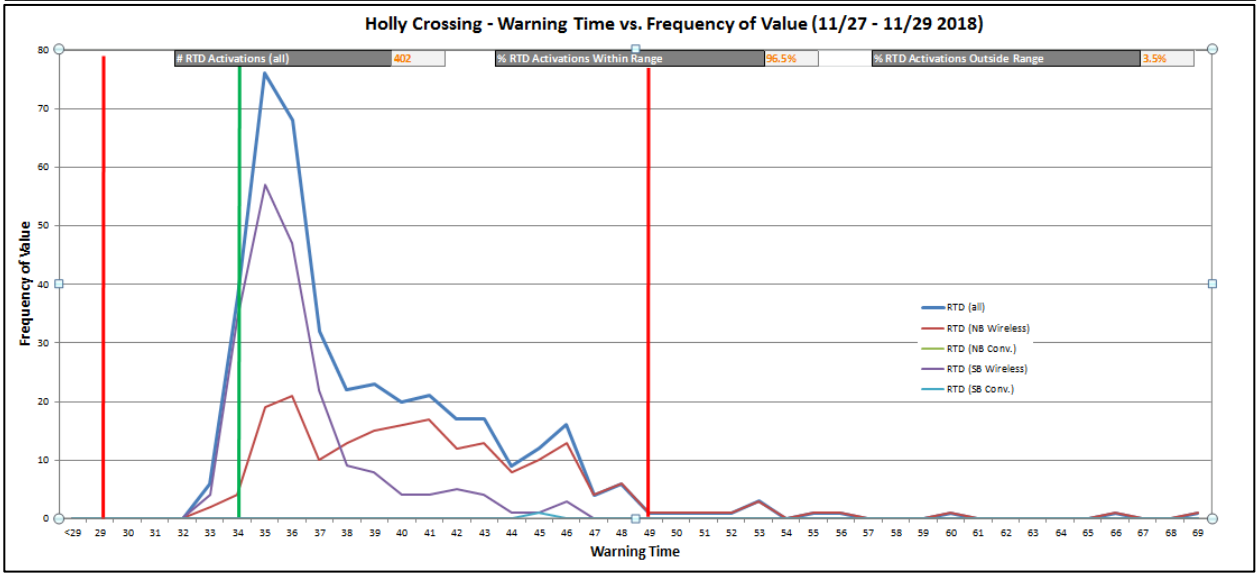

BASELINE - Monaco Crossing Warning Time vs. Frequency of Value (07/31 - 10/02 2017)
PRT
PWT
PWT +15seconds
RTD Activations 3485
% RTD Activations Within Range 83.7%
% RTD Activations Outside Range 16.3%
Frequency of Value
Warning Time
RTD


Monaco - Warning Time vs. Frequency of Value (10/01 - 10/13 2018)
RTD Activations 4161
% RTD Activations Within Range / 1st STDEV 73.2%
% RTD Activations Outside Range / 1st STDEV 26.8%
Frequency of Value
Warning Time
RTD


Monaco Crossing - Warning Time vs. Frequency of Value (11/27 - 11/29 2018)
RTD Activations (all) 372
% RTD Activations Within Range 89.8%
% RTD Activations Outside Range 10.2%
Frequency of Value
Warning Time
RTD (all)
RTD (NB Wireless)
RTD (NB Conv.)
RTD (SB Wireless)
RTD (SB Conv.)


BASELINE Holly Crossing - Warning Time vs. Frequency of Value (07/31 - 10/02 2017)
% RTD Activations Within Range / 1st STDEV
83.0%
% RTD Activations Outside Range / 1st STDEV
17.0%
Frequency of Value
Warning Time
RTD


Holly Crossing - Warning Time vs. Frequency of Value (10/01 - 10/13)
RTD Activations
4167
% RTD Activations Within Range / 1st STDEV
77.8%
% RTD Activations Outside Range / 1st STDEV
22.2%
Frequency of Value
Warning Time
RTD


Holly Crossing - Warning Time vs. Frequency of Value (11/27 - 11/29 2018)
RTD Activations (all)
402
% RTD Activations Within Range
96.5%
% RTD Activations Outside Range
3.5%
Frequency of Value
Warning Time
RTD (all)
RTD (NB Wireless)
RTD (NB Conv.)
RTD (SB Wireless)
RTD (SB Conv.)

8. PLAN INITIATIVES

This Section covers two main areas of focus:

- Consistency of grade crossing warning times as experienced by highway users
  - Acceleration of
    - actions already in development
      - data model 8 software update
      - ACAF adjustments at select crossings
      - Review express train operations
    - innovative new solutions
      - warning time analysis tool
        GPS improvements to address commuter rail originated development

The following sections describe the actions to be maintained and taken in effort to achieve the objective stated above:

8.1 Continuous Improvement Focus On Known Causes of Long Warning Times

The objective of this plan is that RTDC will continuously monitor and maintain a program of continuous improvement to the crossing warning time performance. With respect to warning time consistency, various items are currently at different stages of consideration and development, and may provide opportunities for further improvement. For each crossing data will be analyzed on a regular basis for each warning time over the PWT +15 seconds range with the cause identified. The analysis will then determine specific design tasks to either eliminate the cause or modify the system design to bring the warning time performance into range. The analysis will be conducted by both operations and design project staff as shown in Section 4 and Appendix B.

The following are known causes of long warning times.

- Form C Mandatory Directives (Stop and Proceed). Orders for train operators to stop at a crossing. Form Cs are put in place in response to a credible report of a crossing warning system malfunction causing a CTWS activation and typically causing longer than expected warning time. This is because the train travels slowly and stops at the crossing rather than traveling at MAS as assumed in the calculation of the length of the approach circuit.

- Form S Mandatory Directives (Slow Order). Orders to reduce the train speed before crossing activation do not affect warning times because WCAS detects the slower speed and compensate for the speed reduction. However, if the slow order is in effect after the point of activation, the system has no mechanism to alter the fact that the signals have already been activated.

- PTC Enforcement. If the PTC system recognizes or predicts that a train will arrive too early at a crossing, it will enforce a penalty braking application. The train then comes to a stop and must

re-initialize in PTC before being able to move. This process takes approximately 2 minutes, during which time the crossing gates remain down and the actual warning time is extended. If this happens while a train is on the approaches for multiple crossings, the warning times for all of these crossings are lengthened.

- PTC Cut Out. When an operator cannot initialize a train in PTC, because of a PTC failure, a loss in communication, a loss of GPS signal or other reasons, the Dispatcher may authorize the operator to cut the train out of PTC. As a result, all crossing activations are under CTWS alone with longer warning times typically occurring on crossings with stations in their approach. Historically, this occurs on 2-3% of trips monthly. This data is available in the monthly PTC RSD reports.

- Station Dwell Times. When station dwell times are significantly extended due to passenger loading or other factors, warning times are extended for all crossings for which the station is in the approach.

- Signal or Train Failures. If there is a signal or train failure on a crossing approach, warning times could be extended.

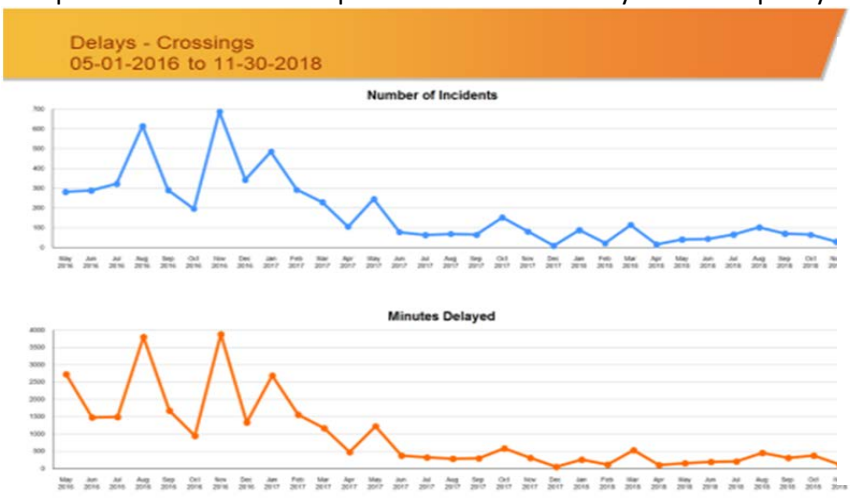
- Train handling. Trains operating more slowly than predicted after the point of activation will lengthen warning times. The system does not record all factors that may cause the operator to proceed more slowly. Weather and poor visibility may be a factor correlated with long warning times.

Under this Plan, the above causes will be further analyzed and any blocking assumptions that cannot be addressed will be removed. RTDC will define the activities and schedule to analyze the occurrence of these events and any correlation with other factors, for example location or equipment or operating conditions and scenarios. Promising solutions will be developed to identify future system modifications, additions or upgrades that may reduce or eliminate these events and/or effects.

RTDC has already made many adjustments to operating practices, equipment and infrastructure and the crossing warning system to limit the impact that these issues on warning times. This effort is continuous.

In addition, operator training and coaching will continue to be updated to keep the train operators current with any system changes.

The following table summarizes the decisive actions RTDC has taken and will continue to take in this regard. RTDC will build upon these efforts based on data driven research and analysis, operating adjustment and available technologies to improve the system.

Event	Analysis
Mandatory Directives (Form C and S)	Several root causes can lead to crossing failures and reports of crossing malfunctions requiring Form Cs. RTDC works continuously to address these root causes thereby minimizing the frequency of Form Cs, as follows: Cause 1: Large vehicles hitting crossing equipment - RTDC installed a traffic barrier around the exit gate at Holly, significantly reducing the frequency of vehicle strikes and consequential Form Cs. Cause 2: Displacement of crossing arms in high winds - RTDC replaced long gate arms at multiple locations with articulated gate arms. In comparison to one-piece gate arms, the articulated arms stay within the wind guards more reliably and bend and break less easily than one-piece arms. Cause 3: Gate keeper failure - RTDC replaced its spring-style gate keepers with heavier duty piston-style gate keepers. RTDC also installed secondary wind guards to help keep longer arms in place. For longer gate arms, there is now one lower and one higher wind guard. These changes reduced failures and consequential form Cs. Cause 4: Long gate arms impacted by high winds. Modifications to the gate arms have been carried out to reduce impact of sudden high winds. RTDC also installed static wires to prevent the gate arms from blowing into the catenary wires. Cause 5: Failures in exit gate loops. RTDC worked with the manufacturer of the exit loops to reduce failures and improve reliability, which initially had been a major cause of reports of malfunctions and consequential Form Cs. Cause 6: STC cards overheating in summer months, which caused a false occupancy on the track circuit. RTDC collaborated with the STC card manufacturer to adjust the temperature tolerance and prevent the unnecessary false occupancy.  *Graphic shows the reduced in delays caused by Form Cs, indirectly indicating the reduction in Form Cs also*

PTC Brake Enforcements	RTDC monitors PTC brake enforcements and identifies operators, locations and circumstances associated with the enforcements. Supervisors are dispatched to ride with the operators most frequently affected by enforcements. RTDC has identified the operators with the fewest PTC enforcements. RTDC is working with them to codify their success to improve training. Some PTC enforcements are predictive in nature, meaning that the operator has not exceeded a civil speed or encroached on a stop target but the PTC algorithm triggers an enforcement based on predictions. Wabtec has agreed to study whether the algorithm is more aggressive than necessary in certain situations and make modifications to the software to reduce unnecessary predictive enforcements.
PTC Cut Outs	Wabtec has developed an industry-wide software upgrade that includes modifications to reduce PTC cut outs and provide other improvements. This "Data Model 8" will be installed at RTDC in the near future. A detailed implementation plan will be developed and provided to FRA in early 2019. In addition, the operations team has developed practices to minimize the number and duration of PTC cut outs. For example, if there is a loss of GPS signal, the Dispatcher instructs the operator to move the train forward slowly to recapture the signal. If this does not work, the Dispatcher will authorize a PTC cut out. DTO will develop a procedure to standardize other practices that have been successful in reducing the number and duration of PTC cut outs.
Improvements to GPS	Data Model 8 will provide some GPS improvements that could improve warning times at York by reducing the number of PTC initializations at 38th/Blake station. RTDC is also investigating ways of improving the GPS signal under the DUS platform canopy with a radio repeater or similar. This opportunity requires further analysis to determine a design and implementation.

Station Dwell Times	System assumes a fixed station dwell time. The impact of actual dwell times will be analyzed to determine if crossing specific adjustments can be made for consistent trends. Evaluate the impact of the operating schedule and actual station dwell times and determine if warning times can be predicted based on schedule and schedule-related dwell time. Station specific analysis to determine potential solutions for very close proximity station stops to crossings. Station dwell times are not currently accounted for in CTWS only approaches. Actively investigate elimination of the potential for an express move so that all trains stop at stations. This will enable the shortening of crossing approaches, in some cases potentially to the point where the station stop is no longer on the approach. This will improve the CTWS warning time performance.
Signal or Train failures	Conduct location based analysis to determine any site specific solutions or action to reduce or eliminate signal and train failure impacts.
Train Handling	Location based analysis to determine any site specific solutions to assist operators with train handling. Acceleration and deceleration smoothing to assist train handling Acceleration and deceleration smoothing to improve system prediction of arrival times at crossings Evaluate human performance and human-machine interface ("HMI") factors. Re-evaluate operator training and mentoring programs.

Table 6 – Events, Analysis, and Actions

While all of the items above may not be precisely scheduled, RTDC will develop a project management plan during the first quarter of 2019 to assure focus is maintained on each potential opportunity. The initial schedule is shown in Appendix A. This will be updated, at a minimum, monthly.

8.2 Warning Time Analysis Tool

Currently, analysis of the grade crossing warning times and correlation with data logs (both onboard PTC logs and Dispatch system logs) is time consuming and manual. RTDC's uses the logs to conduct (a) in-depth analysis of long warning times observed and recorded in the field, and (2) trend analysis. RTDC also analyzes the logs to verify improvements following specific system adjustments, such as changes in ACAF values.

In October, 2018, DTP asked Wabtec to develop an automated software tool that will automate the correlation of data with known operating scenarios or events (e.g. Form C or enforcement), collating

data from multiple sources. The purpose of this tool is to explain and understand long warning times and expedite the railroad's response. RTDC also hopes that this analysis capability will lead to advancements in prediction technology.

The proposed analytical tool, as envisioned, will automatically correlate:

1. Log data for crossing activation and warning times
2. Form C and Form S restrictions
3. PTC brake enforcements
4. Extended station stops
5. Direction of travel
6. Train movement through switches, crossover and other configurations
7. Other data sources, potentially including weather, traffic conditions, passenger count, operator experience.

This analysis tool is intended to improve the efficiency in understanding the causes of long warning times, and assist in the identification of any trends. This tool will be analytical in nature and will improve and replace the manual processes now used to review the data. It will also be used to track progress and improve performance reporting.

A beta version of the tool is expected in March 2019. See Schedule attached as Appendix A for more detail.

8.3 Data Model 8 PTC Software Update

Currently RTDC is using I-ETMS version DE 1.0.11.0. Implementation and test plans for overall system migration to I-ETMS version 3.16.x.x (Data Model 8) are under development. This update will require that application software in the onboard Train Management Computer (TMC) and Back-Office Server (BOS) be updated, along with changes to the format of the Sub-Division file (track database).

This update brings a number of positive improvements including:

1. Reduction of GPS related enforcements with the implementation of non-comm zones.
2. Reduction of onboard PTC failures. In addition, this will reduce PTC cut-outs and in turn reduce non-wireless CTWS only grade crossing activations
3. Improved segregation of Sub Div. files.
4. Improvement to “Braking in Progress” banner to reduce nuisance display.
5. Enhancing the PTC activation process to allow for activation while stationary, resulting in improved crossing warning times when starting from tail track locations. (e.g. Tabor Street)
6. Improvements in the initialization algorithm that will reduce the number of cutout runs due to failed initialization.
7. Incorporation of additional Engineering Change Requests (ECR) which improve overall PTC operation.

The PTC update described above is expected to be implemented by March or April of 2019. RTDC is currently reviewing test plans and evaluating scheduling constraints. The Implementation will be dependent on FRA's timing in the approval of the proposed implementation and test plan as outlined in the schedule (Appendix A). RTDC has targeted providing a proposed implementation and test plan for both BOS and onboard segments to FRA in January 2019. RTDC will keep FRA up to date during planning as assigned by FRA for this purpose.

8.4 PTC Software Human Machine Interface (HMI)

The PTC Human Machine Interface (HMI) will be reviewed, specifically the advisory block which gives the operator the expected time of arrival at each crossing. Operator training currently emphasizes that this is an "advisory message only," not a factor to be considered in controlling train speed. Conceptual improvements are being considered to change the message to one that is much more instructive to the operator, and easier for the operator to use in train handling after the signal activation sequence has begun. This initiative must assure that the operator does not alter train handling solely to make a crossing warning time. This concept will be reviewed with FRA resources further if it appears that changes in the HMI would be beneficial and assure safety. This potential change would only be employed if accepted by the FRA.

The HMI evaluation will be scheduled to begin in January.

8.5 Approach Condition Adjustment Factors (ACAF) Adjustments at Select Crossings

ACAF adjustments are the primary means of optimizing the warning time performance of a crossing. The process is usually a study or analysis of the crossing warning time data and also the typical operating profile, e.g. actual operating speeds, civil speeds and station stop if applicable. The Wabtec engineering team then recommends an ACAF adjustment for test and implementation.

This process of data analysis will continue during this plan period and specific ACAF adjustment implementation plans developed as applicable. It is expected that a further ACAF adjustment test plan will be submitted to the FRA before December 21st, 2018. The change will be implemented upon FRA approval.

Process: Data Analysis, monthly and determination of ACAF requirement will lead to implementation plan development and submission to FRA for approval (A line). G line ACAF adjustments are on hold at the moment pending FRA review and approval of the final test report. After this point these crossings will follow the same process as the A line including implementing the continuous improvement items listed in this plan.

8.6 Improvements to Wireless Activation Algorithms

Through the data analysis exercise proposed as part of this plan we will reassess the WCAS activation and prediction algorithm for the following:

Investigate if the prediction algorithm has too aggressive an acceleration curve with too large a safety factor compared to the real life data.

Investigate the updates of the predicted arrival calculation prior to the point of activation. The onboard Train Management Computer (TMC) re-calculates the predicted arrival time every second and updates the grade crossing wayside equipment if the predicted arrival time has changed by 5 seconds or more. Should this be changed to a lower value balanced against more potential enforcements?

This will be evaluated over the next one-two months with specific implementation plans developed for an onboard software update if a warning time improvement or early arrival enforcement reductions can be realized.

8.7 GPS Improvements at Terminal to Improve PTC Initialization

Specifically at Denver Union Station there has been significant high rise building development in the surrounding area which has impacted reception of GPS signal in the platform area. There are a few PTC initialization issues each day due to poor reception of GPS signal. This increases PTC cut outs for the first section of the train trip and in some cases causes a longer warning time at York crossing once the train initializes at 38th/Blake station.

The project team will evaluate remedies such as Radio Frequency repeaters of GPS signal to improve reception in the platforms. This evaluation would be completed in January 2019 and specific implementation plans developed in the following month for the viable solutions that are identified.

8.8 Review Express Train Operations

Previously investigated and eventually rejected due to safety and operational factors related to protecting the twenty second minimum warning time for a crossing as well as not increasing unintended braking enforcements. This will be revisited by the project team to re-evaluate the design assumptions and determine and develop a viable design and operationally acceptable solution.

Design work on this has already started and implementation proposals are expected to be available for review in January of 2019 on a location by location basis. The schedule gives further detail of the development but the team believes that each solution will need to be tested to demonstrate that the safety factors needed to protect the minimum warning time at the crossings work effectively. The solution will also need to be tested to verify that the WCAS performance is not adversely impacted.

These solutions will impact train service, operation and end to end run times. The design team will determine the most effective design while also seeking to reduce service impacts as much as possible.

8.9 Specific Analysis

Based on data analysis for the crossings covering from March thru Nov 2018, is a list of the approaches we are proposing to prioritize for the A line.

- York NB
- Dahlia SB
- Holly NB and SB
- Monaco NB and SB
- Quebec NB and SB

The selection criteria is to provide the greatest improvement to the conventional warning activations that are going over the acceptable window (PWT+15 seconds) without introducing safety risk. The more complex the solution, the more likely to have unintended consequences and the more difficult to properly test.

These 8 approaches are responsible for 63% of the conventional activations that are above the target window. This could potentially reduce the extended conventional activations to almost 1/3 of what we currently experience. Additionally, these approaches also have the highest occurrence of activations that go more than 35 seconds over the warning time window ("the really long warning times"). We also believe that these may show improvements to the wireless activation times although this needs to be verified.

We are going to proceed analyzing what the causes are for the extended conventional activations and potential solutions for the 8 approaches identified above.

Current solutions under review for:

- York NB: Speed smoothing within the approach and rerunning the approach calculation will potentially move the approach start out of the station. This is expected to reduce the number of conventional activations and improve both the conventional and WCAS activations
- Monaco NB and Holly NB: Speed smoothing within the approach and rerunning the approach calculation will move the approach start out of the station. This is expected to reduce the number of conventional activation and improve the both the conventional and WCAS activations.
- Quebec SB, Monaco SB, Holly SB and Dahlia SB: Ensure a Station stop at Central park and along with Speed smoothing within the approach and rerunning the approach calculation will move the approach start out of the station. Allowing for more accurate warning time at the downstream crossings.
- Quebec NB approach will be improved by speed smoothing and approach calculation update.

Station Specific Analysis (in particular for stations in close proximity to crossings)

The project team will look at and evaluate solution for particular locations, particularly where station stops are in close proximity to a grade crossing and provide particular and specific challenges with respect to warning time consistency. These crossings also have very particular and unique characteristics

such as the average operating speed of the train, passenger and pedestrian loadings and behaviors in and around the crossing.

Location specific analysis has started and will provide output proposals in January 2019.

Review Optimal Train Speeds

A detailed review of the actual train operating speeds compared to the civil design speeds has started. A study of this nature has been done previously to improve operations and also to comply with the Fast Act in 2015. This analysis will be continued to identify further opportunities to reduce or consolidate speed changes along the A and G line alignments. It is intended to provide specific change recommendations in January 2019. The schedule gives further detail.

Review of Dwell Times

RTDC will analyze dwell times and causes of extended dwell times at those stations on crossing approaches. RTDC will evaluate alternative methods of improving dwell time consistency. Some observers have suggested that operators are waiting for scheduled departure times and holding down crossing gates in the process. RTDC will review warning times at the crossings downstream from time-point stations and review schedule adherence to determine whether there is any connection between the schedule and the warning times. If so, RTDC will seek changes in the schedule and/or instructions to operators to improve warning time consistency.

Review of Operating Schedule for Effects on Crossing Warning Times and Optimization

There are a number of operating schedule scenarios that can have impacts on crossing warning times. The operating schedule has timing points to make sure the trains do not leave a station early. There have been efforts to eliminate extended dwells from the normal operating pattern and this will be re-studied.

Transitions between single and double track can often cause trains to have to wait for signals to become clear, termed 'train meets'. The operating schedule can be adjusted to minimize train meets on a normal basis although delays to service and delay recovery can still be impacted by train meets.

Review of Signal or Train Failures

A less likely source of persistent warning time impact however data analysis will look for any trends in location or timing of issues that may have an impact on crossing warning times.

Location Based Analysis to Assist in Train Handling

Data analysis to identify locations that cause the widest variation in train handing will be studied, and if possible, modifications to civil speed or other parameters to increase consistency will be identified.

Review of Integration of Crossings with Overlapping Approaches to Identify Ways of Reducing Impacts of Mandatory Directives

A crossing with a Form C means that every train has to stop before proceeding across the crossing. For crossings with overlapping approaches there will be a significant impact in warning times.

8.10 Reevaluation of Other Systems

Other techniques and technologies, both in use and under development by other railroads and across the railroad industry in general, will be reevaluated to determine if new ideas are applicable to RTDC. These other techniques and technologies include: Predictors, Speed Circuit, TWC loop detection and operator button, and Motion Detection.

Table 7 below is a summary matrix of known characteristics. To date RTDC have not identified any electrified railroad implementing a Speed Sensor or using a Predictor technology to provide constant warning time detection, although one railroad has gone through preliminary testing of Speed Circuit technology to provide differentiation between freight and commuter service. RTDC runs on separate tracks parallel to the freight railroad at the crossings, such that differentiation between freight and commuter trains is not a factor.

Going forward, RTDC will continue to remain abreast of CTWS technology improvements.

Technologies Comparison					
	WCAS	**Predictor**	**Speed Circuits**	**TWC loop detection and Operator button**	**Motion Detection**
Near Side Station Stop	Yes Design assumption 35 second dwell	No. Can also cause multiple activations	No	Partially, signals would need to be added to prevent activation failure. Also, this would require visual proximity to the crossing to verify gates are horizontal, prior to leaving the station. This mode of activation is not constant warning.	Possibly, activates crossing when train begins to move, but may not adjust warning time or address warning time at subsequent crossings in the activation zone. Also tends to lead to multiple activations
Track speed changes before crossing activation	Yes, speed changes are catered for and crossing arrival times recalculated on 5 second intervals until the prediction and design warning time correlate. None possible after activation.	Yes, limited to the speed being instantaneously calculated at the time of detection, and no other speed changes in the approach. System will not automatically take into consideration accelerations and deceleration.	Yes, limited while in timing sections. Detects discrete speeds only, point of detection is typical. Extended detection circuit requires the operator to hold speed constant for a longer period and increases the chance of variability.	No	No.
Track speed changes after crossing activation	No, Early arrival warnings given to Operator. Assumes to some extent the rate of speed change in progress at the time of activation. System will protect against early arrivals due to acceleration after activation. No automatic adjustment for decelerating trains after activation	No, assumes constant speed. No adjustments or protections after activation for accelerating or decelerating trains.	No, assumes constant speed. No adjustments or protections after activation for accelerating or decelerating trains.	No, assumes constant speed. No adjustments or protections after activation for accelerating or decelerating trains.	No, assumes constant speed. No adjustments or protections after activation for accelerating or decelerating trains.

Different Service Speeds (e.g. express and stopping or freight and high speed)	Yes	Yes, although stopping in approach may cause multiple activations	Yes for each, specific for each traffic circuit	Can differentiate base on train identification code.	No
Overlapping Crossing Approaches	Yes, handled with multiple simultaneous wireless sessions	Yes with limitations. Station stop will activate multiple crossings	Frequency separation issues. Multiple crossing or long activations will still result	No	No
Constant Warning Time Device	Yes, adjusts for train speed as described above	Yes, adjusts for train speed as described above	No. Does not adjust for train speed after detection point.	No. Does not adjust for train speed.	No. Does not adjust for train speed.
Safety Factors	Enhanced, short warning time enforcement. Fallback activation with CTWS	Safety default is to activate crossing No short warning time enforcement Multiple Activations	No enforcement or enhancement. Insufficient frequencies to apply in electrified environment. – suitable for discerning between modes	Introduces risk of short warning time and operator error	Multiple crossing activations

Table 7 – Comparison of Other Technologies

8.11 Additional Study of Holly and Monaco

The Holly and Monaco crossings will be further studied by examining the following areas:

- **a.** Operator behavior,
- **b.** Clarity of operating instructions,
- **c.** Additional training needs,
- **d.** Passenger volumes,
- **e.** Boarding and alighting times,
- **f.** Time required to clear the pedestrian crossing in front of the train,
- **g.** Scheduled and actual arrival and departure times at the station,
- **h.** Impact of proximity to Ulster Crossing,
- **i.** Impact of proximity to a neutral section in the catenary system,
- **j.** Service schedule,
- **k.** Signage
- **l.** Other variables and conditions

RTDC will interview and observe operators, gather data for review with Wabtec. RTDC will request that Wabtec evaluate alternative adjustments to the WCAS to reflect the findings and improve consistency of warning times.

The schedule will be determined during the first monthly review in January of 2019. Interviews and observations will begin during January.

This process will be applied to other locations.

8.12 Recoupling or Reintegration of PTC and ATC

FRA ordered that PTC be decoupled from ATC for speed guidance to the operator. As designed, the PTC system provided guidance to the operator for rates of acceleration and deceleration instead of the block approach used by ATC. This change impacted crossing warning times, although the exact impact could not be measured due to other ongoing optimization efforts. Original system logic was developed on the assumption that operators would be guided through acceleration and deceleration, thereby producing a higher level of operator train handling consistency and more consistent crossing warning times.

RTDC does not question the FRA's determination; however, in the spirit to removing blocking assumptions, greater usage of PTC system capabilities should be reexamined.

If the FRA is open to considering the recoupling of PTC and ATC, RTDC would undertake the required study to re-implement.

8.13 Other Areas for Potential Inclusion

Schedule Changes – slightly longer end to end run time

9. PROGRAM MANAGEMENT

An initial schedule is included in Appendix A of this plan. This plan, the activities, analysis and progress will be reviewed weekly by the RTDC Executive Team.

The schedule will be updated with progress at a minimum on a monthly basis and included in an updated report, based on this plan, which will provide data analysis on the improvements achieved and the plan and expected improvements for the following month. The report will status all of the analysis streams and activities and improvement options as they are added to the plan and schedule. We anticipate that the FRA would wish to be involved in the monthly update.

At the completion of each modification there will be a thorough analysis of the warning time performance of the applicable grade crossings to determine if the expected improvement was achieved. The team will determine the next steps for the applicable crossings within the one year term of this plan. It is expected that there will be periodic reviews with FRA staff also.

In summary:

- Weekly Plan and activity reviews by the RTDC executive team
- Monthly Report and schedule updates by RTDC executive team and other parties including FRA

10. CONCLUSION

The Wabtec/Xorail CTWS/WCAS crossing control system used on the RTDC lines offers functionality beyond that traditionally employed by other railroads, including similar North American electrified railroads for which no constant warning time detection capabilities were previously possible. The RTDC crossings are complex and present unique challenges associated with station stops, short distances between crossings, and operational factors. RTDC is committed to further reducing the impacts of such factors and working with Wabtec to explore and implement improvements going forward, as described above and as may emerge at any time in the future. RTDC is equally committed to following advancements available from all suppliers and used on other railroads across the industry, and to employing new advancements where practical for RTDC.

RTDC requests that the approval of this Plan be deemed an extension of the A and B Line crossing-related waiver to the G-Line, with the application of the -5+15 second measurement criteria. RTDC will conduct and report periodic warning time tests and support additional testing by FRA inspectors upon advance notice. Log data will be continuously analyzed as indicated in this Plan: manually until the analytical tool now under development is viable and available.

The G-Line crossings have the same four quadrant gates, medians and other safety measures employed on the A-Line, which assure public safety at the crossings in the event of occasional long warning times by either RTDC or the BNSF. Further delay in opening the G-Line would be an undue burden to the public and other community stakeholders. Upon approval of this Plan, RTDC will request CPUC to

complete its verification testing and approve the removal of the crossing attendants. Crossing attendants would be used for crossings on each of the three lines anytime required under FRA regulations or otherwise determined prudent by RTDC.

RTDC requests that the FRA expedite its review and decisions on the quiet zone applications previously submitted by RTD and the affective municipalities. RTD has accompanied each application with a waiver petition for relief from any constant warning time detection requirement that FRA has determined is not met. The four quadrant gates and other measures and conditions identified in the safety index for each crossing assure public safety with or without constant warning time detection.

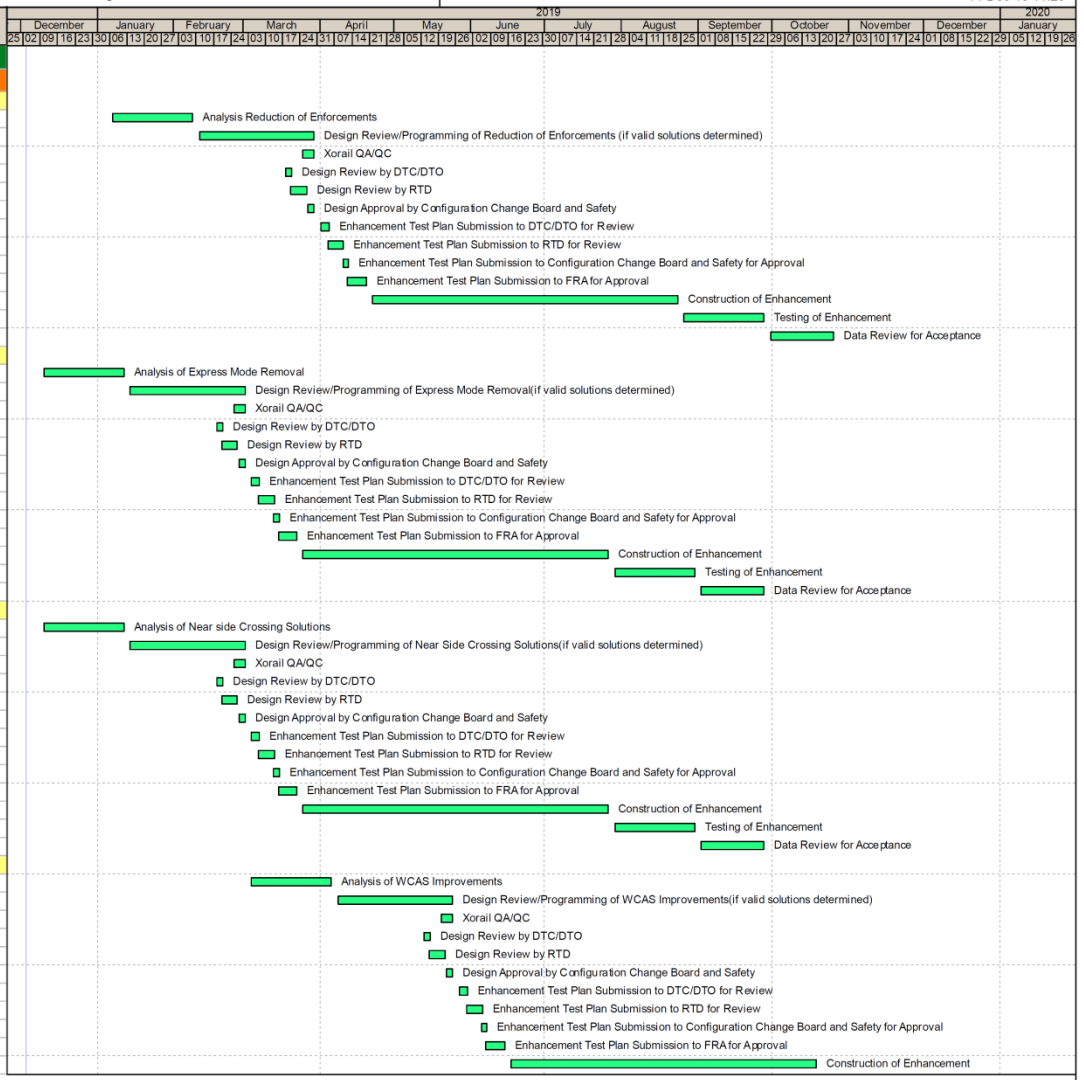
RTDC makes the foregoing requests with the greatest respect for the FRA's vital role.

Appendix A

Schedule

Eagle Project - Denver, Colorado, Crossing Enhancements Schedule — Page 1 of 2 — 14-Dec-18 11:20

Activity ID	Activity Name	Original Duration	Start	Finish
Eagle Project - Denver, Colorado, Crossing Enhancements Schedule				
Crossing Enhancements				
Analysis Reduction of Enforcements				
XE10100	Analysis Reduction of Enforcements	25	07-Jan-19*	08-Feb-19
XE10110	Design Review/Programming of Reduction of Enforcements (if valid solutions determined)	35	11-Feb-19	29-Mar-19
XE10120	Xorail QA/QC	5	25-Mar-19	29-Mar-19
XE10130	Design Review by DTC/DTO	3	18-Mar-19	20-Mar-19
XE10140	Design Review by RTD	5	20-Mar-19	26-Mar-19
XE10150	Design Approval by Configuration Change Board and Safety	3	27-Mar-19	29-Mar-19
XE10160	Enhancement Test Plan Submission to DTC/DTO for Review	4	01-Apr-19	04-Apr-19
XE10170	Enhancement Test Plan Submission to RTD for Review	5	04-Apr-19	10-Apr-19
XE10180	Enhancement Test Plan Submission to Configuration Change Board and Safety for Approval	3	10-Apr-19	12-Apr-19
XE10190	Enhancement Test Plan Submission to FRA for Approval	6	12-Apr-19	19-Apr-19
XE10200	Construction of Enhancement	90	22-Apr-19	23-Aug-19
XE10210	Testing of Enhancement	25	26-Aug-19	27-Sep-19
XE10220	Data Review for Acceptance	20	30-Sep-19	25-Oct-19
Analysis of Express Mode Removal				
XE10300	Analysis of Express Mode Removal	25	10-Dec-18*	11-Jan-19
XE10310	Design Review/Programming of Express Mode Removal(if valid solutions determined)	35	14-Jan-19	01-Mar-19
XE10320	Xorail QA/QC	5	25-Feb-19	01-Mar-19
XE10330	Design Review by DTC/DTO	3	18-Feb-19	20-Feb-19
XE10340	Design Review by RTD	5	20-Feb-19	26-Feb-19
XE10350	Design Approval by Configuration Change Board and Safety	3	27-Feb-19	01-Mar-19
XE10360	Enhancement Test Plan Submission to DTC/DTO for Review	4	04-Mar-19	07-Mar-19
XE10370	Enhancement Test Plan Submission to RTD for Review	5	07-Mar-19	13-Mar-19
XE10380	Enhancement Test Plan Submission to Configuration Change Board and Safety for Approval	3	13-Mar-19	15-Mar-19
XE10390	Enhancement Test Plan Submission to FRA for Approval	6	15-Mar-19	22-Mar-19
XE10400	Construction of Enhancement	90	25-Mar-19	26-Jul-19
XE10410	Testing of Enhancement	25	29-Jul-19	30-Aug-19
XE10420	Data Review for Acceptance	20	02-Sep-19	27-Sep-19
Analysis of Near-side Crossing Solutions				
XE10500	Analysis of Near side Crossing Solutions	25	10-Dec-18	11-Jan-19
XE10510	Design Review/Programming of Near Side Crossing Solutions(if valid solutions determined)	35	14-Jan-19	01-Mar-19
XE10520	Xorail QA/QC	5	25-Feb-19	01-Mar-19
XE10530	Design Review by DTC/DTO	3	18-Feb-19	20-Feb-19
XE10540	Design Review by RTD	5	20-Feb-19	26-Feb-19
XE10550	Design Approval by Configuration Change Board and Safety	3	27-Feb-19	01-Mar-19
XE10560	Enhancement Test Plan Submission to DTC/DTO for Review	4	04-Mar-19	07-Mar-19
XE10570	Enhancement Test Plan Submission to RTD for Review	5	07-Mar-19	13-Mar-19
XE10580	Enhancement Test Plan Submission to Configuration Change Board and Safety for Approval	3	13-Mar-19	15-Mar-19
XE10590	Enhancement Test Plan Submission to FRA for Approval	6	15-Mar-19	22-Mar-19
XE10600	Construction of Enhancement	90	25-Mar-19	26-Jul-19
XE10610	Testing of Enhancement	25	29-Jul-19	30-Aug-19
XE10620	Data Review for Acceptance	20	02-Sep-19	27-Sep-19
Analysis of WCAS Improvements				
XE10700	Analysis of WCAS Improvements	25	04-Mar-19	05-Apr-19
XE10710	Design Review/Programming of WCAS Improvements(if valid solutions determined)	35	08-Apr-19	24-May-19
XE10720	Xorail QA/QC	5	20-May-19	24-May-19
XE10730	Design Review by DTC/DTO	3	13-May-19	15-May-19
XE10740	Design Review by RTD	5	15-May-19	21-May-19
XE10750	Design Approval by Configuration Change Board and Safety	3	22-May-19	24-May-19
XE10760	Enhancement Test Plan Submission to DTC/DTO for Review	4	27-May-19	30-May-19
XE10770	Enhancement Test Plan Submission to RTD for Review	5	30-May-19	05-Jun-19
XE10780	Enhancement Test Plan Submission to Configuration Change Board and Safety for Approval	3	05-Jun-19	07-Jun-19
XE10790	Enhancement Test Plan Submission to FRA for Approval	6	07-Jun-19	14-Jun-19
XE10800	Construction of Enhancement	90	17-Jun-19	18-Oct-19



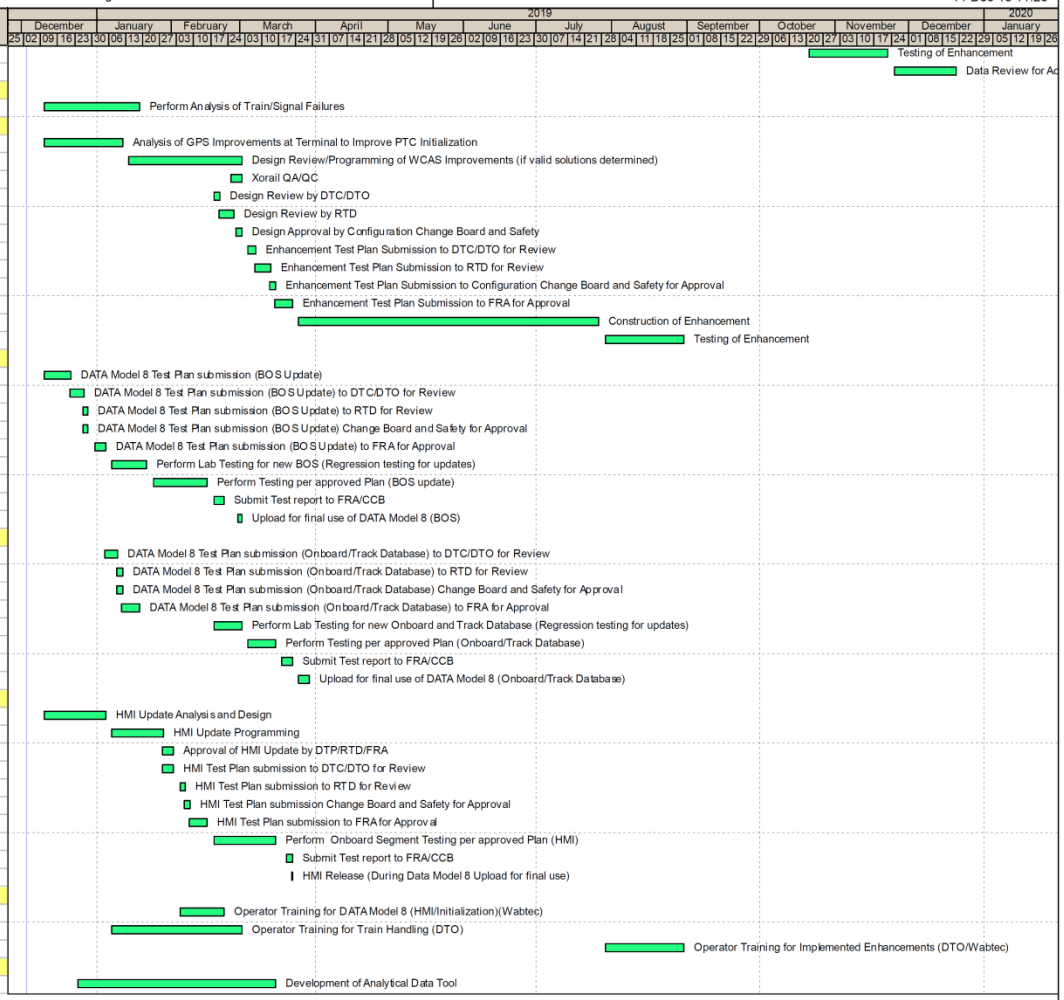
Project Start: 12-Feb-09
Project Finish: 23-Aug-21
Data Date: 03-Dec-18

CROSSING ENHANCEMENTS SCHEDULE

Remaining Level of Effort ◆ Milestone
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work

Eagle Project - Denver, Colorado, Crossing Enhancements Schedule — Page 2 of 2 — 14-Dec-18 11:20

Activity ID	Activity Name	Original Duration	Start	Finish
XE10810	Testing of Enhancement	25	21-Oct-19	22-Nov-19
XE10820	Data Review for Acceptance	20	25-Nov-19	20-Dec-19
Analysis of Signal or Train Failures				
XE10910	Perform Analysis of Train/Signal Failures	30	10-Dec-18	18-Jan-19
Analysis of GPS Improvements at Terminal to Improve PTC Initialization				
XE12100	Analysis of GPS Improvements at Terminal to Improve PTC Initialization	25	10-Dec-18	11-Jan-19
XE12110	Design Review/Programming of WCAS Improvements (if valid solutions determined)	35	14-Jan-19	01-Mar-19
XE12120	Xorail QA/QC	5	25-Feb-19	01-Mar-19
XE12130	Design Review by DTC/DTO	3	18-Feb-19	20-Feb-19
XE12140	Design Review by RTD	5	20-Feb-19	26-Feb-19
XE12150	Design Approval by Configuration Change Board and Safety	3	27-Feb-19	01-Mar-19
XE12160	Enhancement Test Plan Submission to DTC/DTO for Review	4	04-Mar-19	07-Mar-19
XE12170	Enhancement Test Plan Submission to RTD for Review	5	07-Mar-19	13-Mar-19
XE12180	Enhancement Test Plan Submission to Configuration Change Board and Safety for Approval	3	13-Mar-19	15-Mar-19
XE12190	Enhancement Test Plan Submission to FRA for Approval	6	15-Mar-19	22-Mar-19
XE12200	Construction of Enhancement	90	25-Mar-19	26-Jul-19
XE12210	Testing of Enhancement	25	29-Jul-19	30-Aug-19
Data Model 8 Test Plan Submission (BOS Update)				
XE13100	DATA Model 8 Test Plan submission (BOS Update)	10	10-Dec-18	21-Dec-18
XE13110	DATA Model 8 Test Plan submission (BOS Update) to DTC/DTO for Review	4	21-Dec-18	26-Dec-18
XE13120	DATA Model 8 Test Plan submission (BOS Update) to RTD for Review	3	26-Dec-18	28-Dec-18
XE13130	DATA Model 8 Test Plan submission (BOS Update) Change Board and Safety for Approval	3	26-Dec-18	28-Dec-18
XE13140	DATA Model 8 Test Plan submission (BOS Update) to FRA for Approval	5	31-Dec-18	04-Jan-19
XE13150	Perform Lab Testing for new BOS (Regression testing for updates)	11	07-Jan-19	21-Jan-19
XE13160	Perform Testing per approved Plan (BOS update)	17	24-Jan-19	15-Feb-19
XE13170	Submit Test report to FRA/CCB	5	18-Feb-19	22-Feb-19
XE13180	Upload for final use of DATA Model 8 (BOS)	2	28-Feb-19	01-Mar-19
Data Model 8 Test Plan Submission (Onboard/Track Database)				
XE14110	DATA Model 8 Test Plan submission (Onboard/Track Database) to DTC/DTO for Review	4	04-Jan-19	09-Jan-19
XE14120	DATA Model 8 Test Plan submission (Onboard/Track Database) to RTD for Review	3	09-Jan-19	11-Jan-19
XE14130	DATA Model 8 Test Plan submission (Onboard/Track Database) Change Board and Safety for Appr	3	09-Jan-19	11-Jan-19
XE14140	DATA Model 8 Test Plan submission (Onboard/Track Database) to FRA for Approval	6	11-Jan-19	18-Jan-19
XE14150	Perform Lab Testing for new Onboard and Track Database (Regression testing for updates)	10	18-Feb-19	01-Mar-19
XE14160	Perform Testing per approved Plan (Onboard/Track Database)	10	04-Mar-19	15-Mar-19
XE14170	Submit Test report to FRA/CCB	5	18-Mar-19	22-Mar-19
XE14180	Upload for final use of DATA Model 8 (Onboard/Track Database)	5	25-Mar-19	29-Mar-19
HMI Update Analysis and Design				
XE15100	HMI Update Analysis and Design	20	10-Dec-18	04-Jan-19
XE15110	HMI Update Programming	16	07-Jan-19	28-Jan-19
XE15120	Approval of HMI Update by DTP/RTD/FRA	5	28-Jan-19	01-Feb-19
XE15130	HMI Test Plan submission to DTC/DTO for Review	5	28-Jan-19	01-Feb-19
XE15140	HMI Test Plan submission to RTD for Review	3	04-Feb-19	06-Feb-19
XE15150	HMI Test Plan submission Change Board and Safety for Approval	3	06-Feb-19	08-Feb-19
XE15160	HMI Test Plan submission to FRA for Approval	6	08-Feb-19	15-Feb-19
XE15170	Perform Onboard Segment Testing per approved Plan (HMI)	20	18-Feb-19	15-Mar-19
XE15180	Submit Test report to FRA/CCB	3	20-Mar-19	22-Mar-19
XE15190	HMI Release (During Data Model 8 Upload for final use)	1	22-Mar-19	22-Mar-19
Targeted Operator Training and Mentoring				
XE16110	Operator Training for DATA Model 8 (HMI/Initialization)(Wabtec)	15	04-Feb-19	22-Feb-19
XE16120	Operator Training for Train Handling (DTO)	40	07-Jan-19	01-Mar-19
XE16130	Operator Training for Implemented Enhancements (DTO/Wabtec)	25	29-Jul-19*	30-Aug-19
Development of Analytical Data Tool				
XE16200	Development of Analytical Data Tool	60	24-Dec-18*	15-Mar-19



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CROSSING ENHANCEMENTS SCHEDULE

Remaining Level of Effort ◆ ◆ Milestone
Actual Level of Effort
Actual Work
Remaining Work
Critical Remaining Work

APPENDIX B

RÉSUMÉS OF KEY STAFF

David A. Genova – General Manager and CEO – RTD

- A 25-year veteran of the transit industry and of RTD. The agency's General Manager and CEO. Previously served as the Assistant General Manager of Safety, Security and Facilities; the Senior Manager of Public Safety; and the Manager of Safety
- Currently serves in a number of roles at the national level including: American Public Transportation Association's (APTA) Board of Directors Executive Committee; Vice Chair of APTA's Rail Transit Committee; Vice Chair of APTA's Rail Transit CEO's Committee; APTA's Commuter Rail CEO's Subcommittee; a former appointment by the U.S. Secretary of Transportation to the USDOT FTA Transit Rail Advisory Committee on Safety; and former Chair of APTA's Rail Safety Committee
- Diverse experience including the delivery, certification and commissioning of capital projects and Public Private Partnerships (P3s), Asset Management and State of Good Repair, safety, security and multi-modal transit operations
- Bachelor's degree in geology from the University of Colorado at Boulder and a Master of Business Administration degree from Regis University

Andrea Warfield – Fluor SVP O&M

- Responsible for Infrastructure O&M globally for Fluor Enterprises.
- Currently Managing Partner on Denver Transit Partners and Purple Line Transit Partners
- Experience includes managing multi-disciplinary teams to execute billion dollar long term lump sum projects.
- Particular expertise in maintaining the service life of infrastructure assets and managing and mitigation of risk to meet availability and performance of transportation systems.
- Has successfully facilitated stakeholder and partnering meetings to include the owner, regulatory agencies, local entities and partner companies.

Henry Stopplecamp – RTD Assistant General Manager – Capital Programs

- Over 30 years of construction and engineering experience with 24 years in the rail industry
- Held positions from Assistant Roadmaster (BNSF) to Assistant General Manager Capital Programs (RTD)
- 18 years with RTD; worked on every RTD rail expansion project since 1998
- BS and MS in Civil Engineering, Registered P.E. in the state of Colorado

Allen W. Miller – RTD Deputy Assistant General Manager for Commuter Rail Operations

- Over 40 years of experience in passenger (Bullet, Maglev, High Speed, Passenger, Light and Trolley) and freight rail operations, maintenance, and new construction rail projects, in North America and Asia.
- Over 35 years' experience in rail safety, hazard mitigation, planning and regulatory compliance working in FRA Regions 1,2,4 and 6 as well as other international regulatory bodies including the International Standards Organization.
- Managing Partner of IDMS, Ltd. Representing 17 countries and various financial institutions for rail projects and other commercial projects throughout Asia over the last 25 years.
- Former Executive Vice President and General Manager of a Fortune 500 construction company responsible for 10,000 employees worldwide.
- Former Track Maintainer and Inspector, Signal Maintainer and Traction Power Specialist.
- Bachelor of Arts Piano Performance, BS and MS Electrical Engineering, PhD Chinese History, Art and Philosophy
- Member of : NFPA/NEC, ISO, AREMA, APTA, AARS,IHRA,KRA,AJR

John Thompson – DTP Executive Director

- Over 40 years of experience in passenger rail operations, maintenance and new infrastructure and rolling stock acceptance (operations and maintenance interface) in USA (20 years) and UK (20 years)
- Held Post of Professional Head of Operations (defined role in Railway Safety Case) for 5 years in the UK; extension experience in managing small to large operations and maintenance teams (10-1,700)
- Had managerial roles in introducing existing trains to existing infrastructure (new route – Gatwick-Rugby in the UK - as project manager), new trains on existing infrastructure (Bombardier in SE London, UK, CapMetro, Austin TX, Sprinter SoCal), existing trains on new infrastructure (Greenbush Line in MA) and new trains on new infrastructure (Channel Tunnel Rail Link in the UK and EAGLE Denver CO)
- Held managerial O&M roles in in FRA Regions 1, 3, 5, 6 and 7
- Over 4 years on EAGLE, over 2 years as Concessionaire Project Director

Rajendra Jadhav – Wabtec EVP

- 28+ years of International / Global experience in signaling and telecommunication, and in particular, product development, product management, project development and execution
- At Wabtec, responsible for Wabtec's global Electronics business that includes, Locomotive Electronics, Signaling and Construction, PTC and Back office systems, and Condition based Asset Monitoring
- Proven track record of Technology Management, Project Execution, Proactive Risk Management, managing complex Stakeholder Relationships, achieving high levels of Customer Satisfaction
- Hands-on operations experience in introduction of technologies to new markets, setting up business units, delivering on challenging schedules in a multi-national, multi-cultural diversified environment (work experience across Asia, Europe and Americas)

Clifford Eby - Consultant

- Former professional engineer with 45 years of rail infrastructure experience.
- Former Acting and Deputy Federal Railroad Administrator.
- Former president of WSP Parsons Brinckerhoff responsible for a staff of over 4000 technical and administrative experts
- BSCE and MBA

Anne Herzenberg – General Manager Operations & Maintenance

- Over 35 years of experience in rail transit operations and maintenance.
- Over 20 years of experience in oversight and/or delivery of contracted commuter rail operations and maintenance services. (MBTA and RTDC)
- Over 10 years of experience as operations and maintenance lead for the Eagle Project, throughout proposal development, design review, fulfillment of all requirements of FRA's new-starts matrix, testing and commissioning, mobilization, start up and revenue service.
- Master's Degree in Transportation from MIT

Michael Mulhern – ACI Chief Operating Officer

- Over 30 years' experience in transit operations, construction and maintenance
- Over 15 years' experience in "hands-on" control center operations including dispatching, management, design and systems integration oversight
- Former Chief Operating Officer and Chief Executive Officer of the Massachusetts Bay Transportation Authority – responsibilities included management oversight of the sixth busiest commuter rail network in the United States consisting of 12 major routes, 398 miles of track and 137 stations
- Responsible for oversight of the final design (including Quiet Zones), permitting, and construction of the MBTA's 28 mile Greenbush commuter rail line
- Undergraduate degrees in Civil Engineering and Construction Management
- Graduate degrees: MBA in Finance, Masters in Public Administration (MPA)

Peter Strange – DTS Project Director

- Over 28 years' experience in rail systems project management, commissioning and maintenance of rail systems in the US and UK
- Over 9 years on the Denver Eagle Project as System Integration Manager and Project Manager for the procurement of the new rolling stock
- Developed and led the Eagle system testing and commissioning process
- Bachelor of Science degree in Communications and Information Technology

Paul Kenney, DTO Deputy General Manager, Denver, CO – September 2017 – Present

- 25 years of experience in leadership positions in the U.S. Navy, engineering, construction, and operations and maintenance
- Manage and oversee all maintenance functions at Denver Transit Operators: Maintenance of Way and Vehicle Maintenance
- Oversee approximately one hundred managers, supervisors, engineers, analysts and maintenance technicians.

Joe Christie – RTD Project Director

- Over 20 years of general civil engineering, transportation design and construction experience
- 12 years of experience with RTD on West Rail Line, Denver Union Station and EAGLE projects
- BSCE from Colorado State University, Professional Engineer in State of Colorado
- Working on EAGLE Project full time since 2014

Evariste Poissot – DTP Technical & Quality Director

- Five years of working with design construction and maintenance of light rail and commuter rail projects.
- Subject matter expert in digital and analog communication systems.
- Subject matter expert in writing and reviewing procedural manuals.
- Forty years of experience in quality methodology and quality review.
- Consultant and advisor on project procedure methods and reviews.

Luis Rivera, DTO Chief Engineer

- Over 18 years of experience in railroad operations and maintenance
- Responsible for the condition and integrity of RTDC physical infrastructure including track, power substations, overhead catenary systems, signals, communications, facilities, stations and bridges.
- Systems validation for Safety Certification
- Working on the EP3 since 2010

Kelly Abaray, DTO Engineering Program Manager – June, 2017 to present

- 19+ years railroad engineering experience
- Track Design, UPRR, 2 years
- Eng MOW Six Sigma Projects, UPRR, 2 years
- Damage Prevention, UPRR, 5 years
- Industry and Public Projects, UPRR, 6 years
- Rail Project Manager, Jacobs Eng and HDR, 3 years
- Engineering Program Manager, DTO, 1. 5 years
- Five (5) years' experience with UPRR public and private at-grade crossing design and installation as the UPRR Public Projects Manager (CO & WY)
- Five (5) years' experience with Colorado Public Utilities Commission, Rail applications.
- International Society of Configuration Manager certification, June 14, 2018.

Jeff Whiteman, RTD Rail Systems Project Manager, P.E.

- Over 22 years' experience in Structural Design & Construction Project Management
- Over 9 years' experience in Rail System Management
- Construction Services Manager for the Design of Denver Union Station Redevelopment
- Bachelor's Degree in Civil Engineering from the Colorado School of Mines

Jacob Seward - DTP Train Control & Signaling Manager

- Over 18 year of railroad signaling and communication experience
- Over 12 years Signal Construction and Maintenance for Dallas Area Rapid Transit
- Experience with VHLC, EC4/5, MicroLok II, ELX, ElectroLogIXS and relay based systems
- Signal Design work for DART, CLT, Caltrain,
- Supported development of system requirements for the wireless crossing system for the Eagle Project
- Working on the EP3 system since 2012 as Train Control/Communications Manager

Zachary Taylor – Train Control & Signaling Engineer

- Over 12 years of railroad signaling and communications experience
- Signal Design work for BNSF, UP, KCS and Alaska Railroad
- Signal Construction and Maintenance for BNSF Railway
- Experience with VHLC, EC4/5, MicroLok II, ELX, ElectroLogIXS and relay based systems
- Working on the EP3 system since 2015 as Train Control Engineer

Craig Inman – Xorail Project Manager

- 20 years of experience in signal and communications engineering, testing, and construction.
- Experience with Crossing predictor OEM (Harmon, GETS Global Signaling) and engineering contractor (Xorail) as signal engineer and project manager performing the following:
- Application engineering for BNSF, UP, Conrail, Amtrak, NJT, SEPTA, MTA, Denver RTD, Santa Clara VTA, Caltrain, Metrolink, and Sound Transit for crossing and wayside applications including hardware and application programming design.
- Managed wiring shop and performed testing of wayside and crossing bungalows
- Managed service test engineering team performing in-service testing of wayside and crossings.
- Performed Factory Acceptance Testing of Denver RTD EAGLE houses.
- Experience with EAGLE Project
- Signal System Segment Lead performing oversight of the signal team since 2017 to complete the G Line design and testing.
- Support of the Wireless Crossing Team since 2018 for testing on G Line.
- Involved on the EAGLE Project full time since 2017

Nima Tehrani – Xorail VP

- Over 27 years of experience in the field signaling and communications engineering
- Over 17 years of experience in the field of signal engineering with a primary focus on highway crossing systems
- 17 years of experience with crossing predictor OEM (Safetran Systems, Siemens) as a Chief Engineer focused on Application Engineering for CSXT, NS, UP, CN, SEPTA, SNJLR, Phoenix VMR, CTA, METRA, CP, Metrolink, Caltrain, Tri-Rail, etc.
- Product development, support, and product line management of MS 585, MS 2000, GCP 3000, GCP 4000, PSO II, PSO III, PSO 4000, SSCCIII, SSCCIV, GEO, S-40, S-60, etc.
- Development of system requirements for the wireless crossing system
- Working on the EP3 system since 2010 as lead project coordinator

Jeff Kernwein – Wabtec VP

- Over 25 years of experience in development of railroad electronics and systems
- Over 15 years of experience in positive train control development and deployment
- Led development of I-ETMS product with successful interoperable deployment across North American freight and passenger customer base
- Presently leading Wabtec's Electronics Group engineering organization, including systems, software, safety, test, and project management disciplines
- Managed development of On-Board application for Wireless Crossing Activation, including teams for systems, software, safety and test
- Managed Wireless Crossing Activation product improvement activities since initial product deployment on the EP3 system

Timothy Schultz – Wabtec Senior Systems Engineer

- Over 17 years of experience in systems and application engineering
- 6 years of experience in PTC systems engineering.
- 11 years of experience in military communications and commercial avionics.
- Experiences include requirements management, testing, manufacturing support, leadership and system design.
- Designed and supported the deployment of Wireless Crossings in Denver.
- 4 patents pending related to Wireless Crossings and PTC communications.
- Working on the EP3 system since 2013.

Van Fayler – Xorail Signaling Systems Director

- Over 30 years of railroad signaling and communications engineering experience
- Over 21 years of experience in the field of signal engineering with a primary focus on wayside signal design
- 21 years of experience with various processor and relay based signal design and programming
- Signal Design work for BNSF, SCRRA, METRA, PCJPB, CN, UP, KCS and Alaska Railroad
- Support VHLC, VPI, EC4, EL1A, MicroTrax, ELX, ElectroLogIXS and relay based systems
- Supported development of system requirements for the wireless crossing system
- Working on the EP3 system since 2010 as lead Signal Engineer

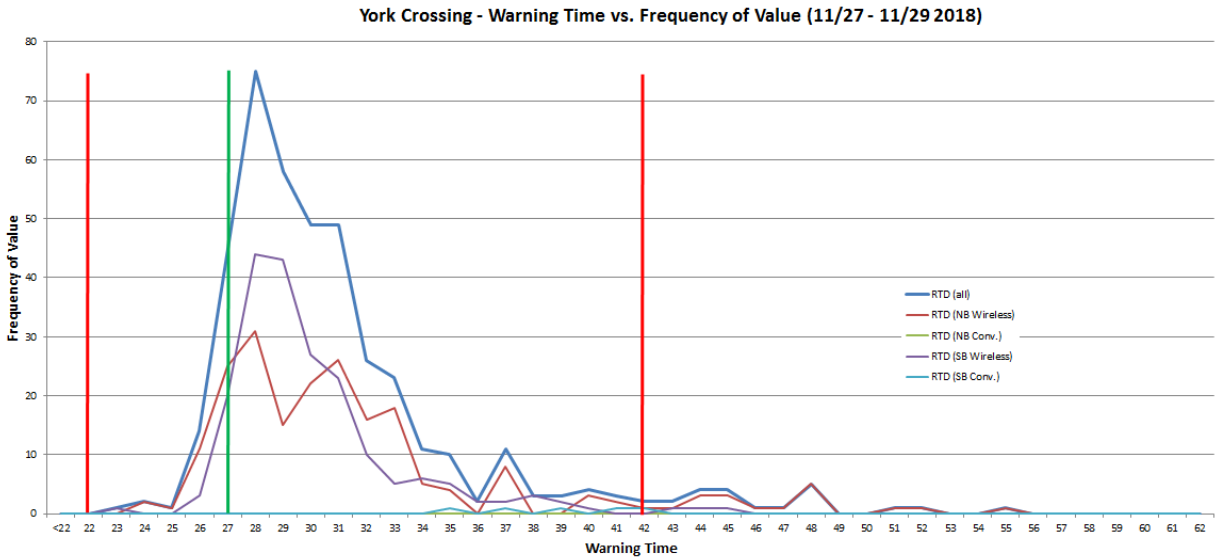
James Mitchell – Xorail Senior Signaling Systems Engineer

- Over 19 years of experience in signaling and communications engineering.
- Application Engineering for UP, BNSF, CN, NS, Metrolink, SEPTA, Utah Transit Authority and METRA.
- Lab and field testing of wayside and highway crossing systems.
- Development and implementation of enhancements to existing signal systems.
- Over 8 years of manufacturing experience, including the development, execution and evaluation of process validation exercises.
- Collect and analyze wireless crossing system performance data.
- Working on the EP3 system since 2014 as an engineer, primarily on the WIU component of the wireless crossing system and PTC.

APPENDIX C

A LINE DATA 27TH TO 29TH November 2018

A Line Bell Curve Data

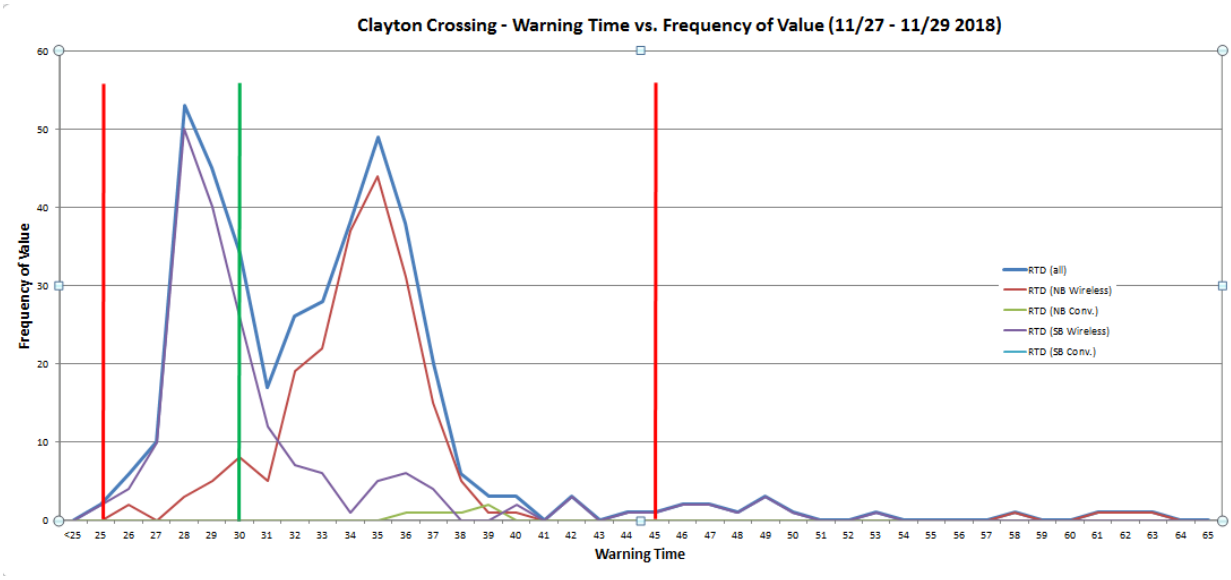


# RTD Activations (all)	414	% RTD (All) Activations Within Range	94.7%	% RTD (All) Activations Outside Range	5.3%
# RTD Activations (NB Wireless)	207	% RTD (NB Wireless) Activations Within Range	91.8%	% RTD (NB Wireless) Activations Outside Range	8.2%
# RTD Activations (NB Conv.)	2	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD (NB Conv.) Activations Outside Range	100.0%
# RTD Activations (SB Wireless)	200	% RTD (SB Wireless) Activations Within Range	98.5%	% RTD (SB Wireless) Activations Outside Range	1.5%
# RTD Activations (SB Conv.)	5	% RTD (SB Conv.) Activations Within Range	100.0%	% RTD (SB Conv.) Activations Outside Range	0.0%

Excluded Long WTs	
Enforcement	4
Form C	0
PTC Braking Event	2
Severe Service Disruption	9
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	15
Long Dwell	4
PTC Timeout	4
WiMAX Data Drop	0
Other	0

% RTD Activations PWT +20 Seconds Range	97.6%

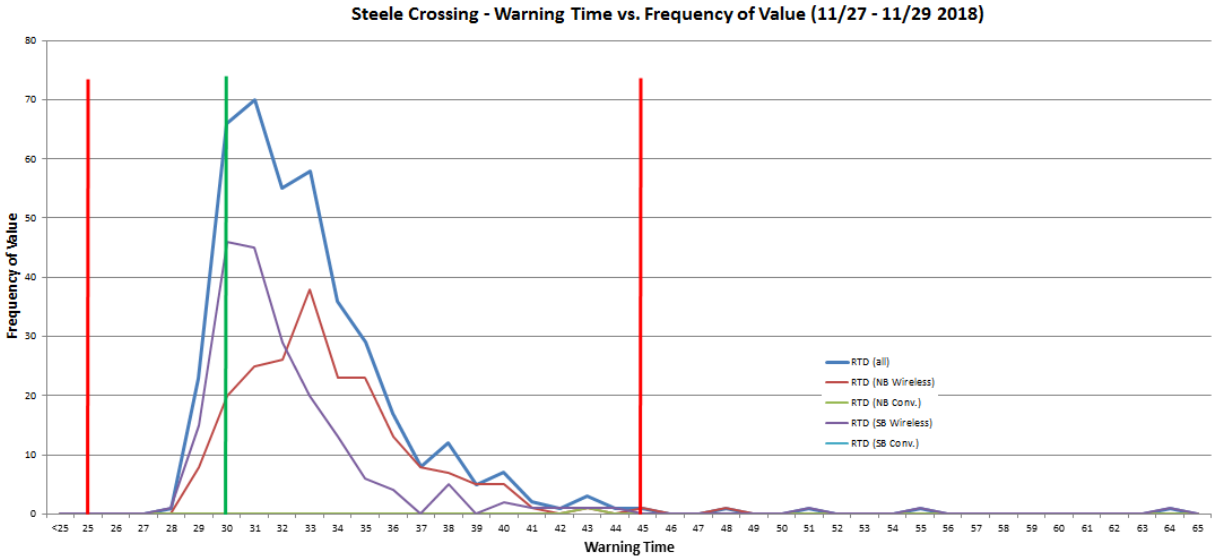


# RTD Activations (all)	401	% RTD (All) Activations Within Range	95.5%	% RTD (All) Activations Outside Range	4.5%
# RTD Activations (NB Wireless)	203	% RTD (NB Wireless) Activations Within Range	97.5%	% RTD (NB Wireless) Activations Outside Range	2.5%
# RTD Activations (NB Conv.)	5	% RTD (NB Conv.) Activations Within Range	100.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	191	% RTD (SB Wireless) Activations Within Range	94.2%	% RTD (SB Wireless) Activations Outside Range	5.8%
# RTD Activations (SB Conv.)	2	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD (SB Conv.) Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	3
Form C	0
PTC Braking Event	0
Severe Service Disruption	12
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	13
Long Dwell	0
PTC Timeout	4
WiMAX Data Drop	0
Other	1

% RTD Activations PWT +20 Seconds Range	97.8%

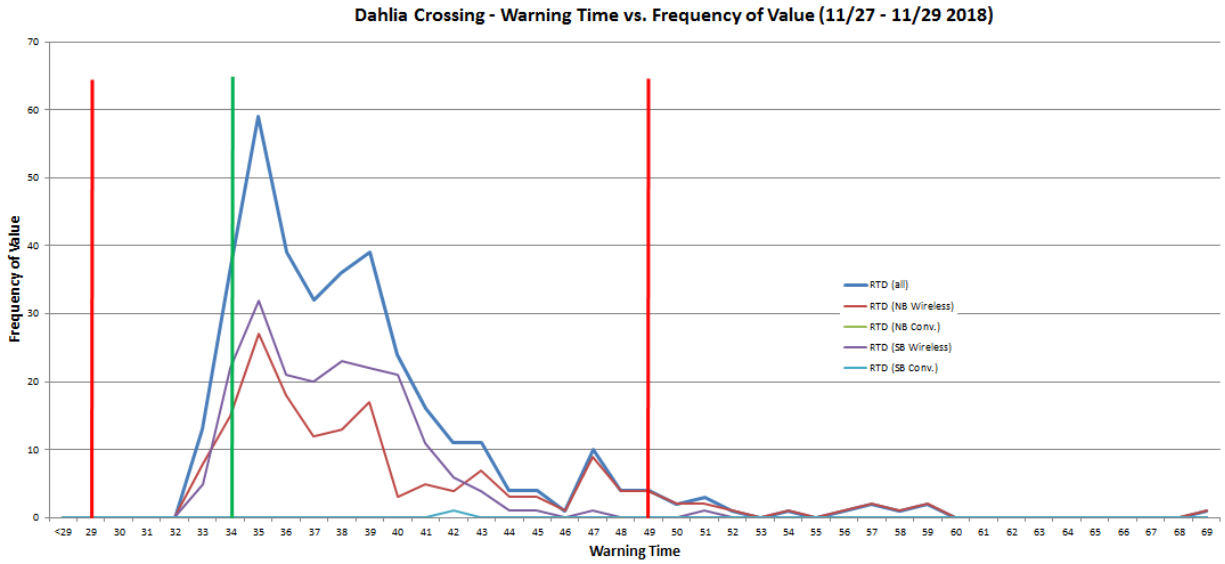


# RTD Activations (all)	404	% RTD (All) Activations Within Range	97.8%	% RTD (All) Activations Outside Range	2.2%
# RTD Activations (NB Wireless)	205	% RTD (NB Wireless) Activations Within Range	99.5%	% RTD (NB Wireless) Activations Outside Range	0.5%
# RTD Activations (NB Conv.)	1	% RTD (NB Conv.) Activations Within Range	100.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	197	% RTD (SB Wireless) Activations Within Range	96.4%	% RTD (SB Wireless) Activations Outside Range	3.6%
# RTD Activations (SB Conv.)	1	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD (SB Conv.) Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	2
Form C	0
PTC Braking Event	0
Severe Service Disruption	11
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	4
Long Dwell	2
PTC Timeout	2
WiMAX Data Drop	0
Other	1

% RTD Activations PWT +20 Seconds Range	98.0%



# RTD Activations (all)	362
# RTD Activations (NB Wireless)	170
# RTD Activations (NB Conv.)	0
# RTD Activations (SB Wireless)	191
# RTD Activations (SB Conv.)	1

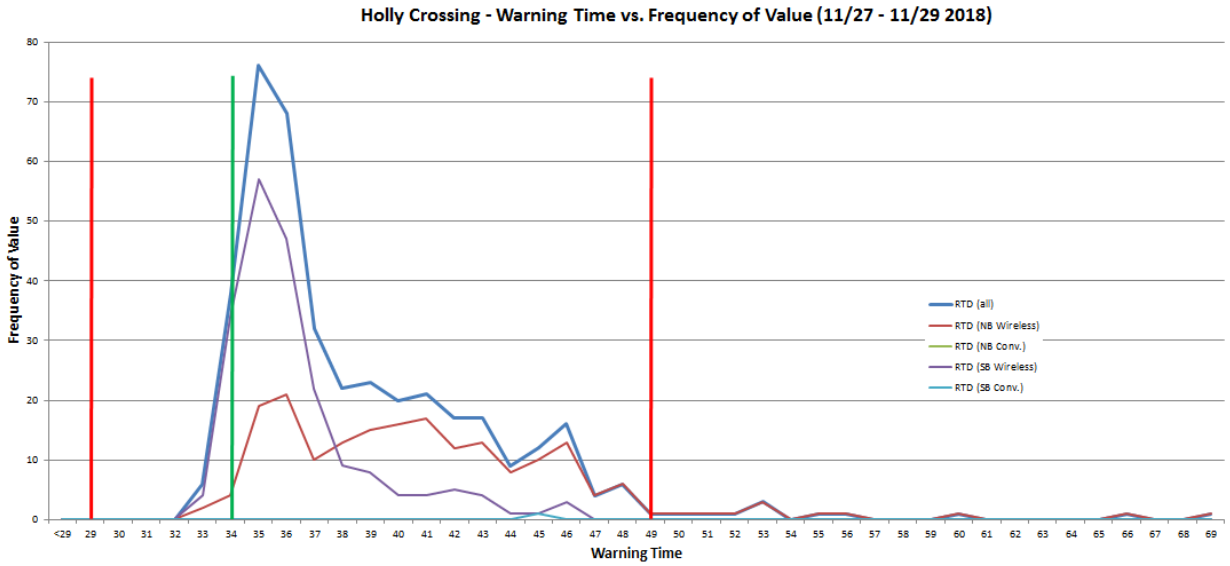
% RTD (All) Activations Within Range	95.0%
% RTD (NB Wireless) Activations Within Range	90.0%
% RTD (NB Conv.) Activations Within Range	0.0%
% RTD (SB Wireless) Activations Within Range	99.5%
% RTD (SB Conv.) Activations Within Range	100.0%

% RTD (All) Activations Outside Range	5.0%
% RTD (NB Wireless) Activations Outside Range	10.0%
% RTD (NB Conv.) Activations Outside Range	0.0%
% RTD (SB Wireless) Activations Outside Range	0.5%
% RTD (SB Conv.) Activations Outside Range	0.0%

Excluded Long WTs	
Enforcement	0
Form C	0
PTC Braking Event	0
Severe Service Disruption	13
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	13
Long Dwell	4
PTC Timeout	0
WiMAX Data Drop	0
Other	0

% RTD Activations PWT +20 Seconds Range	97.0%

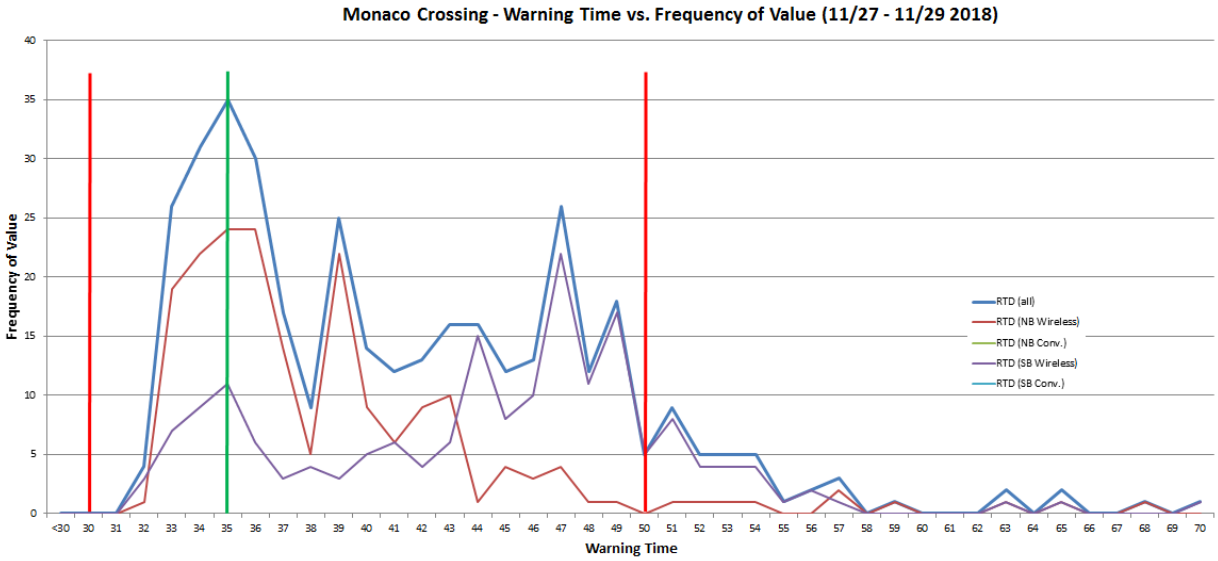


# RTD Activations (all)	402	% RTD (All) Activations Within Range	96.5%	% RTD (All) Activations Outside Range	3.5%
# RTD Activations (NB Wireless)	198	% RTD (NB Wireless) Activations Within Range	92.9%	% RTD (NB Wireless) Activations Outside Range	7.1%
# RTD Activations (NB Conv.)	0	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	203	% RTD (SB Wireless) Activations Within Range	100.0%	% RTD (SB Wireless) Activations Outside Range	0.0%
# RTD Activations (SB Conv.)	1	% RTD (SB Conv.) Activations Within Range	100.0%	% RTD (SB Conv.) Activations Outside Range	0.0%

Excluded Long WTs	
Enforcement	1
Form C	0
PTC Braking Event	0
Severe Service Disruption	14
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	14
Long Dwell	0
PTC Timeout	0
WiMAX Data Drop	0
Other	0

% RTD Activations PWT +20 Seconds Range	98.0%

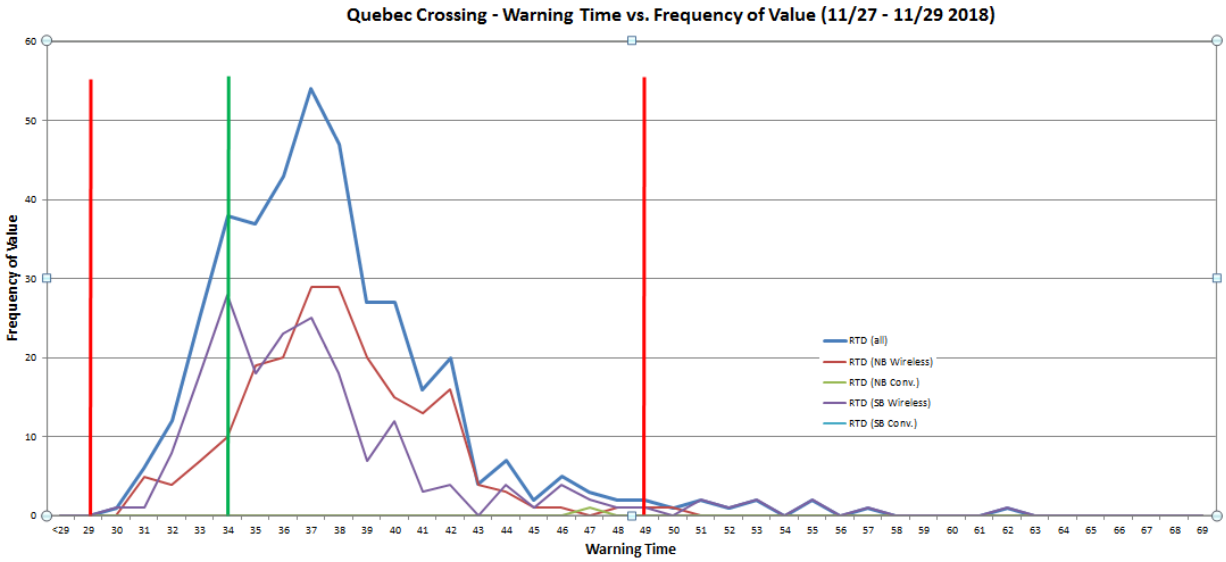


# RTD Activations (all)	378	% RTD (All) Activations Within Range	88.4%	% RTD Activations Outside Range	11.6%
# RTD Activations (NB Wireless)	191	% RTD (NB Wireless) Activations Within Range	93.7%	% RTD Activations Outside Range	6.3%
# RTD Activations (NB Conv.)	0	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD Activations Outside Range	100.0%
# RTD Activations (SB Wireless)	186	% RTD (SB Wireless) Activations Within Range	83.3%	% RTD Activations Outside Range	16.7%
# RTD Activations (SB Conv.)	1	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	1
Form C	0
PTC Braking Event	0
Severe Service Disruption	16
Parser Error	1

Non-Excluded Longer WTs	
Slower train speed than predicted	37
Long Dwell	0
PTC Timeout	1
WiMAX Data Drop	0
Other	6

% RTD Activations PWT +20 Seconds Range	95.0%

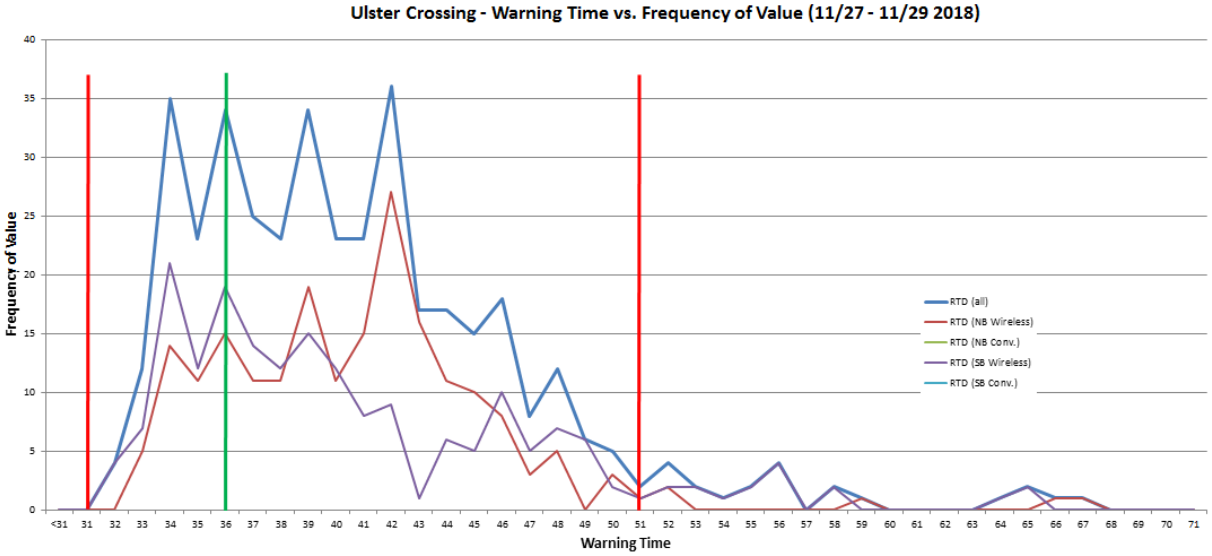


# RTD Activations (all)	395	% RTD (All) Activations Within Range	95.7%	% RTD (All) Activations Outside Range	4.3%
# RTD Activations (NB Wireless)	199	% RTD (NB Wireless) Activations Within Range	99.5%	% RTD (NB Wireless) Activations Outside Range	0.5%
# RTD Activations (NB Conv.)	1	% RTD (NB Conv.) Activations Within Range	100.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	193	% RTD (SB Wireless) Activations Within Range	92.7%	% RTD (SB Wireless) Activations Outside Range	7.3%
# RTD Activations (SB Conv.)	2	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD (SB Conv.) Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	0
Form C	0
PTC Braking Event	0
Severe Service Disruption	8
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	6
Long Dwell	5
PTC Timeout	1
WiMAX Data Drop	0
Other	5

% RTD Activations PWT +20 Seconds Range	97.2%

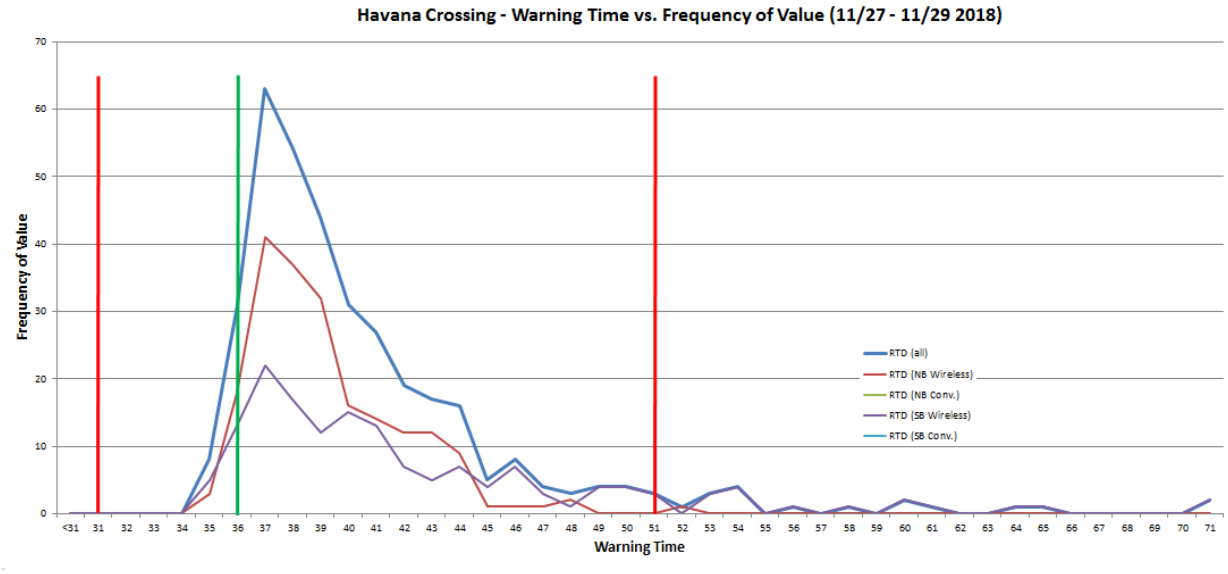


# RTD Activations (all)	398	% RTD (All) Activations Within Range	93.5%	% RTD (All) Activations Outside Range	6.5%
# RTD Activations (NB Wireless)	201	% RTD (NB Wireless) Activations Within Range	97.5%	% RTD (NB Wireless) Activations Outside Range	2.5%
# RTD Activations (NB Conv.)	0	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	196	% RTD (SB Wireless) Activations Within Range	89.8%	% RTD (SB Wireless) Activations Outside Range	10.2%
# RTD Activations (SB Conv.)	1	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD (SB Conv.) Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	1
Form C	0
PTC Braking Event	0
Severe Service Disruption	11
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	13
Long Dwell	6
PTC Timeout	1
WiMAX Data Drop	1
Other	5

% RTD Activations PWT +20 Seconds Range	96.7%

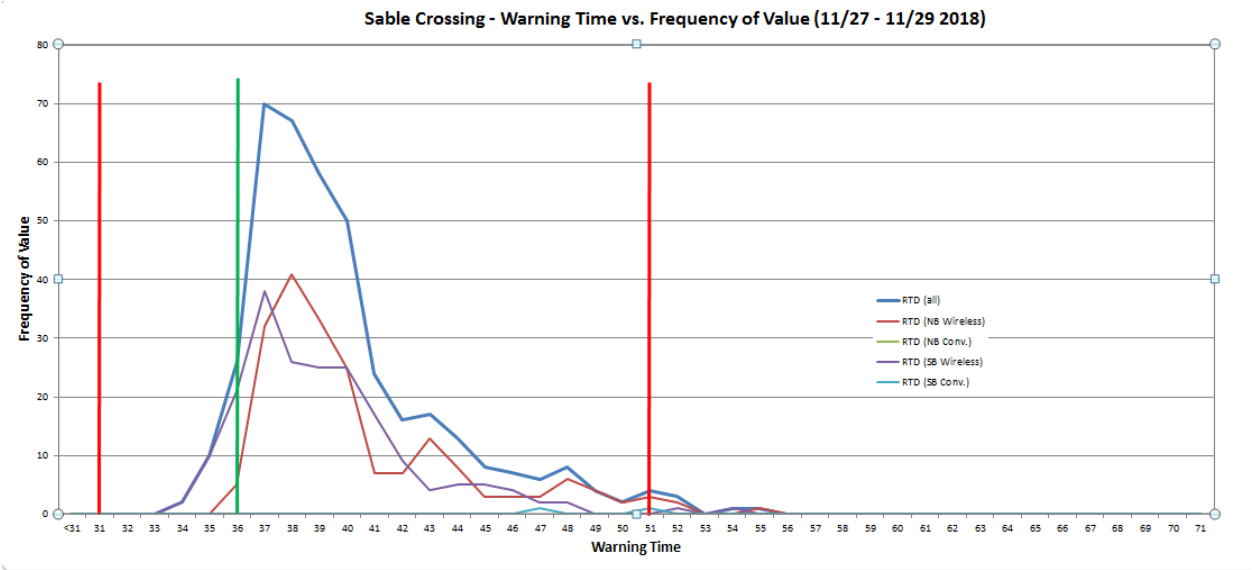


# RTD Activations (all)	364	% RTD (All) Activations Within Range	93.7%	% RTD (All) Activations Outside Range	6.3%
# RTD Activations (NB Wireless)	200	% RTD (NB Wireless) Activations Within Range	99.5%	% RTD (NB Wireless) Activations Outside Range	0.5%
# RTD Activations (NB Conv.)	1	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD (NB Conv.) Activations Outside Range	100.0%
# RTD Activations (SB Wireless)	162	% RTD (SB Wireless) Activations Within Range	87.7%	% RTD (SB Wireless) Activations Outside Range	12.3%
# RTD Activations (SB Conv.)	1	% RTD (SB Conv.) Activations Within Range	0.0%	% RTD (SB Conv.) Activations Outside Range	100.0%

Excluded Long WTs	
Enforcement	1
Form C	0
PTC Braking Event	0
Severe Service Disruption	1
Parser Error	4

Non-Excluded Longer WTs	
Slower train speed than predicted	8
Long Dwell	10
PTC Timeout	1
WiMAX Data Drop	3
Other	1

% RTD Activations PWT +20 Seconds Range	96.2%

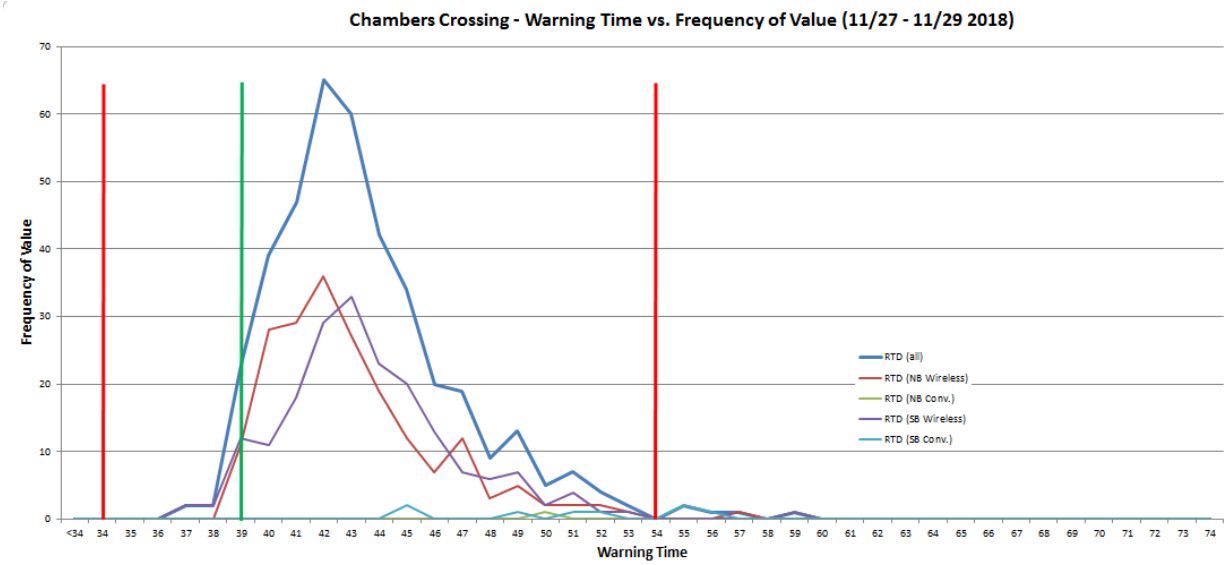


# RTD Activations (all)	398	% RTD (All) Activations Within Range	98.5%	% RTD (All) Activations Outside Range	1.5%
# RTD Activations (NB Wireless)	199	% RTD (NB Wireless) Activations Within Range	98.0%	% RTD (NB Wireless) Activations Outside Range	2.0%
# RTD Activations (NB Conv.)	0	% RTD (NB Conv.) Activations Within Range	0.0%	% RTD (NB Conv.) Activations Outside Range	0.0%
# RTD Activations (SB Wireless)	197	% RTD (SB Wireless) Activations Within Range	99.0%	% RTD (SB Wireless) Activations Outside Range	1.0%
# RTD Activations (SB Conv.)	2	% RTD (SB Conv.) Activations Within Range	100.0%	% RTD (SB Conv.) Activations Outside Range	0.0%

% RTD Activations PWT +20 Seconds Range	99.7%

Excluded Long WTs	
Enforcement	1
Form C	5
PTC Braking Event	1
Severe Service Disruption	1
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	5
Long Dwell	0
PTC Timeout	1
WiMAX Data Drop	0
Other	0



# RTD Activations (all)	400
# RTD Activations (NB Wireless)	198
# RTD Activations (NB Conv.)	2
# RTD Activations (SB Wireless)	192
# RTD Activations (SB Conv.)	8

% RTD (All) Activations Within Range	98.3%	% RTD (All) Activations Outside Range	1.8%
% RTD (NB Wireless) Activations Within Range	99.0%	% RTD (NB Wireless) Activations Outside Range	1.0%
% RTD (NB Conv.) Activations Within Range	50.0%	% RTD (NB Conv.) Activations Outside Range	50.0%
% RTD (SB Wireless) Activations Within Range	99.5%	% RTD (SB Wireless) Activations Outside Range	0.5%
% RTD (SB Conv.) Activations Within Range	62.5%	% RTD (SB Conv.) Activations Outside Range	37.5%

Excluded Long WTs	
Enforcement	2
Form C	4
PTC Braking Event	0
Severe Service Disruption	2
Parser Error	0

Non-Excluded Longer WTs	
Slower train speed than predicted	2
Long Dwell	0
PTC Timeout	4
WiMAX Data Drop	1
Other	0

% RTD Activations PWT +20 Seconds Range	99.5%

RTD EAGLE Project Oversight Commitment

December 14, 2018

Part 1 – Executive Summary

The Regional Transportation District (RTD) is the railroad owner of record for the RTD Commuter Rail system (RTDC). RTD entered into a Concession Agreement with Denver Transit Partners (DTP) to design, build, finance, operate, and maintain the EAGLE Project, which is comprised of the University of Colorado A Line, G Line, and B Line.

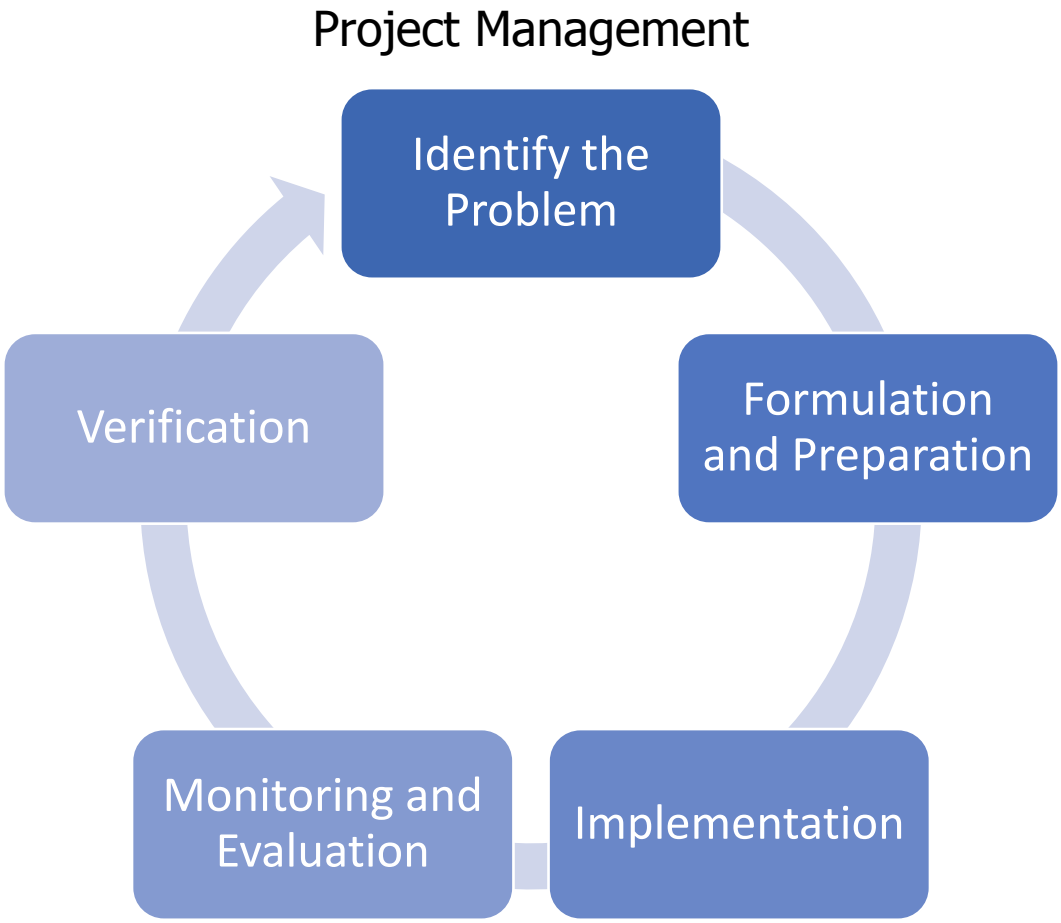
The purpose of this document is to provide RTD's oversight commitment to supplement and support the RTDC provided plan developed by DTP in conjunction with RTD to illustrate the specific actions RTDC intends to take to ensure continued compliance with the FRA waiver conditions. RTDC's plan focuses on the crossing warning time issue, in response to the FRA's letter to RTD dated November 15, 2018 in Docket Number FRA-2016-0028. RTD's further commitment includes the following sections:

- Part 2 identifies RTD-specific roles and responsibilities in oversight of the Eagle Project, in particular, the issues identified in FRA's November 15th letter;
- Part 3 describes RTD's plan to independently analyze the crossing warning time data provided by DTP;
- Part 4 outlines RTD's plan to address the FRA's concerns beyond the crossing warning times; and
- Part 5 explains RTD's continued process to oversee DTP's operations and maintenance of the RTDC pursuant to the Concession Agreement.

Part 2 – RTD Roles and Responsibilities

RTD's Mission Statement is to "Meet our constituents' present and future public transit needs by providing safe, clean, reliable, courteous, accessible and cost-effective service throughout the District." Our dedication to safety is our number one goal. RTD is committed to ensuring that DTP and RTD will follow through on their portions of the Plan. This commitment starts with our General Manager and CEO along with our Senior Leadership Team.

As outlined within this commitment, RTD continues to demonstrate our desire to comply with the regulations surrounding commuter rail. Our Senior Leadership Team will meet weekly with DTP to track progress and reevaluate each task in order to determine if we are getting the results that we need. We plan on breaking down the system into discrete projects and tackling each one individually. We realize that some of the solutions may solve more than one shortcoming. By looking at each crossing and the unique characteristics, we should be able to guide DTP to prioritize their efforts. RTD plans on evaluating the data independently from DTP and then comparing the results (discussed further in part 3). The graphic below outlines our thought process.



The table below lists the key members of the Oversight Team. These individuals and their staff are committed to supporting this project and satisfying the requirements of the FRA.

Role	Name	Title	Organization
Owner Executive Committee Member	David A. Genova	General Manager and CEO	RTD
Owner Sponsor	Henry Stopplecamp	Assistant General Manager, Capital Programs	RTD
Operations Oversight	Allen Miller	Deputy Assistant General Manager, Commuter Rail	RTD
Design-Build Oversight	Joe Christie	EAGLE Project Director	RTD
Data Analysis Project Management	Jeff Whiteman	Systems Project Manager	LTK

Part 3 – RTD Data Analysis

RTD has analyzed some of the crossing data manually to see if there was enough usable data to make informed decisions. We have discovered that it is time consuming to filter out the excused events and determine the dwell time at the stations. With that said, RTD plans on reviewing the ongoing daily data to identify the common factors causing additional gate down time. Through our exercise we have been able to focus on a few key elements and eliminate some of the activation scenarios.

RTD has analyzed existing data for the A and G Line crossings in order to identify root cause(s) of the long warning times at these crossings. The root cause analysis will need to be as specific as possible for each crossing, including direction of travel, if there is a station stop on the approach, if there are overlapping approaches, whether it is caused by the CTWS or WCAS, etc. Once the technical solutions have been applied, RTD will further analyze the data to determine the actual performance improvements needed, and the next steps to be evaluated. This process will be repeated until the system is operating at the desired performance levels.

At a high level, the crossings can be broken down into NB or SB moves with WCAS on or Conventional controlling the crossings. Next step is to determine which scenario is causing the additional time and then perform a root cause analysis. We will prioritize the effort on the quickest, biggest impact and identify available solutions and develop the strategy going forward, and will coordinate our efforts with DTP.

RTD's goal is to work in parallel with DTP's process and use our work to provide checks and balances to DTP's recommendations and potential solutions.

Part 4 – Response to FRA Concerns Other Than Crossing Warning Times

The RTD Oversight Team will also be responsible for ensuring that all of FRA's concerns in addition to crossing warning times have been addressed. As stated in the FRA November 15th letter:

- "Recent FRA inspections have found that neither the WCAS nor the CTWS consistently provide warning times within the acceptable ranges allowed under the waiver. For instance, during the week of August 13, 2018, FRA inspectors identified 63 instances of warning times outside the acceptable ranges allowed under the waiver. Of those 63 instances of noncompliance, 53 involved warning times provided by the WCAS with RTD's PTC system active, and 10 occurred when the PTC system was cut out and the CWTS was activated."

- "Failure to perform proper route and indication locking tests as required by 49 CFR § 236.379."

- "Noncompliance with FRA's locomotive engineer qualification and certification regulations."

- "Block signal application which, if implemented, would correct the safety issues associated with RTD's noncompliance with 49 CFR § 236.301."

- "Since 2016, FRA has initiated enforcement action on over 1,000 identified defective conditions involving RTD's operations and infrastructure."

RTD has been working well with the FRA Local, Regional and Headquarters staff over the years and this commitment will continue. As part of this commitment, RTD Senior Leadership is willing to meet with FRA Headquarters staff in Washington D.C. each month, or such other time, until the RTDC meets FRA's expectations. In addition, the RTD Eagle and NMRL project teams currently meet with your Local and Regional Teams on a regular basis.

Part 5 – Oversight of the Concession Agreement

As mentioned above, RTD has contracted out our operations and maintenance to DTP. RTD is the Railroad of Record and takes this role very seriously. RTD has varied contractual oversight, performance monitoring and contract management responsibilities ranging from annual budgets and special event service plans to the day-to-day oversight of service performance and maintenance of the RTDC. This document reviews some of the practical day-to-day oversight activities that are required during revenue operation, including those mechanisms critical to calculating monthly service payments to DTP, managed by the RTD Commuter Rail Oversight Team (RTD Oversight). RTD's commitment to appropriate oversight within the parameters of the Concession Agreement will continue to improve as commuter rail operations expand and continue.

The cardinal goals of RTD Oversight are to ensure that our patrons are moved safely and efficiently, that the public is kept safe, and that the workforce is protected through safety standards compliance. The next objective of RTD's oversight - beyond ensuring safe, reliable service - is to ensure that each month's availability payment reflects DTP's actual performance. A further objective of the oversight is to ensure that DTP meets the other contractual obligations of the Concession and Lease Agreement between the two parties. The final objective is to provide a framework for collaboration and partnering between RTD and DTP for their mutual benefit.

RTD Oversight consists of the organization outlined below and several outside consultants that perform track, signal and OCS work:

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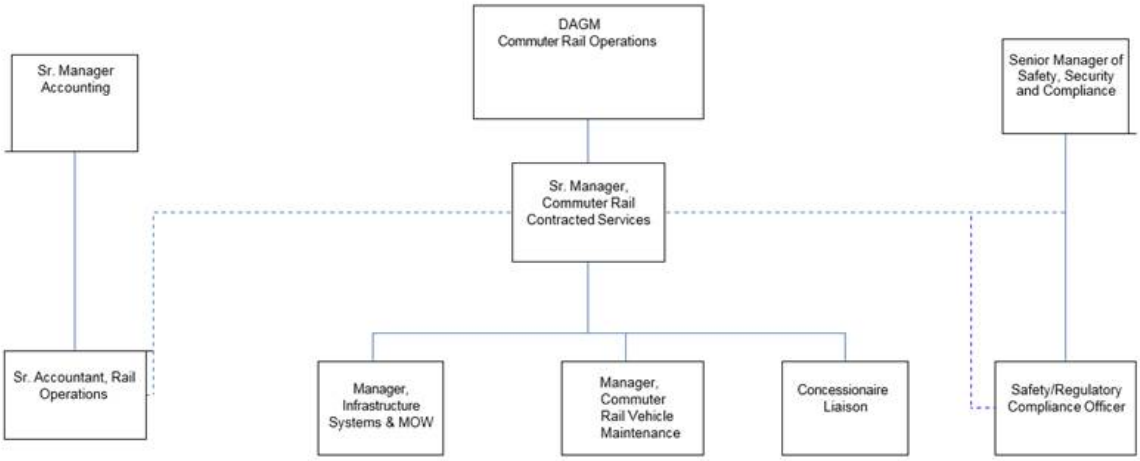

Performance audits conducted by the RTD Commuter Rail Oversight Team assess the State of Good Repair, Planning, Training and Implementation of the Department Programs in accordance with Federal and State Regulations, Engineering Standards, and the Concessionaire Agreement and Attachments. The results from the audit work determine whether the Department and Programs are accomplishing their purposes, whether they can do so with greater efficiency and economy, and whether there are deficiencies and areas of improvement needed.

RTD's Commuter Rail Oversight Team conducts such performance audits in accordance with the International Standard ISO 19011, "Guidelines for Auditing Management Systems." Those standards require that the Team plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for their findings and conclusions based on the audit objectives. The Team believes that the evidence obtained provides a reasonable basis for the findings and conclusions based on the audit objectives. Members of the performance audit team have appropriate expertise in the disciplines appropriate to the audit.

A. Signal, Track and Roadway Worker Protection Audits

RTD constantly performs independent signal, track and roadway worker protection audits of the various Departments of our Concessionaire, DTP. When deficiencies are noted, RTD issues corrective action documents specifying deadlines for response. These performance audits include the following objectives:

- Determine the level to which the applicable Department has implemented the Code of Federal Regulations (CFRs) which govern the rules, standards, inspection, maintenance and repair of these systems and programs.

- Determine the level to which the Department has implemented the CFRs, the response to credible reports, efficiency testing, and training as basis to gauge compliance.

- Determine if the Department Program and Engineering Standards are in compliance with applicable CFRs.

- Determine the level of Training and knowledge of Department Staff.

Purpose

The purpose of RTD's oversight audits is to determine if DTO / RTDC has been effectively implementing their Engineering Plans in accordance with CFRs. In general, the audits determine the level to which the DTO / RTDC's State of Good Repair is in keeping with Good Industry Practices.

Audit Methodologies

To accomplish these objectives, RTD's Commuter Oversight Team uses the following methodologies:

- Conduct multiple interviews with Department staff to review authority, responsibilities, training, planning, and work prioritization.

- Review state and federal law, regulation, and rules.

- Review Plans and Programs for the Department.

- Review all documents provided relating to the audit scope.

- Test the Department's Plan and Program against FRA Regulations, documentation provided, interview data, training provided, and Good Industry Practices by conducting field audits of select signal houses.

It is the aim of RTD's audits to provide comments on areas that are performing well, provide insight to areas where there are deficiencies with prompt response by the Concessionaire, and provide recommendations to enhance and improve the overall Department.

Audit Scope

RTD's Commuter Rail Oversight Team audits focus on risk areas identified during field assessments. The first area of focus consists of field inspections. The second area of focus is inspections and findings. The third area of focus is a review of safety and maintenance procedures as related to the Plan, Engineering Standards and FRA regulations. The fourth focus is to review the current training plans and qualifications of employees to determine if the qualifications reflect the individual's assigned duties.

B. Overhead Catenary Audit

RTD's performance audits of the overhead catenary system include the following objectives:

- Determine the level to which the Department is inspecting the OCS system in accordance with Engineering Standards, Infrastructure Maintenance Plan and the Concessionaire Agreement.

- Determine the level to which the Department has maintained all the functional elements of the OCS system according to RTD Design Criteria.

- Determine the level of Training and knowledge of Department Staff.

Purpose

The purpose of this audit is to determine if DTO/ RTDC Traction Power Department has been effectively implementing their Infrastructure Maintenance Plan, Section 8, and Traction Electrification System. In general, this type of audit determines the level to which the DTO/ RTDC Traction Power Department's State of Good Repair is in keeping with Good Industry Practices.

Audit Methodologies

To accomplish the objectives, the Team completes the following methodologies:

- Test the Department's Plan and Program against the documentation provided, and Good Industry Practices by conducting field audits of the OCS on East and Northwest Corridors.

- Review state and federal law, regulation, and rules.

- Review RTD Design Criteria, Plans and Programs for the Department.

- Review all documents provided relating to the audit scope.

It is the aim of this audit to provide comment on areas that are performing well, provide insight to areas where there are deficiencies with prompt response from the Concessionaire, and provide recommendations to enhance and improve the overall Department.

Audit Scope

This audit focuses on risk areas identified during field assessments. The first area of focus consists of walking field inspections conducted by an RTD OCS Inspector of the East and NWES Corridors. The second area of focus is review of all OCS inspection reports in accordance with departmental maintenance plans. The third area of focus is a review of safety and maintenance procedures as related to the Infrastructure Maintenance Plan, Engineering Standards and NESC regulations. The fourth focus is to review the current training plans and qualifications of Traction Power employees to determine if the qualifications reflect assigned duties.

C. Daily Report Audit

RTD's Oversight Team audits the Daily Report generated each day concerning the performance and issues facing the RTDC. Items of concern could be PTC related issues, trespassing issues, Accidents and other related matters. RTD staff endeavors to obtain clear answers to these matters

and enforce the Concession Agreement according to each situation, and document findings and corrective actions taken to remediate these types of issues.

D. RTDC Decertification Audit

Each month RTD Oversight Safety and Security collects metadata concerning decertification of operators, causes and results, while maintaining Personally Protected Information of each Denver Transit Operator employee.

E. Equalizer Beam Audit

This ongoing audit by RTD Oversight reviews the weekly and monthly logs and progress concerning the Equalizer Beam Replacement schedule of the RTDC Hyundai Rotem Fleet.

F. Station Availability Audit

This is an ongoing semi-monthly audit that checks for station safety and compliance with the Concession Agreement as well as local, state and federal requirements.

G. Efficiency Checks

The RTD Oversight Team is currently establishing an Efficiency Check Program which will provide spot audits of a wide variety of elements of the RTDC from employee knowledge and performance to State of Good Repair. This Program will be fully implemented by June 2019.

H. The QMO (Quality Management Oversight) Operations and Maintenance Module

RTD Oversight is currently working with Parsons to enhance the auditing and reporting processes between RTD and DTP via the QMO module. To this end this team is developing the Operations and Maintenance Module of the QMO. This system of reporting defects and findings is familiar to the DTP organization and by developing the O&M Module, the Oversight team will be able to present findings in a more productive and familiar method. It is anticipated that the O&M QMO will be established and functioning by March 2019.

I. Other Oversight Audits and Observations

RTD's Commuter Rail Oversight Team conducts a wide variety of additional audits and ongoing observations:

- Train and car compliance/Rolling Stock Availability
- Schedule and On-Time Availability
- Operations Control Center Performance
- Monthly Invoicing Audit
- Traction Power Audit
- Contract and Document Maintenance
- Preventative Maintenance Records Review
- Customer Complaints
- Shop, Yard and Right of Way Inspections

U.S. Department
of Transportation

**Federal Railroad
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

NOV 15 2018

Mr. Henry J. Stopplecamp
Assistant General Manager, Capital Programs
Regional Transportation District
1560 Broadway, Suite 700
Denver, CO 80202

Re: Docket Number FRA-2016-0028

Dear Mr. Stopplecamp:

Since early 2016, the Federal Railroad Administration (FRA) has worked to support Denver Regional Transportation District's (RTD) development and implementation of its Eagle Project, including the initiation of commuter rail operations on the East Corridor (A Line) and Northwest Electrified Segment (B Line), as well as positive train control (PTC) system testing on the Gold Line (G Line). However, on numerous occasions since the start of this work, FRA has expressed concern to both RTD and its partner, Denver Transit Partners (DTP), about the significant level of noncompliance the agency has identified with the conditions of the waiver granted to RTD in the above-identified docket and other applicable Federal railroad safety regulations.

FRA has initiated enforcement action on a substantial number of the noncompliant conditions FRA has identified, but this letter is intended to notify RTD of FRA's continued concern about this noncompliance and to explain how this noncompliance may impact RTD's related waiver requested under Title 49 Code of Federal Regulations (CFR) Part 222 and its request to begin revenue service demonstration (RSD) of its PTC system on the G line. This letter also serves to notify RTD and its partners, including DTP, that unless immediate action is taken to bring RTD's operations into compliance with the existing waiver and other applicable Federal safety requirements, FRA will take other actions it deems necessary to bring about compliance. These actions may include, but are not necessarily limited to, enhanced enforcement of all applicable FRA safety regulations against RTD and its partners and/or modification or revocation of the existing waiver.

Section 234.225 Waiver and Identified Noncompliance

As FRA has stated in previous correspondence, RTD's Conventional Track Warning System (CTWS) and the Wireless Crossing Activation System (WCAS) along the A and B Lines must independently meet the requirements of 49 CFR § 234.225. That section requires a grade crossing warning system to: (1) "activate in accordance with the design of the warning system" (i.e., to activate at specific prescribed warning times), and (2) provide at least 20 seconds' warning time for the normal operation of trains through the crossing.

In early 2016, FRA provided limited, conditional relief from 49 CFR § 234.225's requirement that the grade crossing warning system along the A Line "activate in accordance with the design of the warning system."[1] FRA conditioned the waiver, in part, on RTD providing grade crossing attendants (in accordance with RTD's Grade Crossing Attendant Plan) at each crossing to provide for the safety of the public and railroad employees. FRA has since extended the waiver numerous times, and most recently—in response to RTD's request for additional operational flexibility outside of what the initial waiver already provided—in a letter dated September 28, 2017, FRA approved RTD's request for a 20-second "buffer time"—i.e., allowing activation warning times to be considered "as designed" if the warnings occur up to 5 seconds before and 15 seconds after a crossing's programmed warning time (PWT). In granting this waiver and providing the 20-second buffer time, FRA took into consideration RTD's assertion that FRA's traditional allowances for warning time variances are not "readily applicable or appropriate based on the design of the system utilized on the Eagle Project."[2] Instead, RTD asked FRA to accept as compliant with 49 CFR § 234.225 warning times occurring within "5 seconds before and 15 seconds after" the programmed warning time for each crossing. RTD asserted that providing this 20-second buffer time would be a "more appropriate application" of 49 CFR § 234.225 given the unique design of its system.

FRA granted RTD the exact relief that it requested and additionally provided RTD with a path forward to safely discontinue the use of grade crossing attendants if the WCAS and CTWS operate as designed (i.e., with the additional flexibility of warning times 5 seconds shorter and 15 seconds longer than the specified PWTs as RTD requested).[3] Despite FRA approving RTD's request for additional warning time flexibility and providing a path forward to discontinue the use of grade crossing attendants, recent FRA inspections have found that neither the WCAS nor the CTWS consistently provide warning times within the acceptable ranges allowed under the waiver. For instance, during the week of August 13, 2018, FRA inspectors identified 63 instances of warning times outside the acceptable ranges allowed under the waiver. Of those 63 instances of noncompliance, 53 involved warning times provided by the WCAS with RTD's PTC system active and 10 occurred when the PTC system was cut out and the CWTS was activated. In all, FRA inspectors measured crossing activation warnings at the 13 grade crossings on the A and B line a total of 540 times over the course of that week. The resulting data demonstrates that even with the PTC system active and the WCAS being activated, approximately 10 percent of the crossing warning times did not fall within the -5/+15 second buffer allowed by the waiver. In some instances (e.g., the Holly and Monaco crossings), the warning times fell outside the acceptable ranges approximately 20–30 percent of the times measured. This level of noncompliance with the conditions of the waiver is unacceptable.

Section 222.35 Waiver Request and Quiet Zones

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[1] Letter from Robert C. Lauby, Associate Administrator for Railroad Safety, Chief Safety Officer, FRA, to Mr. Gregory D. Straight, Eagle Project Director, RTD (April 19, 2016).

[2] Letter from Mr. Henry J. Stopplecamp, Assistant General Manager, Capital Programs, RTD, to Mr. Robert C. Lauby, Associate Administrator for Railroad Safety, Chief Safety Officer, FRA (September 8, 2017).

[3] Letter from Robert C. Lauby, Associate Administrator for Railroad Safety, Chief Safety Officer, FRA, to Mr. Henry J. Stopplecamp, Assistant General Manager, Capital Programs, RTD (September 28, 2017).

Currently, RTD's request for a waiver from 49 CFR § 222.35(b)(1) (requiring grade crossing warning devices at public highway-rail grade crossings within quiet zones to provide constant warning time) is pending with FRA. As previously noted in FRA's July 19, 2018, letter to RTD, however, any waiver from this regulatory requirement would need to be predicated on the existence and use of a grade crossing warning system that reliably activates as designed (under the terms of RTD's current waiver, this means the warning system must provide a warning within -5/+15 seconds of the PWT). FRA cannot justify granting this waiver request until RTD demonstrates compliance with the conditions of the waiver and other applicable Federal railroad safety regulations.

Request for PTC System RSD Approval on the Gold Line

FRA also notes that RTD has asked for permission to initiate commuter rail operations using RTD's PTC system in RSD on the G Line under 49 CFR § 236.1035. FRA acknowledges RTD's efforts to rectify a recent Category 1 software failure RTD experienced, and FRA has recently approved the release of a solution on the A and B Lines, as well as continued field testing of the PTC system on the G Line.

Despite this positive progress, however, FRA remains concerned that crossing warning times on the G Line are routinely outside the -5/+15 second buffer allowed by the waiver. Recent data provided to FRA relating to WCAS crossing performance indicate that, on average, crossing warning times on the G Line are outside the -5/+15 second buffer approximately 18 percent of the time, with five individual crossings providing warning times outside the acceptable range over 20 percent of the time.

Again, this level of noncompliance with the existing waiver conditions is unacceptable. I understand that RTD continues to tune the WCAS crossing design, and I look forward to seeing further improvements in crossing performance prior to the commencement of RSD; however, FRA cannot justify approving the initiation of RSD on the G Line until RTD has satisfactorily addressed this noted noncompliance. FRA encourages RTD and its partners to act with a sense of urgency to address these significant ongoing safety concerns.

Other Noted Non-Compliance

RTD's noncompliance with Federal safety regulations is not limited to noncompliance with the terms of the waiver in this docket. FRA continues to remain concerned about RTD's significant noncompliance with other aspects of FRA's signal regulations identified over the last few years (e.g., the failure to perform proper route and indication locking tests as required by 49 CFR §§ 236.379 and 236.380 for over 2 years and the failure to provide a signal governing train movements into Denver Union Station in violation of 49 CFR § 236.301) and noncompliance with FRA's locomotive engineer qualification and certification regulations. I understand that, to date, despite FRA approving a block signal application which, if implemented, would correct the safety issues associated with RTD's noncompliance with 49 CFR § 236.301, RTD has yet to implement the approved modifications. As a result, the interlocking leading into Denver Union Station remains noncompliant with FRA regulations.

Conclusion & Required Next Steps

As noted above, the longer-than-designed warning times, particularly the warning times outside of the tolerances of the existing waiver, remain of significant concern to FRA. This safety issue has existed since the commencement of RTD's Eagle Project, and FRA has expended considerable time and resources to support and assist RTD to come into compliance. In addition, since 2016, FRA has initiated enforcement action on over 1,000 identified defective conditions involving RTD's operations and infrastructure. FRA has also issued an individual liability warning letter to the individual responsible for directing the design, construction, and testing of the Eagle Project. Despite these efforts, approximately 2 1/2 years have passed since FRA's initial grant of relief in this docket, and RTD has not made substantial progress in correcting the critical safety issues that exist involving the Eagle Project.

As a result, FRA requests that RTD develop and submit to FRA for approval, within 30 days of receipt of this letter, an action plan for correcting the identified noncompliance and ensuring that its grade crossing warning systems meet the conditions of the waiver granted in this docket and, overall, its signal system and operations meet all other applicable Federal regulatory safety requirements. The action plan must include: (a) detailed procedures for correcting the identified noncompliance; (b) a schedule demonstrating RTD's commitment to bring its grade crossing warning systems on the A, B, and G Lines into compliance within one year; (c) detailed procedures, methods, milestones, and timelines for completion; and, (d) a description of the technical resources to be employed.

If RTD fails to submit an acceptable action plan within 30 days of RTD's receipt of this letter, FRA will have no choice but to consider other actions as appropriate, potentially including enhanced enforcement, modification of the existing waiver—including by imposing additional conditions as necessary for rail safety and/or reducing the duration of the waiver—or revoking the waiver.

Sincerely,

Robert C. Lauby
Associate Administrator for Railroad Safety
Chief Safety Officer

cc: John F. Thompson, Denver Transit Partners