HEAVY HAUL SEMINAR

Marco Santoro

Global Friction Management Applications Manager at **LB Foster**

JUNE 10-12, 2025

WRI2025HH

HEAVY HAUL SEMINAR

Greg Harrington

Manager Rail Maintenance – System at **Canadian Pacific Kansas City (CPKC)**

JUNE 10-12, 2025

WRI2025HH

HEAVY HAUL - JUNE 11-12, 2025

Effect of Total Friction Management on CPKC Thompson Subdivision Rail Wear

Greg Harrington – CPKC
Marco Santoro – L.B. Foster

WRI2025HH

TABLE OF CONTENTS

Thompson Subdivision

- CPKC operate on legacy CPR track in Western Canada with difficult operating conditions. This paper focuses on the Thompson Subdivision near Kamloops, BC
- This is a critical area within the network due to traffic, curve density and access
- The area is predominantly single track, with high tonnage and very high curvature
- ≈ 100MGT with coal, grain, potash, intermodal and mixed freight traffic
- Temperature extremes in the Thompson River Valley range from 110°F (+43 ° C) to -30 ° F (-34 ° C)

“100% Effective Lubrication and FM”

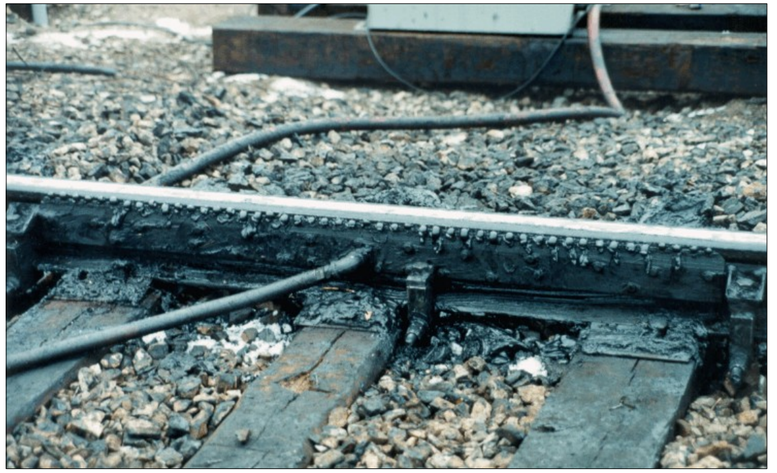
- The Thompson Subdivision was the location of one of the first large-scale modern lubrication studies and was followed by Friction Management/TFM
- The “100% Effective Lubrication” AREMA 2001 [Stroba, Roney, Dashko, Magel]
- Key features were the use of modern electric lubricators, application bars, non-contact wheel sensors and improved quality rail curve grease
- The results were dramatic, with an >85% average reduction in wear
- Key items to maintaining these benefits were:
  - Dedicated maintainers and bulk filling
  - Centralized Friction Management budget
  - Regular measurements
- TOR and Friction Management Program were added and results published:
  - IHHA 2005 CPR 100% Effective Friction Management Strategy [Stroba, Oldknow, Roney, Dashko]
  - IHHA 2009 Total Friction Management on CP [Stroba, Eadie, Oldknow, Roney, Caldwell, Santoro]

2001 GF Equipment/Consumable

- Electric lubricators replaced previous hydraulic unit providing much more accurate control over grease output
- Non-contact wheel sensors replaced wheel activated plungers
- Improved distribution bar technology, longer bars
- Seasonal petroleum-based grease designed for rail curve application replaced moly lubricant
- Maintenance by dedicated maintainer not section crew

Hydraulic lubricator, pre-2001

2001 Protector electric lubricator



GF XL 48-port application bar

Equipment/Coverage Over Time

- GF equipment was installed in 2001 and TOR added in 2005
- Traffic of approximately 4 million axles per year
- Equipment efficiency decreased, primarily pump output declines after 10 years
- Increased traffic put more pressure on bulk filling cycles
- Difficulties with seasonal changeouts of grease with wide ranging temperatures of Western Canada
- Result was increased rail wear compared to the smaller zone trial phase

PIV lubricator after 15 years service.

Winter grease in warmer weather.

Poorly lubricated high rail GF/GC.

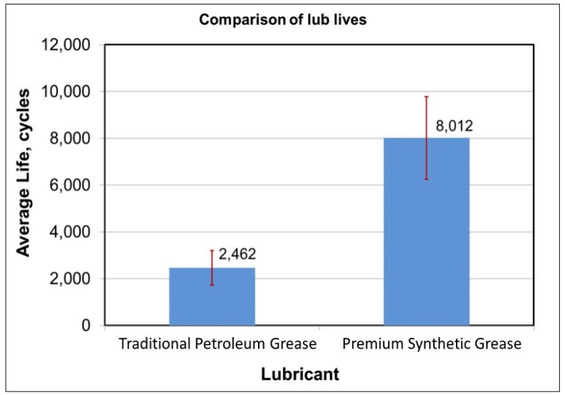
GF Units: PX

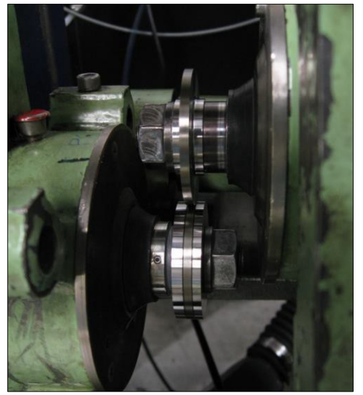
- Installed 2019 Q4
- Conical reservoir design
  - Able to utilize larger percentage of the product in the reservoir
- Larger reservoir size: 1250lbs
- The benefit of larger reservoirs can only be utilized with the advent of true all-season grease
- New pump/motor assemblies, distribution bars and hoses replacing end of life 15+ year old equipment
- AC power used in areas with low sunlight in winter months

LB Foster PX 1250 GF lubricator.

All-Season Synthetic Grease: SYNCURVE

- CPKC switched from seasonal petroleum-based grease to premium synthetic SYNCURVE in January 2020
- Premium synthetic greases use highly refined base oils that increase retentivity which equates to more durability in the rail/wheel interface and lower product application rates
- The matrix of the grease is different to petroleum-based and provides a much wider operating temperature, creating a verified all-season grease





National Research Council twin disk machine and comparison of CP's traditional petroleum-based grease versus premium synthetic used during the field trial

All-Season Synthetic Grease: SYNCURVE

- CPKC conducted extensive testing of SYNCURVE on the Shuswap Subdivision in 2018/19, measuring rail wear and product output rates
- AREMA 2020 “Premium Synthetic Grease in a Heavy Haul Environment

[Santoro, Cotter, Furlong, Foot]

Product Characteristics	Traditional Petroleum Grease	Synthetic Grease
Base Oil Type	Petroleum	Synthetic or highly refined petroleum
Thickener Content	>10%	<10%
Thickener Type	Typically, Metal Soap-type	Typically, Silica-based
Thickener Size	Macro-sized	Nano-sized
Solid Lubricant Content	0-5%	0-5%
Grades	Summer, Winter, Arctic	All-season
Temperature ranges	Summer: 60 to 115F Winter: 0 to 60F Arctic: -20 to 40F	-10 to 115F
Cold Temperature Pumpability	Summer: Poor Winter: Good Arctic: Excellent	Excellent
Biodegradability	Not Biodegradable	Ultimately Biodegradable

TFM Bulk Fill Truck

- CPKC designed bulk filling trucks
- Carries both GF and TOR product, internal pumps and work area
- Eliminates loading and unloading of totes with a crane
- Dedicated to Friction Management

CPKC Friction Management dedicated bulk filling truck.

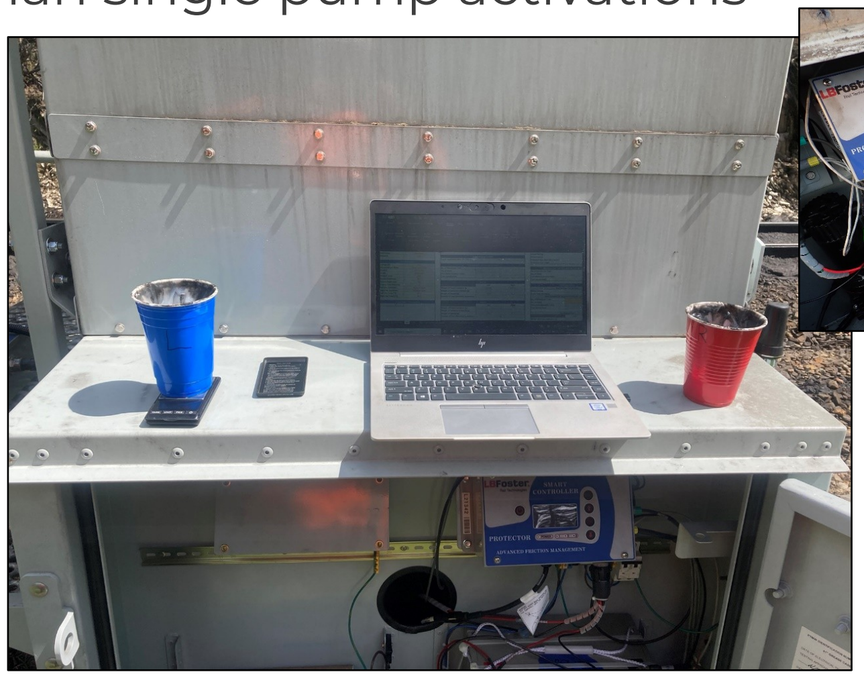
10-ton section truck, pre-2020.

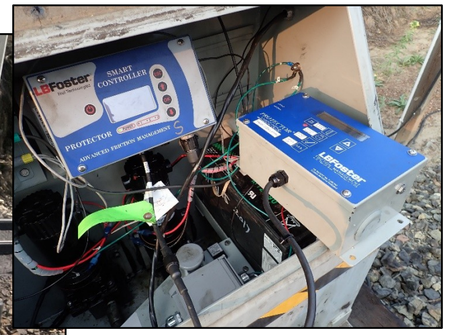
TFM tuck being bulk filled in yard.

Bulk filling a PIX GF unit.

Measured Output Rates

- The output rate of both GF grease and TOR friction modifier is critical to both the performance/benefits and the economics of friction management
- Application settings are not output rates
- LB Foster uses a train simulator that mimics a full train activates the pump multiple times. Samples are collected and weighed
- This process is much more accurate than single pump activations
- Factors for output rate include consumable type, NLGI grade, direction of traffic, age/type of equipment
- GF in lb. per 1,000 axles
- TOR in gal. per 1,000 axles



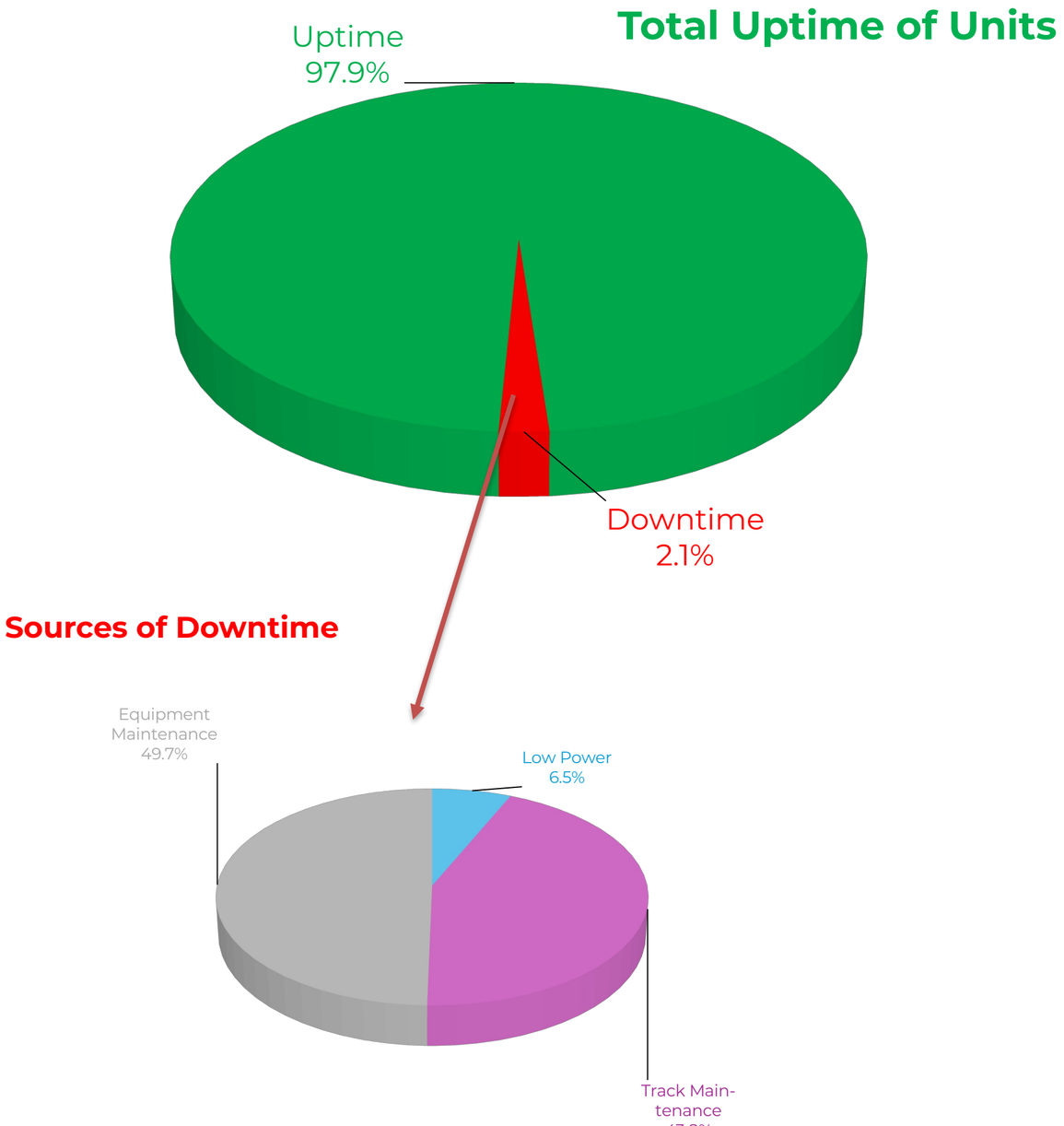


Train simulator [above]

Weighing of grease output samples [left]

Remote Performance Monitoring

- CPKC uses Remote Performance Monitoring on all trackside units in the Western Corridor, including the Thompson Subdivision
- The data collected is critical for the effective allocation of resources for filling and maintenance, allowing larger coverage areas
- The downtime is analyzed to determine root causes and implement corrective actions
- Uptime data between 01/01/2022 and 04/23/2025



Rail Wear Monitoring

- CPKC Fleet: TEC92 – Rail bound Consist, CP11 / CP12 – Heavy Trucks
  - Equipped with Ensco TGMS / RPMS
- Profiles taken every foot, tagged with MP information and GPS
- Main tracks with greater than 75MGT are measured at least 3X per year
- Utilized by Capital Planning and Rail Grinding for maintenance/renewal programs
- CPKC believe rail wear rates can also be used as a key indicator of the effectiveness of the friction management program

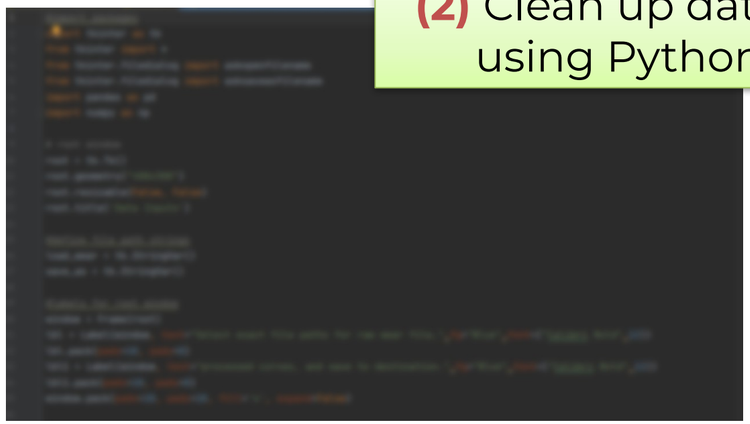
How We Calculate Rail Wear

- Uses selected curves from the Geometry Files, aligning the bodies of each curve to calculate average vertical/lateral wear
- Process presented at 2017 WRI Montreal [Paradise; Stock; Santoro]

(1) Raw wear data files sent by railway

TSC	MP	FEET	SC	SS	LEFT Type	B%	C%	Ht	Wd	CtoG	Lip	Lat	Long	RIGHT Type	B%	C%	Ht	Wd	CtoG	Lip	Lat	Long
Count = 292380																						
0	1	2680	0	2	136RE	2.92	2.51	0.023622	0.015748	0	0	0	0	136RE	5.35	4.61	0.043307	0.019685	0	0	0	0
0	1	2681	0	3	136RE	2.92	2.51	0.023622	0.015748	0	0	0	0	136RE	5.35	4.61	0.043307	0.023622	0	0	0	0
0	1	2682	0	4	136RE	2.92	2.51	0.023622	0.019685	0	0	0	0	136RE	5.83	5.03	0.047244	0.023622	0	0	0	0
0	1	2683	0	5	136RE	2.92	2.51	0.023622	0.015748	0	0	0	0	136RE	5.35	4.61	0.043307	0.023622	0	0	0	0
0	1	2684	0	6	136RE	2.43	2.09	0.019685	0.019685	0	0	0	0	136RE	5.35	4.61	0.043307	0.023622	0	0	0	0
0	1	2685	0	7	136RE	2.92	2.51	0.023622	0.023622	0	0	0	0	136RE	4.86	4.19	0.03937	0.023622	0	0	0	0
0	1	2686	0	8	136RE	3.4	2.93	0.027559	0.019685	0	0	0	0	136RE	5.35	4.61	0.043307	0.023622	0	0	0	0
0	1	2687	0	9	136RE	3.4	2.93	0.027559	0.019685	0	0	0	0	136RE	5.35	4.61	0.043307	0.027559	0	0	0	0
0	1	2688	0	10	136RE	2.92	2.51	0.023622	0.015748	0	0	0	0	136RE	5.35	4.61	0.043307	0.023622	0	0	0	0
0	1	2689	0	11	136RE	3.89	3.35	0.031496	0.015748	0	0	0	0	136RE	5.91	5.09	0.047244	0.027559	0.003937	0	0	0
0	1	2690	0	12	136RE	3.89	3.35	0.031496	0.015748	0	0	0	0	136RE	5.83	5.03	0.047244	0.023622	0	0	0	0
0	1	2691	0	13	136RE	4.37	3.77	0.035433	0.015748	0	0	0	0	136RE	5.83	5.03	0.047244	0.023622	0	0	0	0
0	1	2692	0	14	136RE	3.89	3.35	0.031496	0.015748	0	0	0	0	136RE	5.83	5.03	0.047244	0.023622	0	0	0	0
0	1	2693	0	15	136RE	4.86	4.19	0.03937	0.03937	0	0	50.68281	-120.363	136RE	5.91	5.09	0.047244	0.027559	0.003937	0	50.68281	-120.363
0	1	2694	0	16	136RE	2.92	2.51	0.023622	0.023622	0	0	50.68282	-120.363	136RE	5.91	5.09	0.047244	0.023622	0.003937	0	50.68282	-120.363
0	1	2695	0	17	136RE	1.94	1.68	0.015748	0.027559	0	0	50.68282	-120.363	136RE	5.92	5.16	0.047244	0.023622	0.007874	0	50.68282	-120.363
0	1	2696	0	18	136RE	2.92	2.51	0.023622	0.023622	0	0	50.68282	-120.363	136RE	5.83	5.03	0.047244	0.027559	0	0	50.68282	-120.363
0	1	2697	0	19	136RE	2.92	2.51	0.023622	0.019685	0	0	50.68282	-120.363	136RE	6.32	5.44	0.051181	0.019685	0	0	50.68282	-120.363
0	1	2698	0	20	136RE	3.4	2.93	0.027559	0.019685	0	0	50.68282	-120.363	136RE	6.8	5.86	0.055118	0.023622	0	0	50.68282	-120.363
0	1	2699	0	21	136RE	3.4	2.93	0.027559	0.023622	0	0	50.68282	-120.363	136RE	6.4	5.51	0.051181	0.019685	0.003937	0	50.68282	-120.363
0	1	2700	0	22	136RE	3.4	2.93	0.027559	0.023622	0	0	50.68282	-120.363	136RE	6.32	5.44	0.051181	0.019685	0	0	50.68282	-120.363
0	1	2701	0	23	136RE	3.4	2.93	0.027559	0.023622	0	0	50.68282	-120.363	136RE	6.32	5.44	0.051181	0.027559	0	0	50.68282	-120.363
0	1	2702	0	24	136RE	3.89	3.35	0.031496	0.019685	0	0	50.68282	-120.363	136RE	6.8	5.86	0.055118	0.023622	0	0	50.68282	-120.363
0	1	2703	0	25	136RE	3.89	3.35	0.031496	0.019685	0	0	50.68282	-120.363	136RE	7.29	6.28	0.059055	0.023622	0	0	50.68282	-120.363
0	1	2704	0	26	136RE	3.89	3.35	0.031496	0.019685	0	0	50.68282	-120.363	136RE	8.26	7.12	0.066929	0.019685	0	0	50.68282	-120.363
0	1	2705	0	27	136RE	4.37	3.77	0.035433	0.019685	0	0	50.68282	-120.363	136RE	8.75	7.54	0.070866	0.015748	0	0	50.68282	-120.363
0	1	2706	0	28	136RE	4.37	3.77	0.035433	0.023622	0	0	50.68282	-120.363	136RE	10.28	8.86	0.082677	0.019685	0.003937	0	50.68282	-120.363
0	1	2707	0	29	136RE	3.89	3.35	0.031496	0.023622	0	0	50.68282	-120.363	136RE	7.78	6.7	0.062992	0.023622	0	0	50.68282	-120.363
0	1	2708	0	30	136RE	5.35	4.61	0.043307	0.03937	0	0	50.68282	-120.363	136RE	5.35	4.61	0.043307	0.023622	0	0	50.68282	-120.363
0	1	2709	0	31	136RE	5.35	4.61	0.043307	0.043307	0	0	50.68282	-120.363	136RE	5.35	4.61	0.043307	0.023622	0	0	50.68282	-120.363
0	1	2710	0	32	136RE	4.37	3.77	0.035433	0.027559	0	0	50.68282	-120.364	136RE	5.35	4.61	0.043307	0.023622	0	0	50.68282	-120.364

(2) Clean up data format using Python code



MP	Degrees	Curve	HR Vert (in)	HR Gage (in)	LR Vert (in)	LR Gage (in)
0.4		RC	0.2954	0.049	0.0804	0.0227
0.8	1.15	RC	0.0052	0.0283	0.355	0.0039
1	1.15	RC	0.542	0.025	0.2629	0.0131
1.3	4.9	LC	0.463	0.0364	0.4198	0.0049
1.9	1.91	RC	0.1505	0.0214	0.3379	0.0054
2.3	2.51	RC	0.1142	0.0248	0.1145	0.0104
4.4	5.9	RC	0.4382	0.0615	0.1288	0.0041
4.7	4.97	LC	0.5327	0.0897	0.1307	0.0203
5.7	5	LC	0.1155	0.0261	0.1185	0.0231

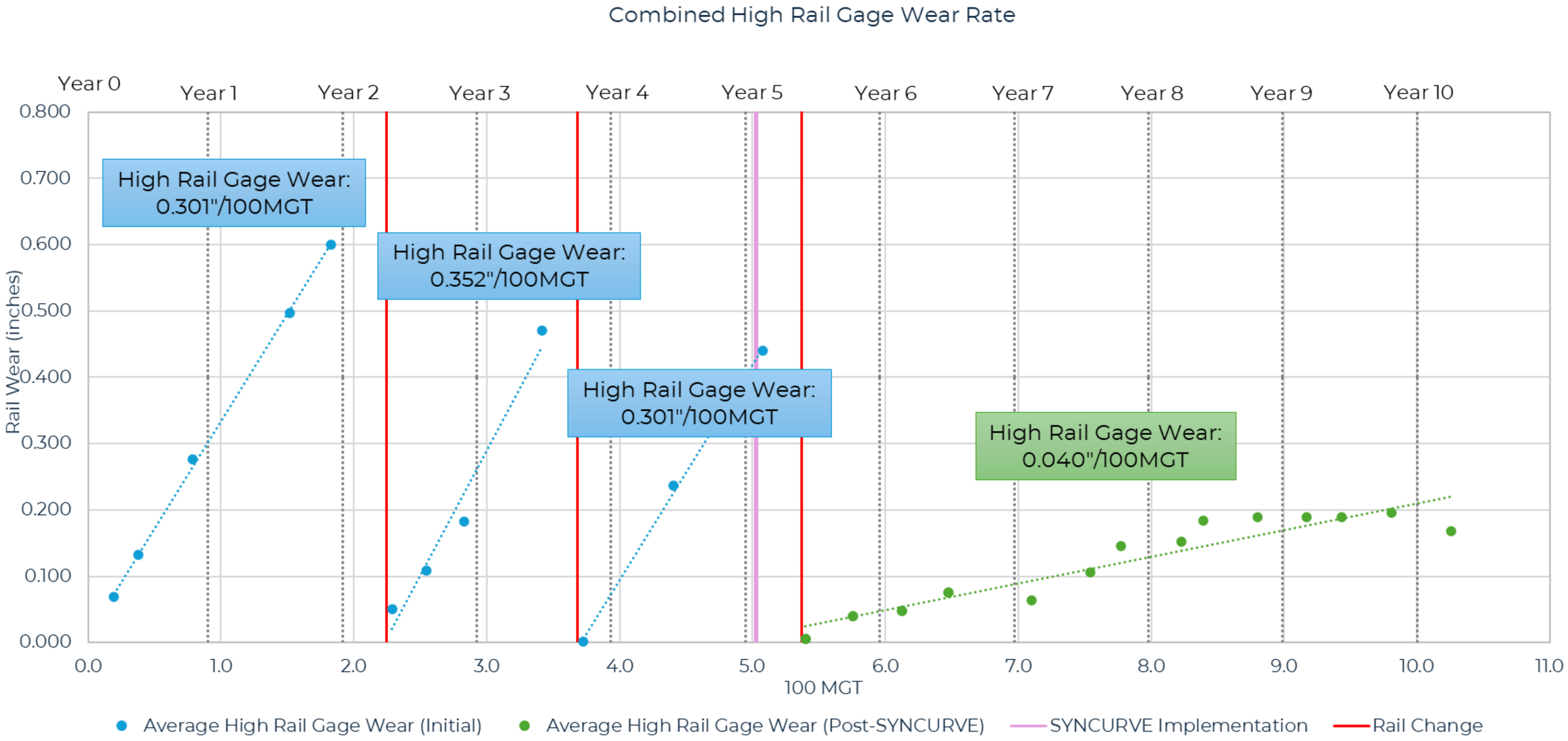
(3) Extract data directly out of cleaned summary file

Thompson Subdivision Curve Selection

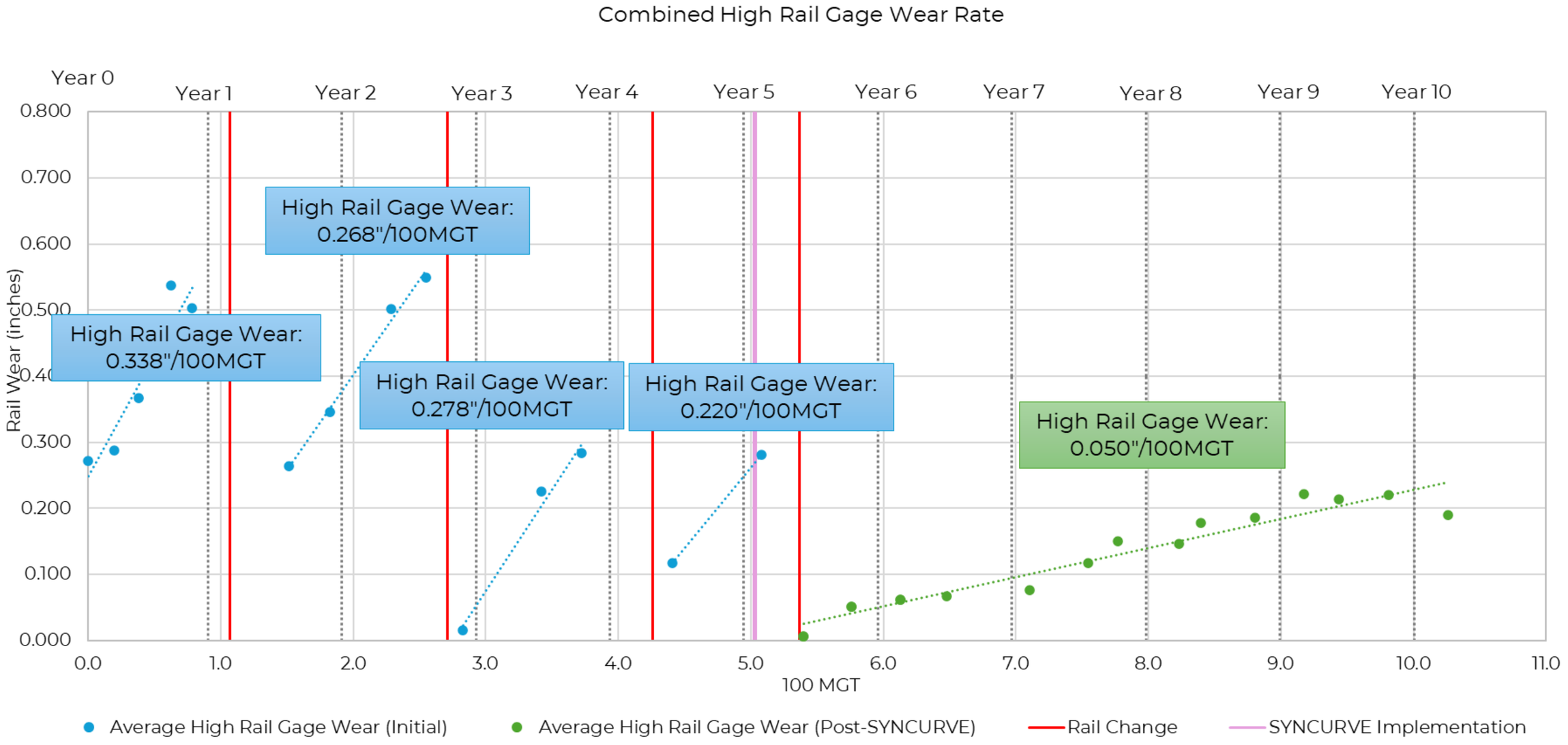
- The study concentrates on the high curvature area Tranquille [MP8.9] and Cherry Creek [MP14.2]
- Total of 18 curves selected
- Curvature ranges from 7°15” to 11°30”
- Traffic is bidirectional
- ≈100MGT
- There are four PX GF lubricators applying SYNCURVE covering this section of track:
  - MPs 6.9, 10.0, 11.8 and 14.4

Curve	MP	Deg of Curve	Direction	Length of Curve (ft)
1	8.9	8,25	L	787
2	10.4	10,15	L	825
3	10.6	11,30	L	693
4	11.05	11,30	R	568
5	11.1	10,45	L	445
6	11.7	8,30	L	503
7	12.3	10,52	L	666
8	12.5	10,34	L	460
9	12.85	11,0	R	761
10	13.1	10,0	L	803
11	13.2	8,30	L	286
12	13.3	9,98	R	526
13	13.4	11,15	L	745
14	13.5	10,30	R	302
15	13.7	7,15	R	595
16	13.8	10,19	L	900
17	14.05	10,30	R	751
18	14.2	11,0	L	533

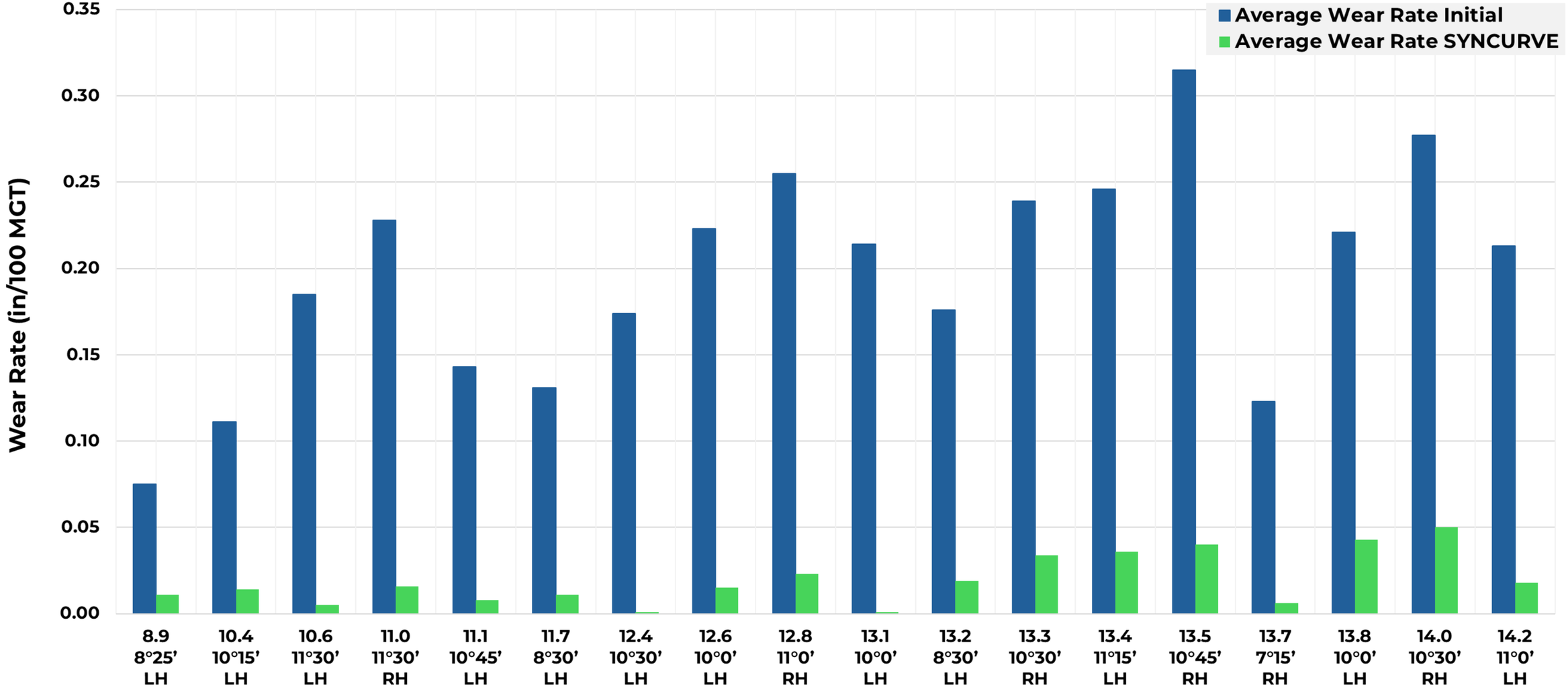
MP 13.5 10°45’ RH Curve Rail Wear



MP 14.0 11°0’ RH Curve Rail Wear



Rail Wear Summary



- Average initial wear rate of **0.192"/100MGT** reduced to **0.020"/100MGT** with SYNCURVE
- Result is a **90%** overall wear reduction

Track Accesses – Pre TFM

- PIV units: 800lbs capacity
- units total in this area:
  - Mileposts 6.9, 10, 11.8, 14.4
- Petroleum grease, 0.75lb / kaxle output rate
- Refill units when they draw down to 30% full
- Uptime = 95%*
- 50 days between fill ups

Bulk filling of PIV 800lb lubricator on Thompson Sub using section 10-ton truck. 2008.

Track Accesses Comparison

- Comparison of track access frequency required between existing PIV units and PX replacement units

PIV	
Capacity	800 lbs
Product	Petroleum Grease
Output Rate	0.75 lb/kaxle
Uptime	95% *
Days Between Fill-ups	50
Track Accesses Per Unit	7.2
Track Accesses Total (4 Units)	28.9

PX	
Capacity	1250 lbs
Product	Synthetic Grease
Output Rate	0.30 to 0.45 lb/kaxle
Uptime	95%
Days Between Fill-ups	172
Track Accesses Per Unit	2.1
Track Accesses Total (4 Units)	8.4

71% reduction in track accesses

Track Accesses Extrapolated

- Thompson Subdivision lube filler also responsible for Cascade Sub
  - Both subdivisions are 127 miles in length
  - Kamloops to Vancouver, BC
- The 4 units in this study are 4% of the employee's total units
  - 46 additional gauge face + 50 top of rail units
- Pre-TFM ~4 lubricators/shift can be filled due to traffic and hirail only access in some locations on Thompson Subdivision
- Post-TFM with PX and new style trucks, ~8 lubricators/shift can be filled
- Extrapolating for remaining gauge face units yields **77 workdays freed up**

- *95% uptime pre-TFM – used for comparison purposes – number was not this high
- *Pre-TFM – lube filler reported to local section – had other duties

ECONOMIC IMPACT

Track Access and Rail Wear

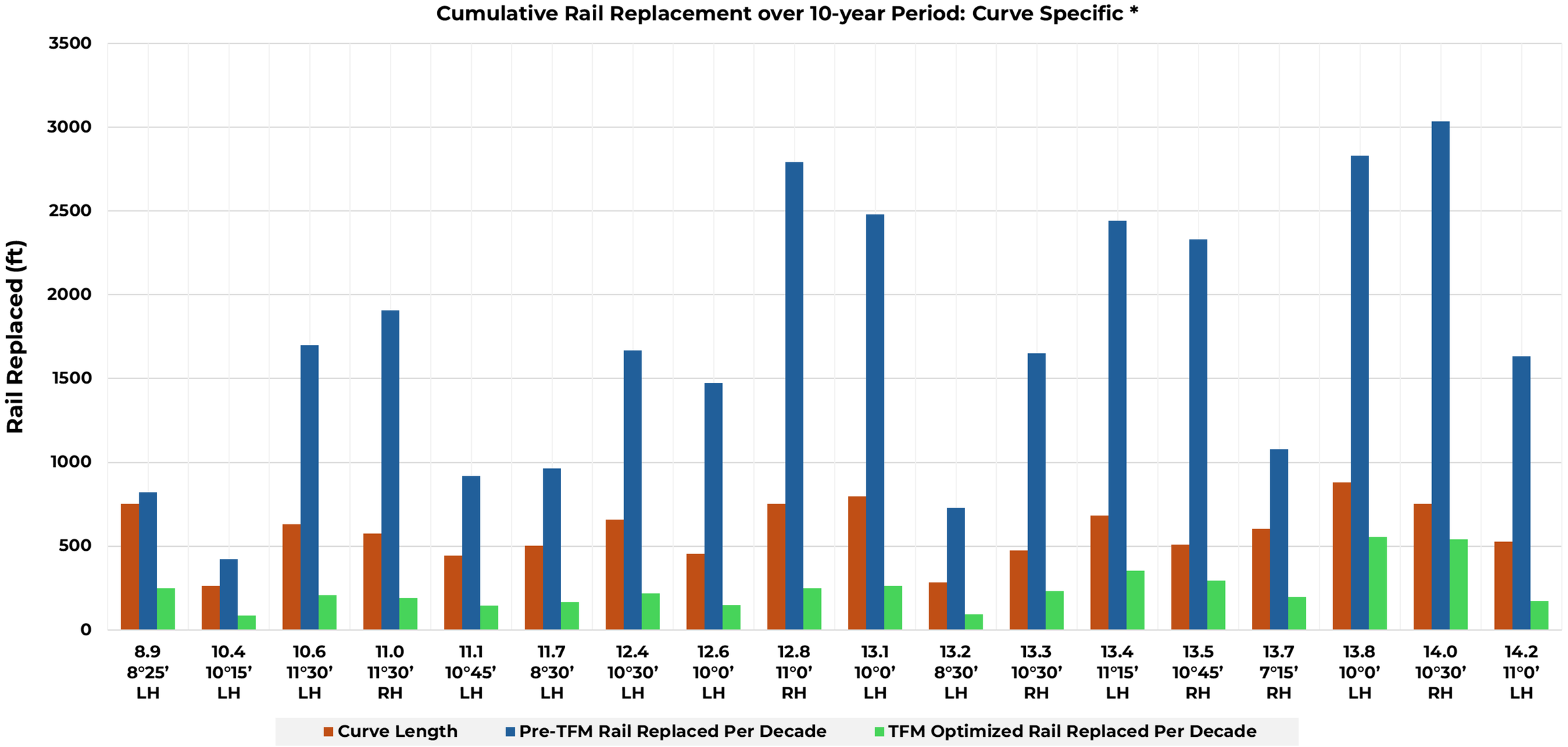
Track Accesses Economics

- Pre-TFM, old style trucks, ~4 lubricators/shift can be filled
- Post-TFM, new style trucks, ~8 lubricators/shift can be filled
- Annual labour/OH cost of pre-TFM track accesses, these 4 units: ~$5,600
- Annual labour/OH cost of post-TFM track accesses, these 4 units: ~$800
- Annual labour/OH savings: $4,800 (4 units)
- Applied to all 50 gauge face units on lube filler territory: **~$60,000/year saved** (or spent on other productive work)

Rail Wear Economics: Methodology

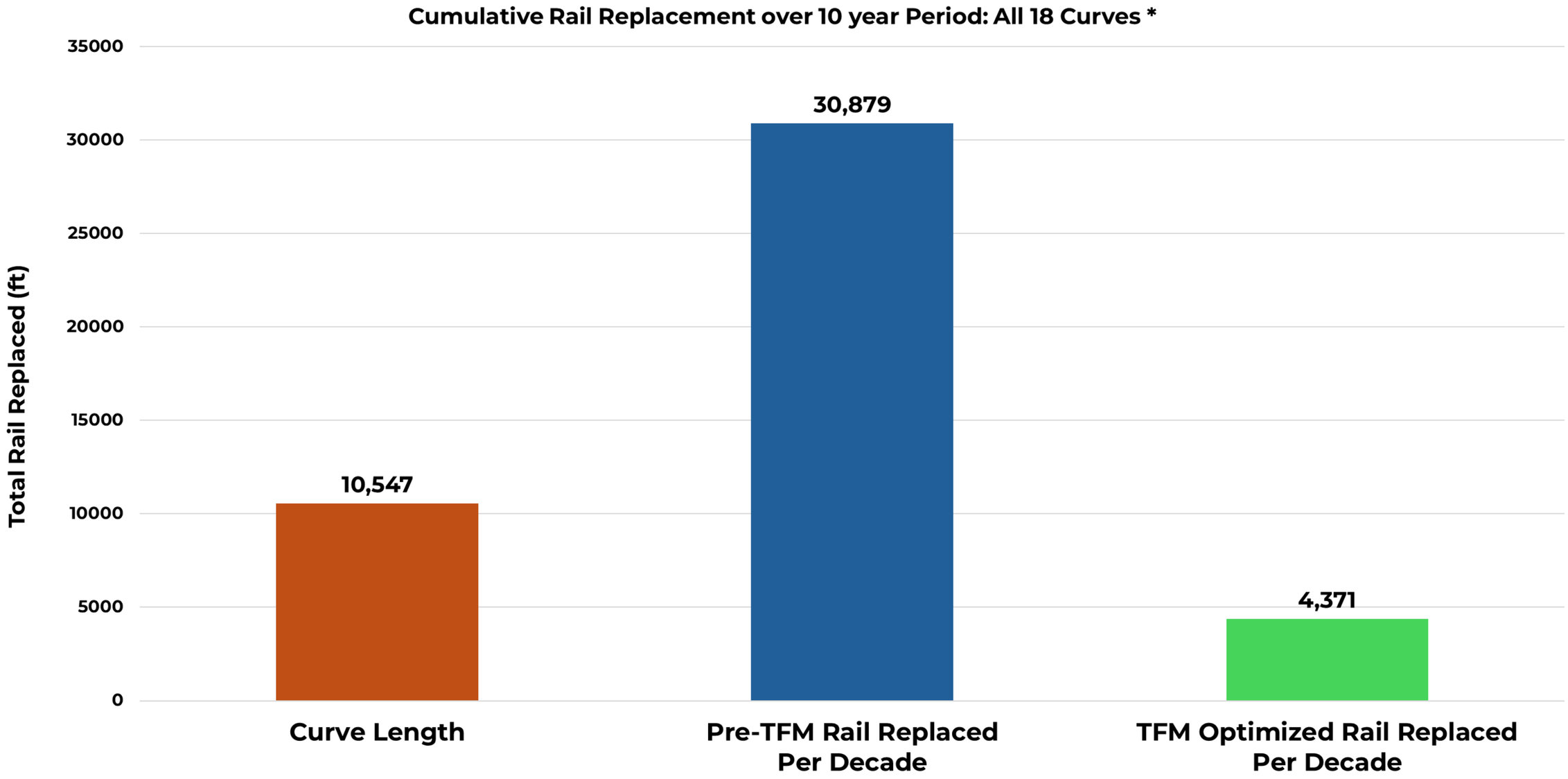
- Compared pre-TFM rail wear rate versus post-TFM rail wear rate
- Used an average wear rate derived from the measured data from the 18 curves
- Calculated the years to Line B based on 100MGT annually
- Capped rail life at 30 years
- Then calculated the rail saved per decade in feet and the dollars saved per decade [labour, materials, OH, consumables]

Rail Wear Economics: Per Curve



** Assumes annual tonnage of 100 MGT.*

Rail Wear Economics: All 18 Curves



** Assumes annual tonnage of 100 MGT.*

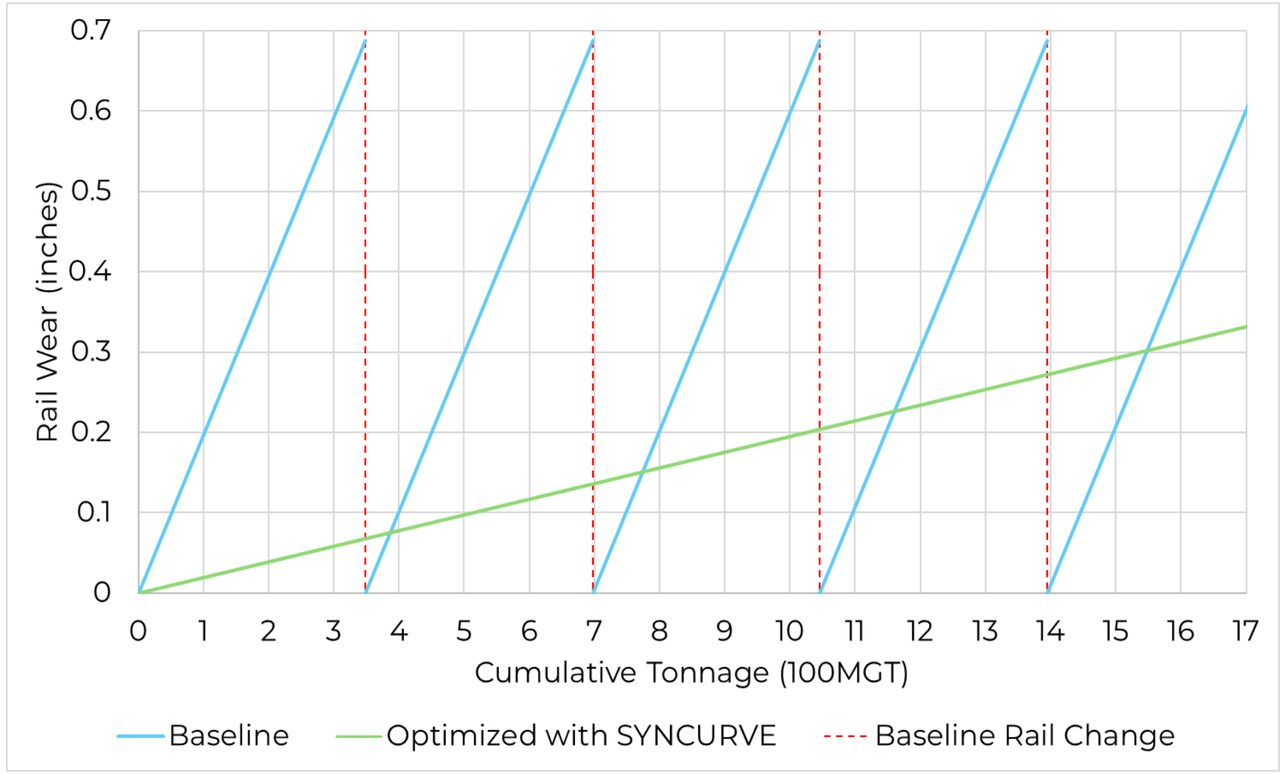
Rail Wear Economics: Summary

Total rail saved per decade: **26,479 ft**

Total $ saved per decade: **$2,665,431**

Saving are only for the 18 curves in the 6-mile segment, protected by 4 lubricators

There over 100 curves in this 6 mile segment. The test segment is only 5% of the total subdivision.



CONCLUSIONS

FM Improvements

Improvements in the program and centralized budgeting and in technology including grease, equipment, bulk filling trucks and remote monitoring have made large sustainable improvements in overall program effectiveness.

Measure/Data

Monitoring and measurement are critical. Validation can be achieved with rail wear data that is already collected. RPM and output measurements make execution exact.

Economic Benefits

The benefits of Friction Management for CPKC are significant. The savings for this 6-mile segment are in the millions of dollars. They can be quantified in terms of track access, labour hours and rail replacement.