STAFF REPORT
ACTION REQUIRED

Presentation: 2016 – 2025 Bus Fleet & Facility Plan

Date:	October 28, 2015
To:	TTC Board
From:	Chief Executive Officer

Summary

A presentation entitled: 2016 – 2025 Bus Fleet and Facility Plan will be submitted to the Board for discussion.

The presentation will respond to the motion from the July 29, 2015 Board meeting where staff were requested to report back with an analysis and comparison of lifecycle costs on 12-year buses versus 18-year buses, as well as other appropriate comparisons, including leasing as an option. The presentation will also respond to the motion from the September 15 TTC Budget Committee that requested TTC to report back on its bus procurement strategy and the growth assumptions inherent in the plan.

Recommendation

It is recommended that:

1. The Board receive the presentation for information.

Contact

Richard Wong
Head of Bus Maintenance
Phone: 416-393-3564
E-Mail: rich.wong@ttc.ca

Attachment: 2016 – 2025 Bus Fleet and Facility Plan Presentation

2016-2025 BUS FLEET & FACILITY PLAN

BUS MAINTENANCE & SHOPS DEPARTMENT

October 21, 2015

BUS FLEET & FACILITY PLAN

Objectives

1. Address Service, Maintenance & Facility Requirements
2. Identify Most Cost Effective Strategy

BUS FLEET & FACILITY PLAN

Bus Operations

1. Service Stats
2. Historical Maintenance Practices & Policies
3. Opportunities

Development of Service Plan & Bus Fleet Plan

1. Development of Service Plan
2. Development of Bus Fleet Plan

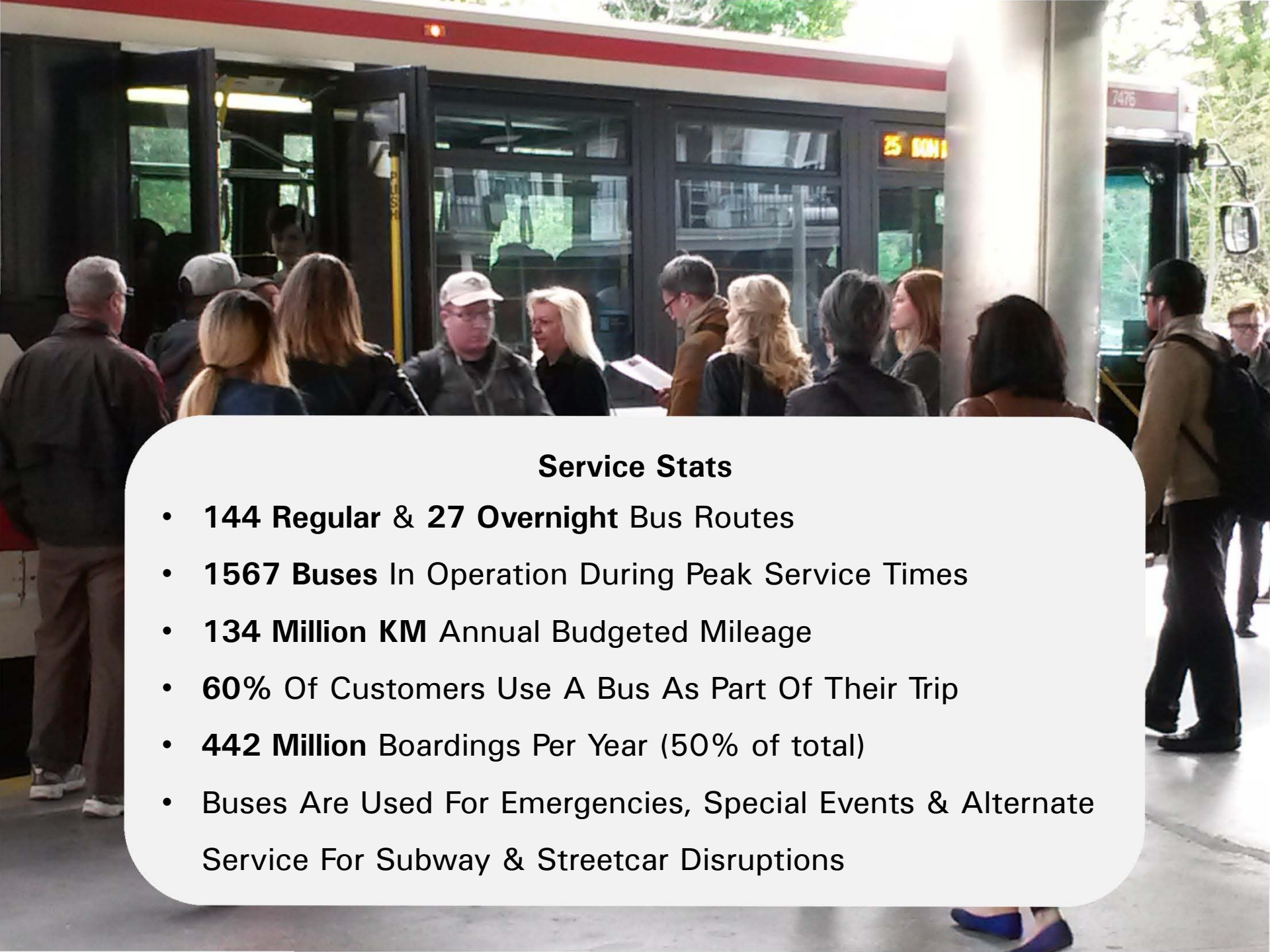
BUS FLEET & FACILITY PLAN

Initiatives Proposed In 2016-2025 Bus Fleet Plan

Business Transformation Through Implementation Of Industry Best Practices & Policy Changes:

1. Accelerate Steady State Procurement
2. Increase Bus Spare Ratio
3. Early Retirement Of Hybrid Bus Fleet
4. Re-Align Diesel Bus Overhaul Schedule
5. Improve Bus Reliability
6. Review Optimal Bus Replacement Strategy
7. Identify Additional Facility Requirements

BUS OPERATIONS



Service Stats

- **144 Regular** & **27 Overnight** Bus Routes
- **1567 Buses** In Operation During Peak Service Times
- **134 Million KM** Annual Budgeted Mileage
- **60%** Of Customers Use A Bus As Part Of Their Trip
- **442 Million** Boardings Per Year (50% of total)
- Buses Are Used For Emergencies, Special Events & Alternate Service For Subway & Streetcar Disruptions

Historical Maintenance Practices & Policies

- **12%** Operating Spare Ratio
- **80%** Corrective vs **20%** Preventative Maintenance
- **18 Year** Bus Life
- **End of Life** Procurement Policy
- **$998 Million** Total Capital Budget (2015-2024)
- **$180 Million** Total Operating Budget (2015)

Opportunities

- Modernize Bus Fleet & Implement Best Practices
- Improve Vehicle Availability & Reliability
- Improve Bus Service

DEVELOPMENT OF SERVICE PLAN & BUS FLEET PLAN

DEVELOPMENT OF SERVICE REQUIREMENTS

- **Ridership Growth** (2016: +12M trips = 17 buses)
- **Service Initiatives** (Reduced Peak Crowding, Express Buses)
- **Service Changes** (Reduction In YRT/Viva Contract Service)
- **Vehicle Changes** (Higher Capacity Articulated Buses)
- **Rapid Transit** (Crosstown Construction, TYSSE Completion)
- **City Construction** (Road, Water Works)
- **Other** (Transit Signal Priority)

DEVELOPMENT OF SERVICE REQUIREMENTS

Ridership Growth:

- Short-Term Ridership: 2016 – 2018: Statistical & Economic Analysis (GDP & Employment Forecasts, Service Level Enhancements, Changes To Fares, etc.)
- Long-Term Ridership: 2019 – 2025: Population Growth Rate (1.5% Per Annum Based On City of Toronto Official Plan)

Peak Buses To Accommodate Ridership Growth:

- +1 Million Riders Per Annum ≈ 1.4 Buses

DEVELOPMENT OF SERVICE REQUIREMENTS

Rapid Transit Projects:

- Construction: Buses To Offset Delays And Diversions
  (e.g. York U During TYSSE Construction)
- Implementation: Fewer Buses When Projects Open
  (e.g. TYSSE → Discontinue 196 York University Rocket)

2016-2025 BUS FLEET & FACILITY PLAN

PEAK BUS SERVICE REQUIREMENTS

Factor			18	2019	2020	2021	2022	2023	2024	2025
ridership growth			10	12	12	12	12	12	12	12
service initiatives	57	33	45	38	1	1	1			
vehicle changes	0	-1	4		-		4		-	
rapid transit	0	0	7	0	0	5	-42	-101	-34	-33
city construction	3	2	9	6						
sub- (annual				59						
bus requiremen	,64	,68	,76	1,822	1,828	1,861	1,836	1,751	1,729	1,709

+ Service Reliability
+ Reduced Peak Crowding
+ Express Buses

+ Sheppard East LRT construction begins

- Line 2 Extension completed
- Sheppard East LRT completed

+ Eglinton Crosstown construction intensifies
+ Finch West LRT construction begins
- TYSSE completed
+ Line 2 Extension construction begins

DEVELOPMENT OF SERVICE REQUIREMENTS

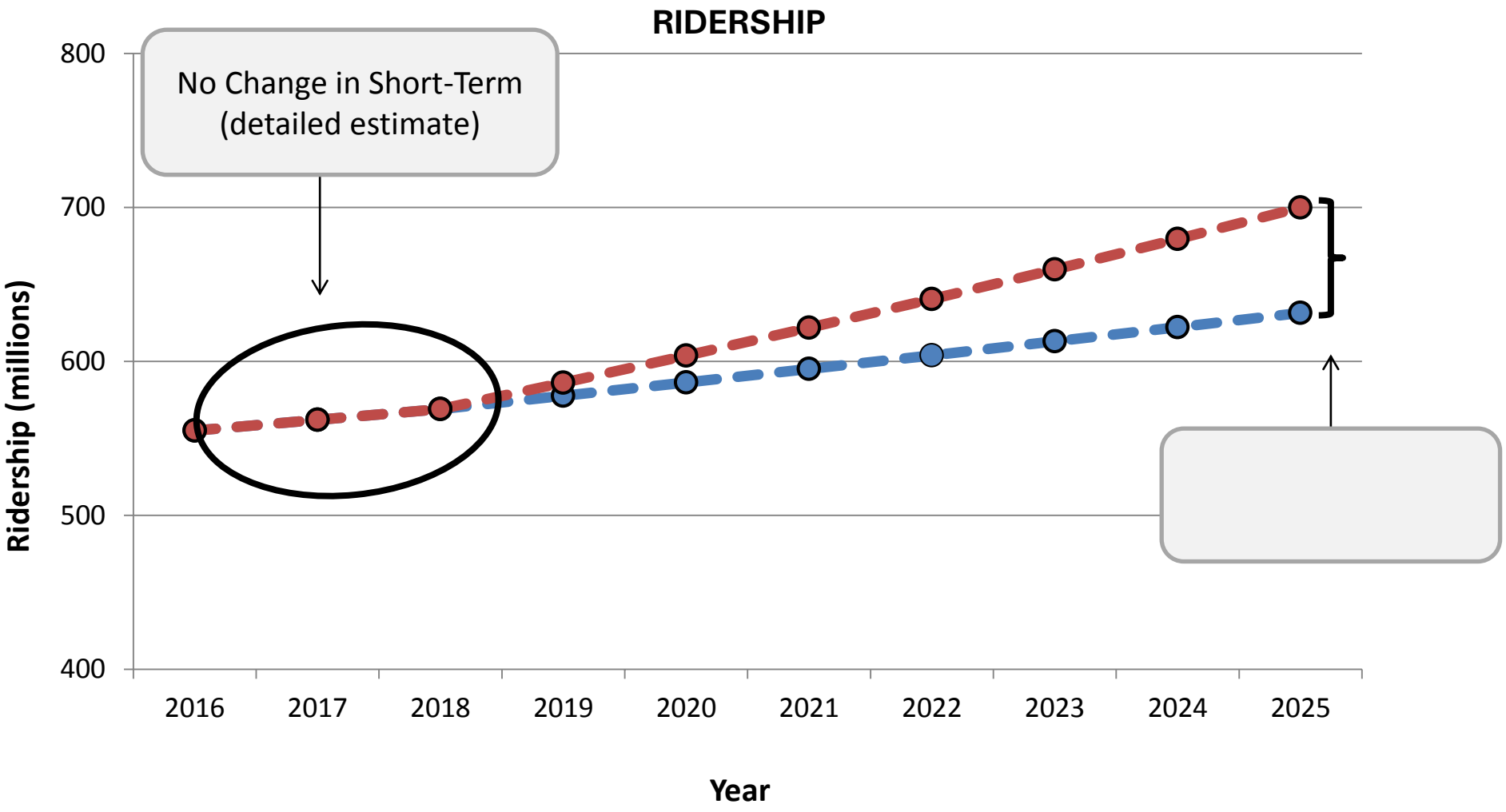
Ridership Growth:

- Short-Term Ridership: 2016 – 2018: Statistical & Economic Analysis (GDP & Employment Forecasts, Service Level Enhancements, Changes To Fares, etc.)
- Long-Term Ridership: 2019 – 2025: Population Growth Rate (**1.5%** Per Annum Based On City of Toronto Official Plan)

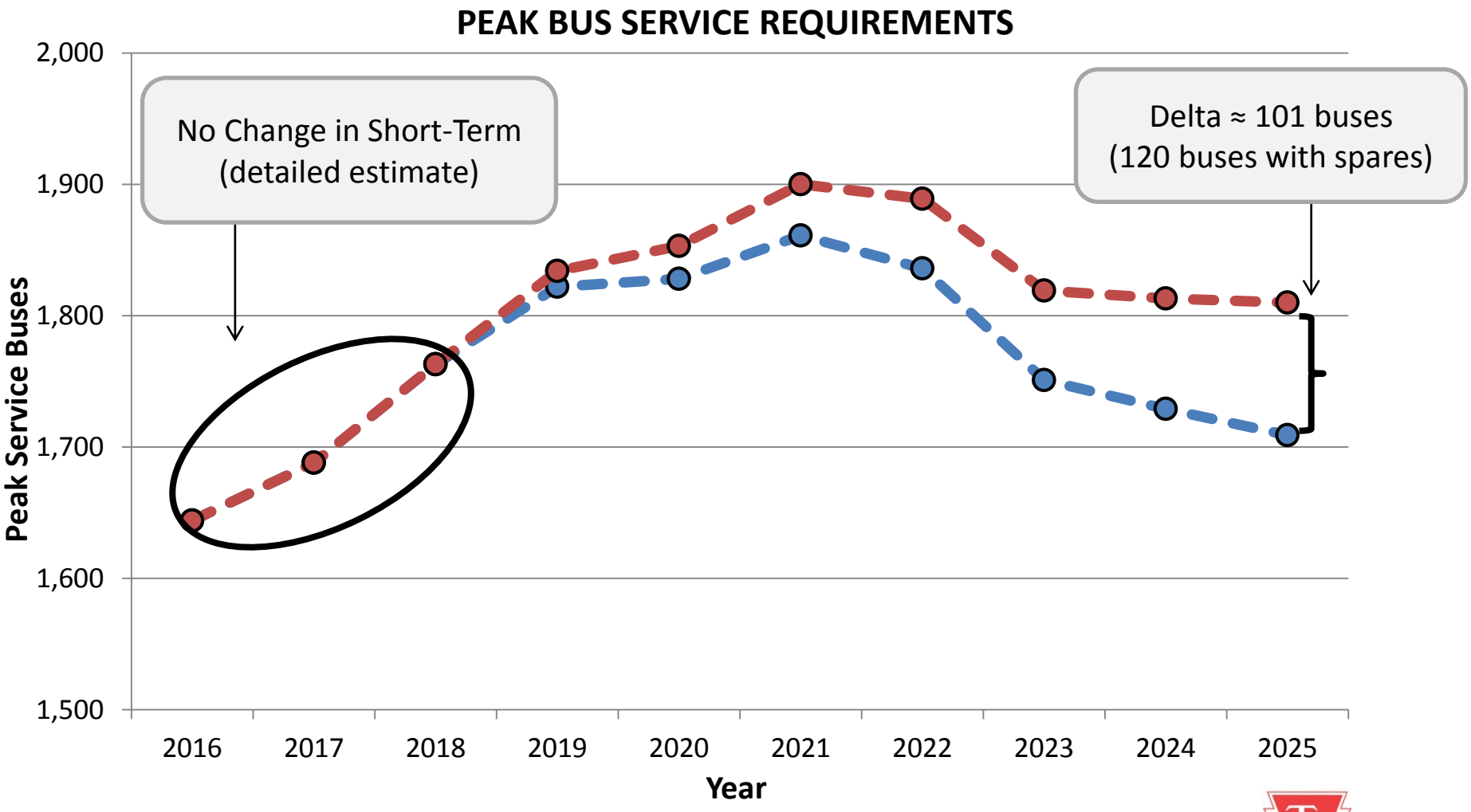
Peak Buses To Accommodate Ridership Growth:

- +1 Million Riders Per Annum ≈ 1.4 Buses

CHANGE TO RIDERSHIP GROWTH RATE



CHANGE TO RIDERSHIP GROWTH RATE



DEVELOPMENT OF SERVICE & BUS FLEET PLAN

Calculating Total Bus Requirements

	End of Year	2016
Peak Service		**1644**
SERVICE REQUIREMENTS	- 2015 Peak Service	1567
	- Ridership Growth	17
	- Service Initiatives	57
	- City Construction	3
Operating Maintenance Spares		**296**
	- 18% of peak service	296
Capital Spares (Rebuild/Warranty/Retrofit/Programs)		**102**
MAINTENANCE REQUIREMENTS	- Rebuild Programs	43
	- ADOA - External Stop Announcements / CAD AVL / Presto	36
	- Warranty/Retrofit	23
Total Bus Requirements		**2042**

Total Buses Available	**2029**
Less: Total Buses Required	**2042**
Less: Total Buses Scheduled For Retirement	**0**
Bus Surplus/Deficit	**(13)**

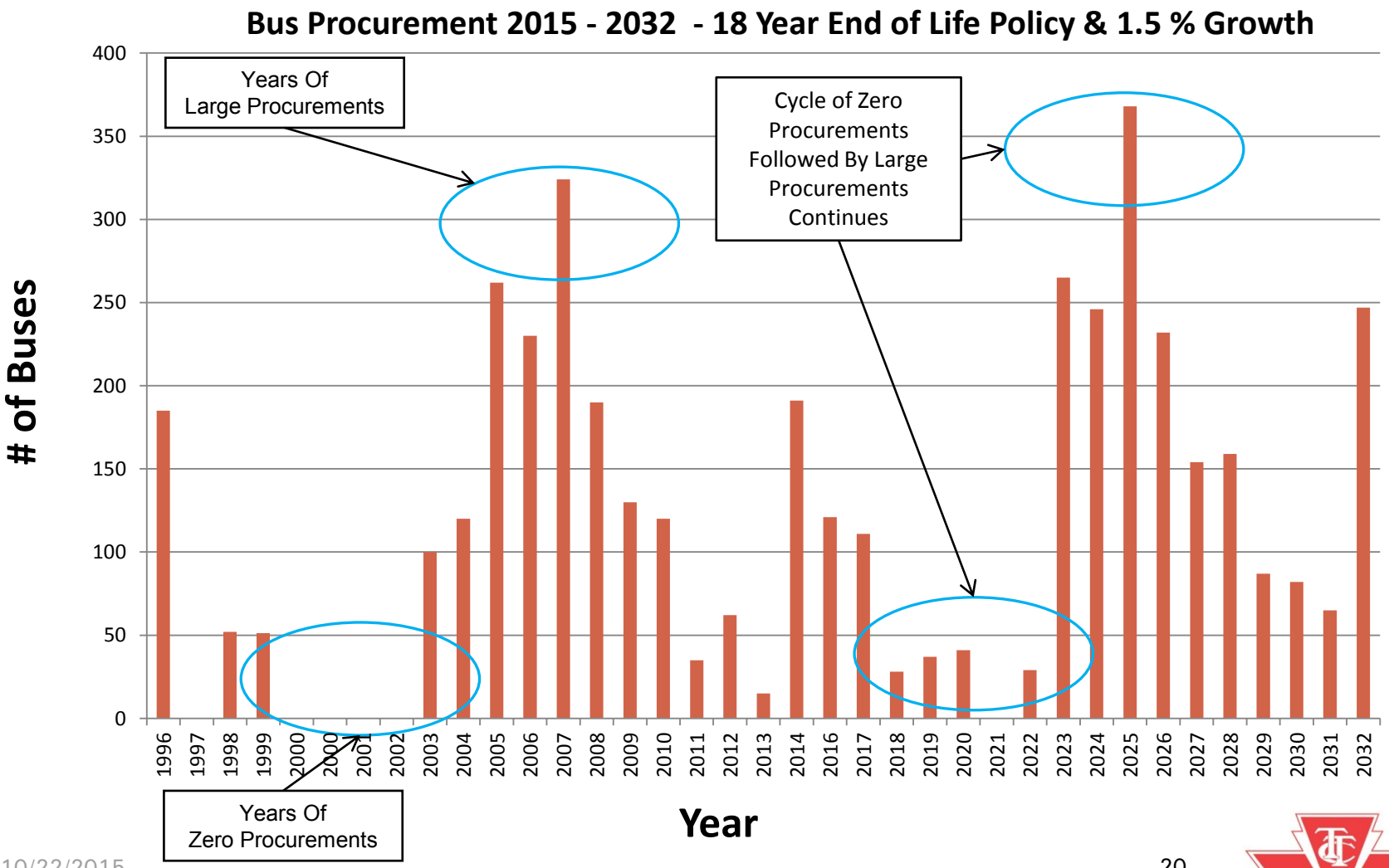
Streetcars moved from 504 King Line to 501 Queen Line to improve service reliability. Temporary requirement in 2016 for 13 buses on the 504 King Line.

INITIATIVES

ACCELERATE
STEADY STATE PROCUREMENT

APPROVED IN 2015-2024 BUDGET
INDUSTRY BEST PRACTICE

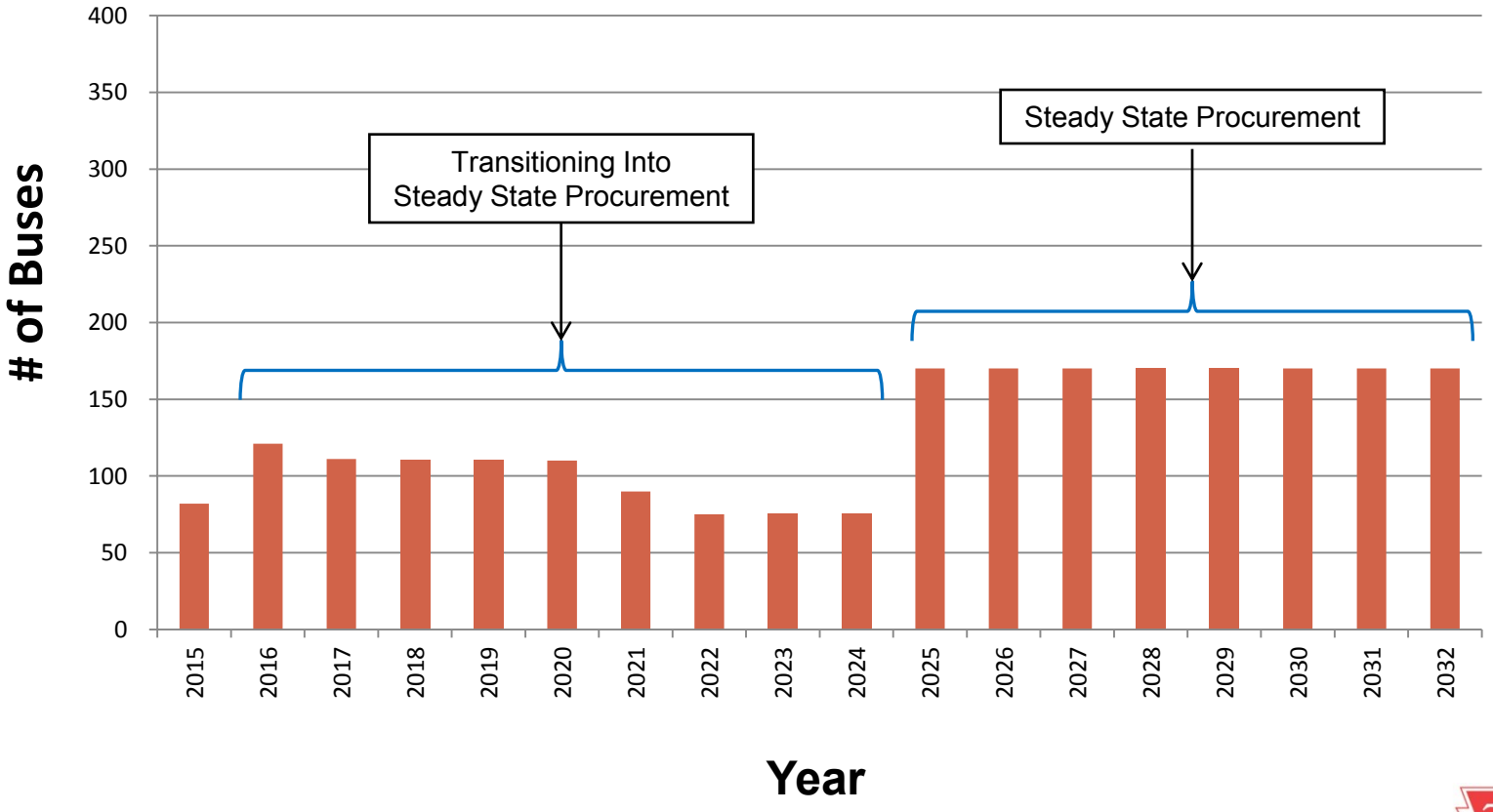
STEADY STATE PROCUREMENT



STEADY STATE PROCUREMENT

Bus Procurement 2015 – 2032

Approved Steady State Procurement
1.5% Annual Ridership Growth



STEADY STATE PROCUREMENT

Benefits of Steady State Procurement

- Consistent Funding Requirements
- Opportunity For Long Term Partnership With OEM
- Consistent Upgrade Of Technology / Continuous Training / Modernization
- Consistent Average Age Of Fleet
- Steady State Bus Overhaul Programs
- Consistent Bus Overhaul Workforce
- Recruitment Drives, Layoffs, Bumps & Master Sign Ups Avoided
- Consistent Material Inventory & Facility Requirements

STEADY STATE PROCUREMENT

Cash Flow

City Bus Procurement Cashflow ($M)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	202
Current Replacement Policy														
Schedule	82	121	111	28	37	41	-	29	265	246	368	232	154	1
Cash Flow	$49.2	$76.2	$78.1	$20.6	$28.4	$32.9	$0.0	$25.7	$243.8	$236.8	$370.8	$244.6	$170.0	$183
Steady State Procurement														
Schedule	82	121	111	110	110	110	90	75	75	75	170	170	170	1
Cash Flow	$49.2	$76.2	$78.1	$80.9	$84.4	$88.3	$75.8	$66.4	$69.0	$72.2	$171.9	$180.5	$187.6	$196
Variance														
Schedule	-	-	-	82	73	69	90	46	(190)	(171)	(19		16	
Cash Flow	$0.0	$0.0	$0.0	$60.3	$56.0	$55.4	$75.8	$40.7	-$174.8	-$164.6	-$198.9	-$64.1	$17.6	$1

PARTIALLY FUNDED YEARS

ACCELERATE TRANSITION TO STEADY STATE PROCUREMENT

ADDITIONAL 223 BUSES TO MODERNIZE FLEET & EARLY RETIRE HYBRIDS

UNFUNDED YEARS

BENEFIT

LEASE VS PURCHASE OPTIONS

	PURCHASE	LEASE TO OWN		LEASE
Supplier:	**NOVA Bus**	**New Flyer**	**SBL (Shuttle Bus Leasing)**	**?**
Cost Per Bus:	**$593K**	**$630K**	**TBD**	**?**
Cost Per Month: (Over Bus Life)	**$2.8K CDN (18 Years)**	**$2.9K CDN (18 Years)**	**$3.0K US (5 Years)**	**?**
Bus Age:	**New**	**New**	**15-18 Years**	**?**
Included/Not Included:	**Included:** TTC Design Specifications Extended Warranty Cross Vendor Parts Reference List TTC Testing Requirements	**Not Included:** TTC Testing & Other Technical Requirements Would Have Been Required To Be Waived By TTC Subsequent Negotiations On Terms & Conditions Re: Warranty Delivery Schedule, Liquidated Damages (If Applicable)	**Not Included:** TTC Design Specifications Delivery Costs ($8.5K US Per Bus) Warranty Vehicle Accessories: - Ramps - Station Stop Announcements - Ext Announcement Speakers - Interior Security Cameras - CIS System - Fare Card System MTO Certification Costs	**?**
Comments:	Current TTC Bus Contract Awarded On A Competitive Request For Bid Basis	Financial Details Were Subject To Negotiation Based On Financing Agreement Which Would Have Resulted In Higher Costs	SBL Failed To Respond To Requests For Quotation Based On Retrofit For Vehicle Accessories Useful Bus Life Limited To 5 Years	Staff Is Unaware Of Companies That Will Lease Buses Only

INCREASE BUS SPARE RATIO

APPROVED IN 2015-2024 BUDGET

RECOMMENDED & INDUSTRY BEST PRACTICE

BUS OPERATING SPARE RATIO

- **Purpose**
  - Provides Buses For Preventative & Corrective Maintenance Activities
- **Pre 2015 Bus Operating Spare Ratio**
  - 12% Operating Spare Ratio
  - Based On Diesel Bus Design With Outdated Systems From 1990
- **Approved 2015-2024 Bus Operating Spare Ratio**
  - Transition To 18% Spare Ratio In 2016
  - 20% Operating Spare Ratio Recommended By The US Federal Transportation Association & Industry Practice

BUS SPARE RATIO

12% Spare Ratio Based On Old Technology

GM Bus Model – 1990's		Current Fleet	
Systems	**Preventative Maintenance Programs**	**Systems**	**Preventative Maintenance Programs**
Major Components: • Engine • Transmission • Steering • Suspension • Structural • Heating	**Inspections:** • Service Checks • Lube & Inspection • Semi Annual **Programs:** • Spring Seasonal • Fall Seasonal • Air Dryer Service • Air Dryer Replacement • Engine Tune Up	**Major Components:** • Engine • Transmission • Steering • Suspension • Structural • Heating • Diesel Particulate Filter & Emission Controls System • Power Steering & Hydraulics • Air Conditioning • Anti- Lock Braking System • Kiddie Fire Suppression System • Hybrid Electric Systems • SVSCS – Surface Vehicle Safety Camera System • SVASAS – Surface Vehicle Automatic Stop Announcement System • AODA Bus Kneeling System • AODA Bus Wheelchair Ramp System • Passenger Bike Rack • Automatic Passenger Count System • Presto Fare Card System • CAD/AVL Route Management System	**Inspections:** • Service Checks • Lube & Inspection • Semi Annual • MTO Inspections **Programs:** • Spring Seasonal • Fall Seasonal • Air Dryer Service • Air Dryer Replacement • Engine Tune Up • Diesel Particulate Filter Service • Crankcase Filter Service • SVSCS Inspections • SVASAS Inspections • AODA Inspections • ESS Battery Tub Service • ESS Filter Replacement & System Check • ACTG Rear End Bell Service • ACTG Spider & Coupler Service • ACTG Replacement • ACTM Replacement • ESS Li Ion Module Replacement • PCS Replacement

Technology Improvements

Legislative Requirements

Additional Systems

Hybrid Systems

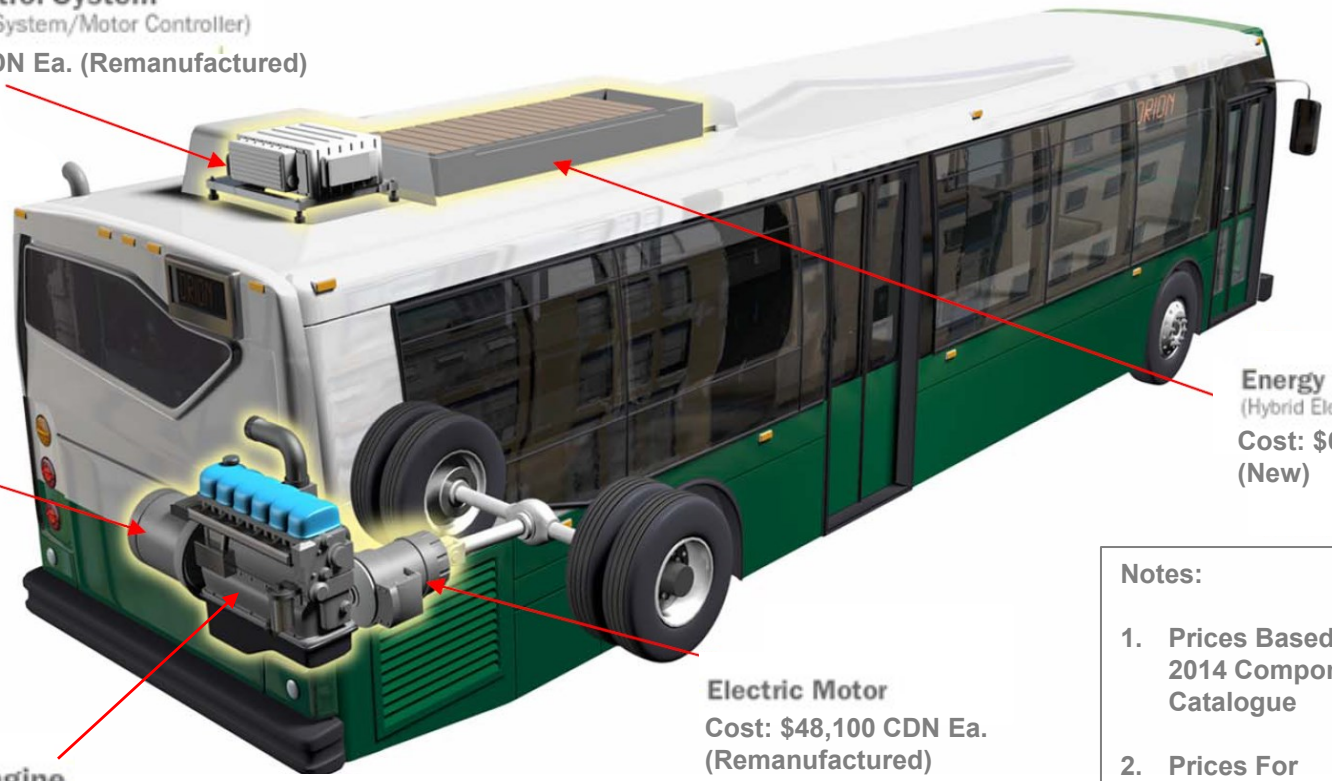
EARLY RETIRE HYBRID BUS FLEET

PROPOSED IN 2016-2025 BUDGET

HYBRID BUS FLEET

Major Systems

Propulsion Control System
(Power Inverter and System/Motor Controller)
Cost: $18,858 CDN Ea. (Remanufactured)



Energy Storage System
(Hybrid Electric Battery Pack)
Cost: $62,250 CDN Ea. (New)

Electric Generator
Cost: $20,995 CDN Ea. (Remanufactured)

Electric Motor
Cost: $48,100 CDN Ea. (Remanufactured)

Diesel Engine
Cost: $16,600 CDN Ea. (Remanufactured)
* 5.9L & 6.7L Cummins Engine – Also Used In Dodge Pickup Trucks

Notes:

1. Prices Based On BAE 2014 Component Price Catalogue
2. Prices For Remanufactured Components Is Based On Core Returns To BAE

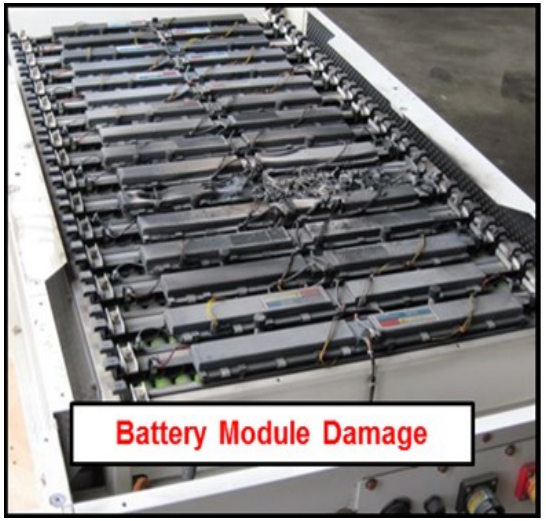
HYBRID BUS FLEET

- **691 Buses Delivered 2006-2009**
  - Series 1000-1149
  - Series 1200-1829
- **Experimental Technology**
  - Poor Reliability In High Humidity, Rain and Snow
  - High Hybrid Component Replacement Cost
- **Sole Source Vendor (BAE Systems Controls)**
  - Poor Aftermarket Support
  - Limited Number of New Components Available
  - Spare Pool of Components is Shared By New York, San Francisco, Houston, Toronto, Ottawa & Mississauga Transit Agencies
  - High Cost Of Ownership

HYBRID BUS FLEET

Roof Mounted Storage System Failures

- Electrical Shorting & Arcing
- Thermal Events (Overheating & Smoldering)



HYBRID BUS FLEET

Cost of Ownership

DIESEL VS HYBRID COST OF OWNERSHIP (18 YEAR BUS LIFE)				
	Diesel	Hybrid	Premium	
	Labour and Non-Labour Total Per Bus ($000)	Labour and Non-Labour Total Per Bus ($000)	Total Premium Per Bus ($000)	Total Premium 691 Bus Fleet ($000)
Purchase Cost:	$450.0	$675.0	$225.0	$155,475.0
Capital Costs:				
- 6 Year Mechanical	$85.0	$78.2	($6.8)	($4,704.9)
- 9 Year Mechanical & Structure	$134.8	$126.0	($8.9)	($6,122.9)
- 12 Year Mechanical	$85.0	$78.2	($6.8)	($4,704.9)
- 12 Year Hybrid	$0.0	$109.8	$109.8	$75,840.0
- 14 Year Energy Storage System	$0.0	$62.5	$62.5	$43,219.3
Operating Costs:				
- Running Maintenance	$970.20	$1,108.80	$138.6	$95,772.6
- Fuel Costs	$954.4	$720.0	($234.4)	($161,983.3)
Total Cost of Ownership	**$2,679.4**	**$2,958.4**	**$279.0**	**$192,790.9**

72 New Diesel Buses

HYBRID BUS FLEET

Proposed Retirement Plan

- **150 Hybrid Buses**
  - Approved In 2015-2024 Capital Budget For Early Retirement At 16 & 17 Years Of Age
- **255 Hybrid Buses**
  - Proposed In 2016-2025 Budget For Early Retirement At 12-15 Years Of Age
- **286 Hybrid Buses**
  - Proposed In 2016-2025 Budget For Retirement At Planned 18 Years Of Age

HYBRID BUS FLEET

Proposed Retirement Plan

- **Capital Cost Savings**
  - Elimination of Hybrid Overhaul Program
  - Reduced Need To Procure Hybrid Components (Capitalized)
  - Approximately $141M Estimated Cost Avoidance
- **Operating Cost Savings**
  - Harvesting Of Hybrid Components To Support Remainder Of Fleet
- **Reduced Dependency On OEM Supplier BAE Control Systems**

RE-ALIGN DIESEL BUS OVERHAUL SCHEDULE

PROPOSED IN 2016-2025 BUDGET

DIESEL BUS OVERHAUL PROGRAM

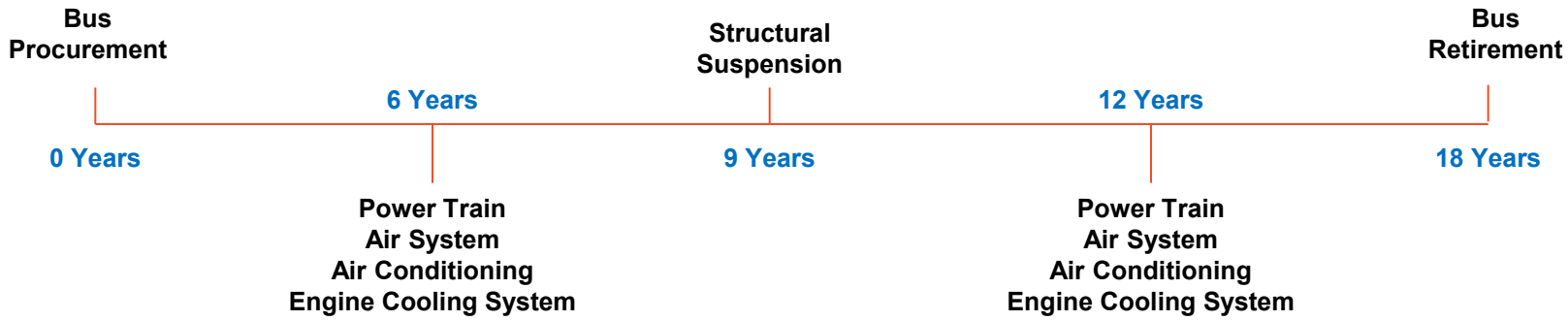
Existing Program

- 9 Year Body, Mechanical & Structural Overhaul
- 15 Year Mechanical Overhaul

Proposed Program

- 6 Year Mechanical Overhaul
- 9 Year Body & Structural Overhaul
- 12 Year Mechanical Overhaul

Proposed Program Scope of Work

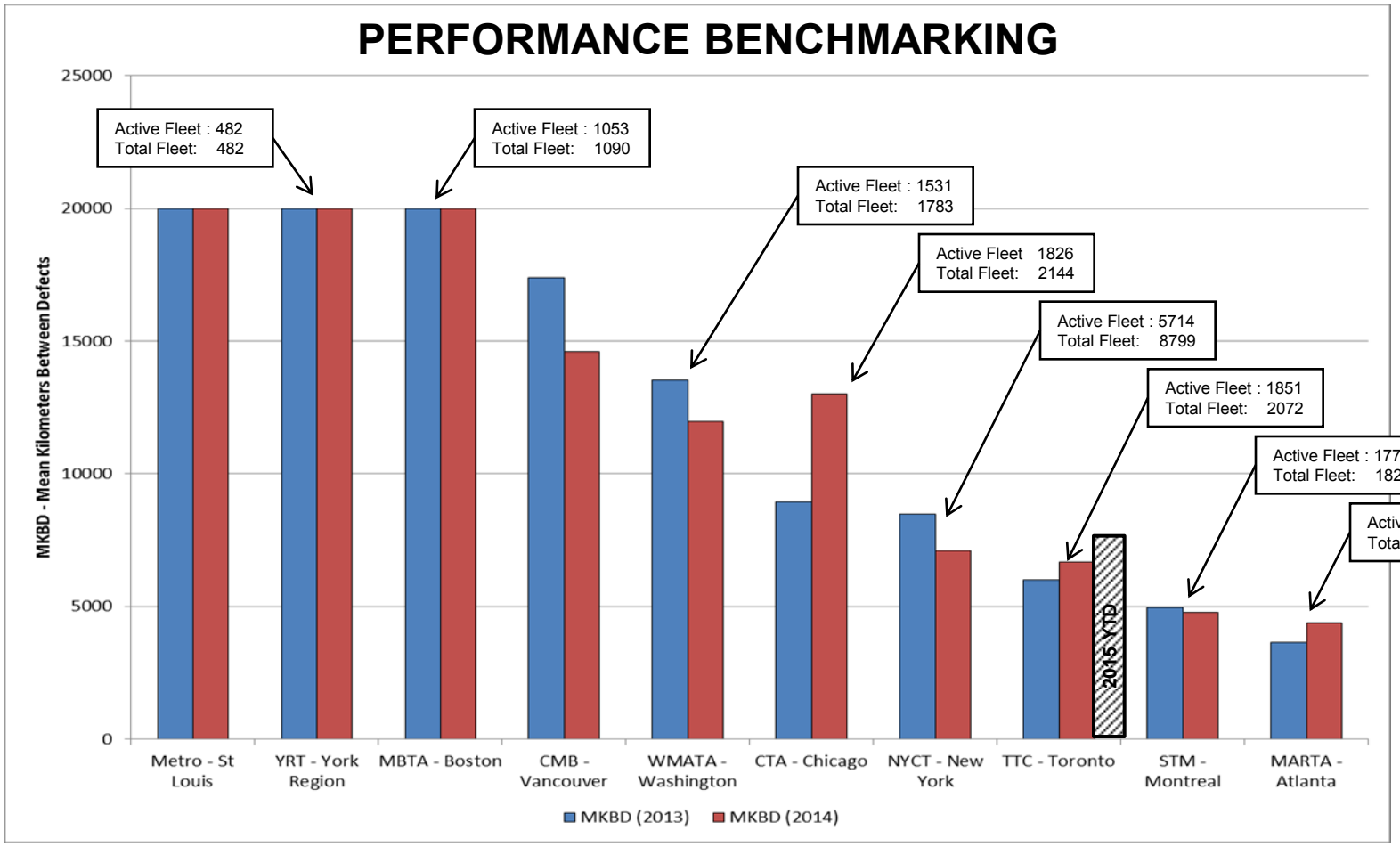


IMPROVE BUS RELIABILTY

RELIABILITY CENTERED MAINTENANCE

PROPOSED IN 2016-2025 BUDGET

BUS RELIABILTY IMPROVEMENT



BUS RELIABILITY IMPROVEMENT

- **Existing Maintenance Program**
  - Reactive Maintenance Program
  - 80% Corrective Maintenance / 20% Preventative Maintenance
  - "Fix On Fail"

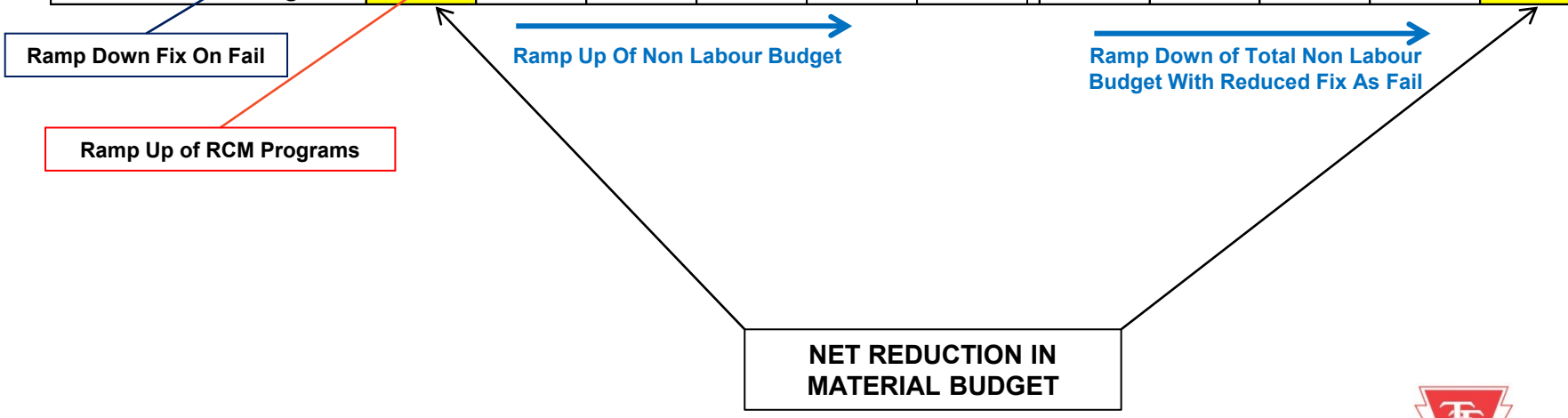
- **Best Practice / Opportunity**
  - Reliability Centered Maintenance (RCM)
    - Maintenance Based On Life Cycle Analysis
    - Planned Replacement Of Components Before Failure
    - 20% Corrective Maintenance / 80% Preventative Maintenance
    - Results In Less In Service Failures, Quicker Fault Diagnosis & Improved Vehicle Reliability
  - Oversight By Quality Assurance Section

BUS RELIABILITY IMPROVEMENT

Reliability Centered Maintenance (RCM)

- **Conversion From 'Fix on Fail' to RCM Requires Transition Of Material Budget**

	Fix On Fail to RCM Transiton Period Estimated Material $ (000,000)										
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Fix on Fail Budget	$52.0	$51.5	$51.5	$50.7	$50.4	$49.2	$47.8	$46.0	$40.8	$31.9	$21.0
RCM Program Budget	$0.0	$7.7	$15.0	$15.5	$15.9	$16.4	$16.9	$17.4	$17.9	$18.4	$19.0
Total Non-Labour Budget	**$52.0**	**$59.2**	**$66.5**	**$66.2**	**$66.3**	**$65.6**	**$64.7**	**$63.4**	**$58.7**	**$50.3**	**$40.0**



BUS RELIABILITY IMPROVEMENT

Reliability Centered Maintenance (RCM)

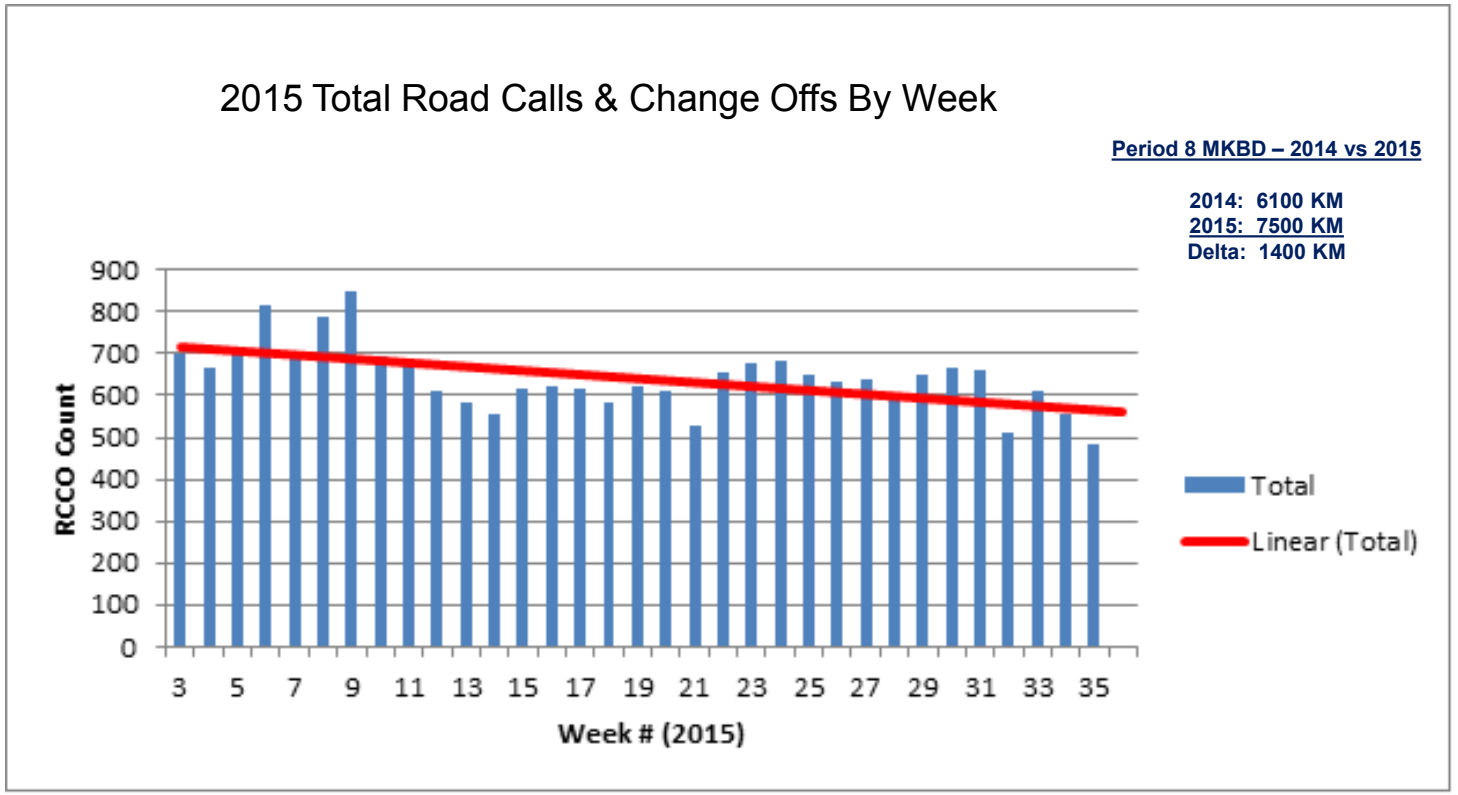
- **2015 RCM Programs – Start Up**
  - 405 Buses Heating System
  - 120 Buses Engine Cooling System

- **2016 RCM Programs – Planned**
  - 753 Buses Heating System
  - 217 Buses Air Conditioning System
  - 97 Buses Engine Cooling System
  - 1723 Buses Brake System

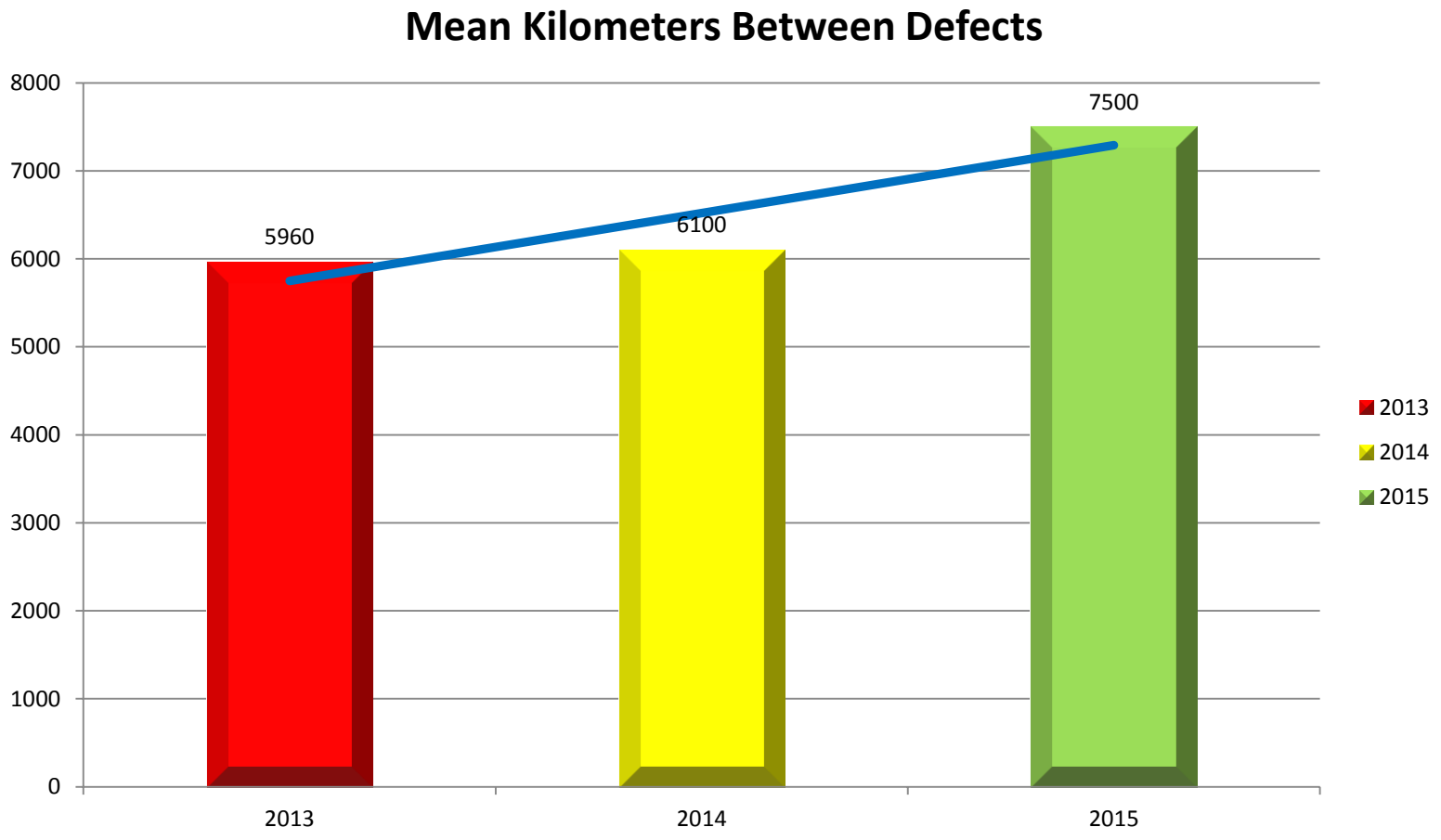
$7.7 M

BUS RELIABILITY IMPROVEMENT

Road Calls & Change Offs Trending



BUS RELIABILITY IMPROVEMENT



REVIEW OPTIMAL BUS REPLACEMENT STRATEGY

UNDER REVIEW FOR 2017-2026 BUDGET

BUS LIFE

Current Bus Life Policy

- 18 Year Bus Life Policy

- Policy Based On Past Funding Arrangement:
  - Provincial Government (~1970) To Fund 75% Of Bus Procurement
  - Funding Available Every 18 Years

- Bus Life Policies Vary Amongst Agencies:
  - US Agencies: 12-15 Years
  - Hamilton Transit: 12 Years
  - Mississauga Transit: 12 Years
  - Ottawa Transit: 15 Years
  - Montreal Transit: 16 Years
  - Brampton Transit: 18 Years

BUS LIFE

Optimal Bus Replacement Analysis

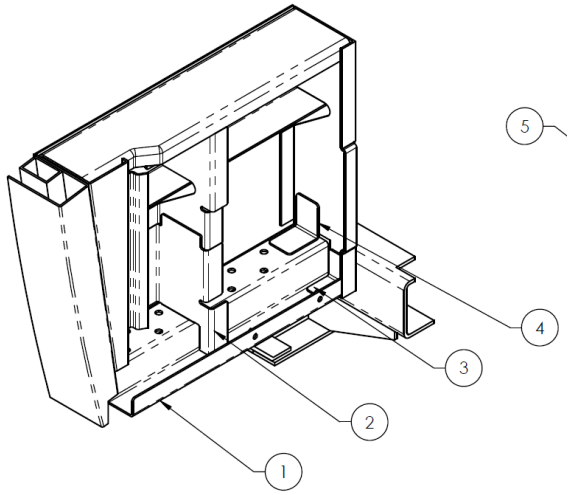
- United States Federal Transit Administration (FTA)
  - Provide Funds For Procurement At 12 Year Bus Life
- Booz Allen Hamilton Bus Optimal Life Study – August 2010
  - Recommended Replacement Of Buses At 12-15 Years
- Parsons Brinckerhoff (WSP Group) Bus Optimal Life Study – December 2015
  - Recommendation TBD

STRUCTURAL DETERIORATION 15–18 YEARS
(NOVA RTS BUS FLEET)

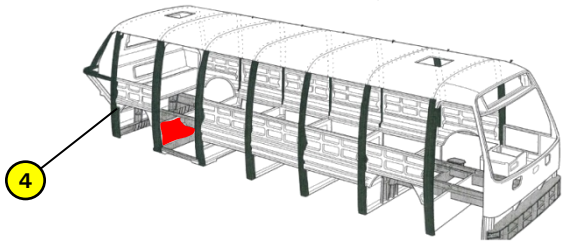
4 Exit Door Lift-U Bulkhead Repair

Exit door Lift-U bulkhead corroded and perforated.

Repair Details



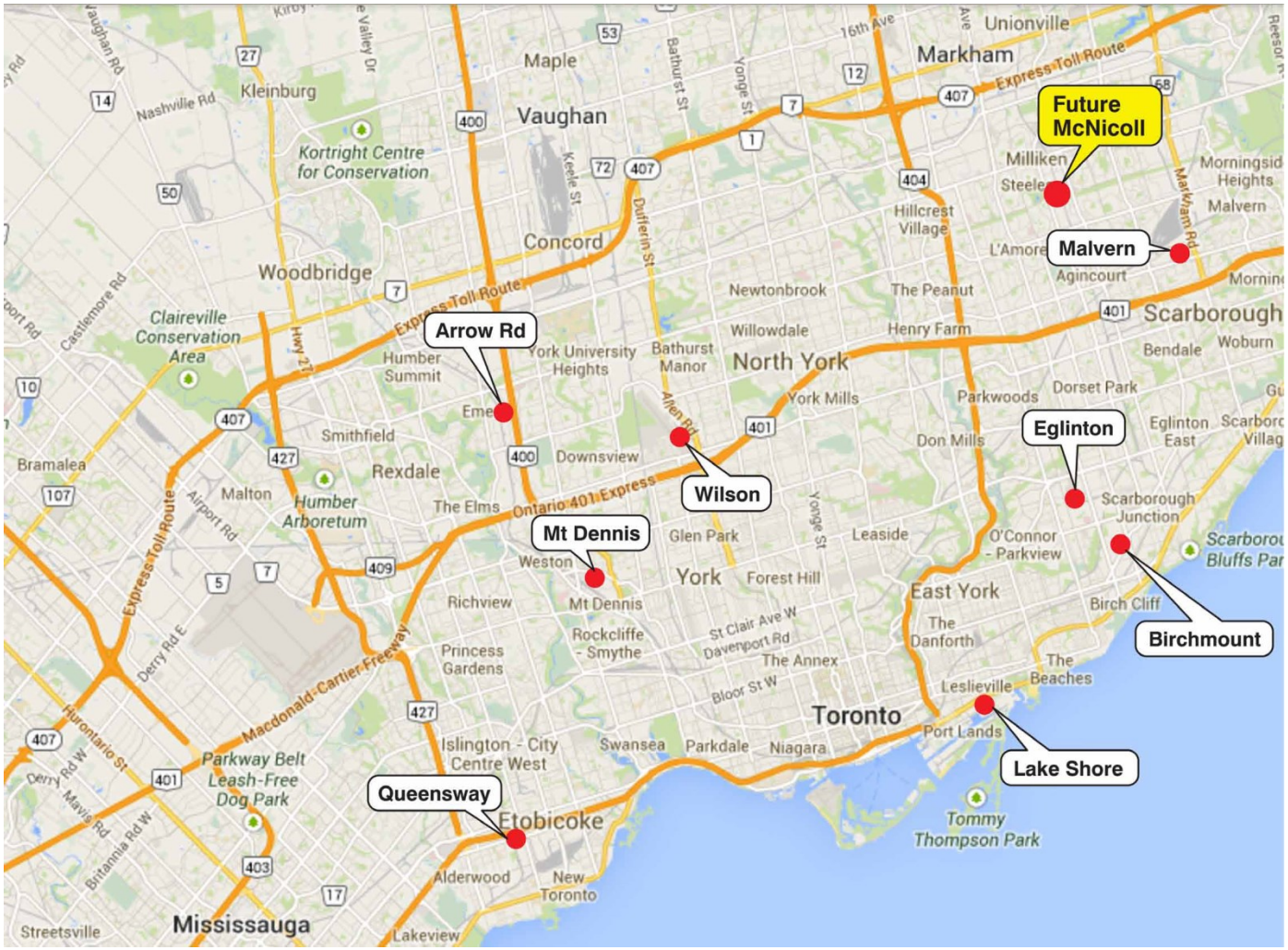
(1) Remove Lift-U unit
(2) Cut & remove corroded members
(3) Weld 4 reinforcement plates
(4) Re-install Lift-U unit



IDENTIFY ADDITIONAL FACILITY REQUIREMENTS

UNDER REVIEW FOR 2017-2026 BUDGET

TTC BUS FACILITIES

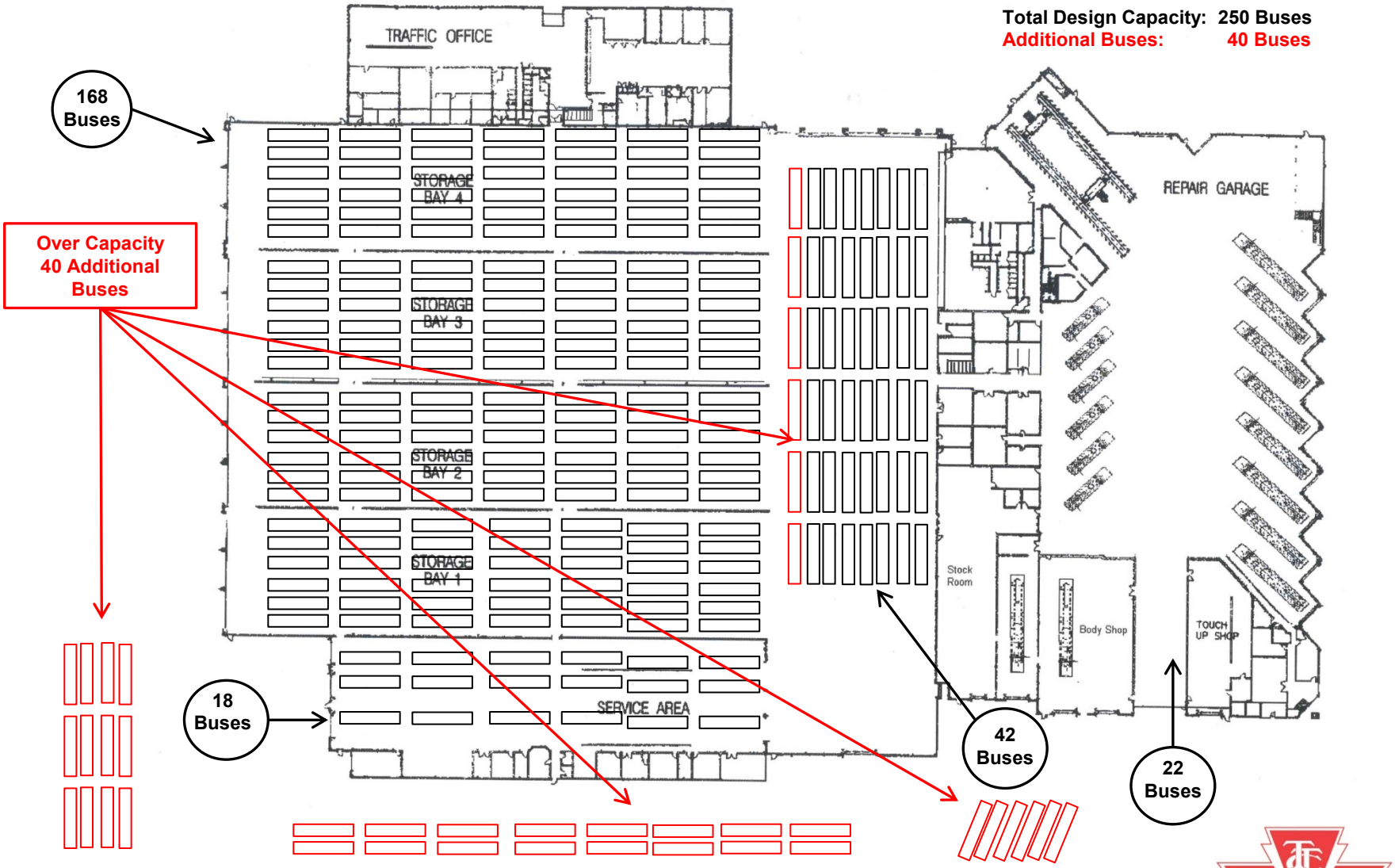


GARAGE DESIGN & DAILY MAINTENANCE ACTIVITIES

- Bus Garages Designed To Store & Maintain 250 Buses
- Hoist To Bus Ratio: 1 Hoist Per 12 Buses
- Daily Maintenance Activities (24 Hour Period):
  - 60 Buses For Inspections, Repairs & Servicing
  - 240 Buses For Cleaning & Fuelling

2016-2025 BUS FLEET & FACILITY PLAN

CURRENT MT DENNIS GARAGE OVERCAPACITY

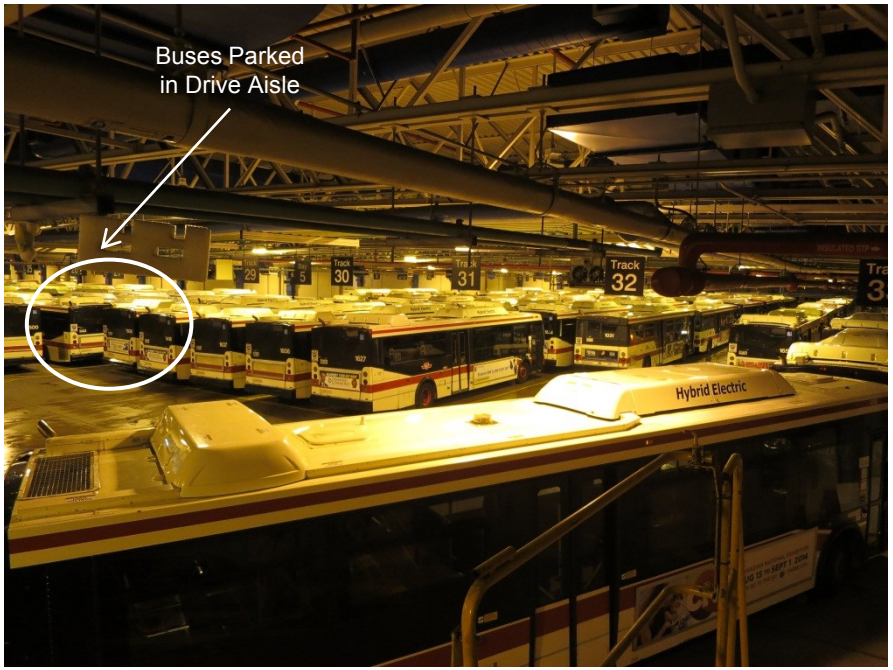


OVER CAPACITY

Storage Facility

Buses backed up in service line due to unavailability of parking

Overcrowding of buses in the storage bays – buses parked in circulation lanes



OVER CAPACITY

Impact to Operations

- **Maintenance Over Capacity**
  - Hoist To Bus Ratio Increased From 1:12 To 1:18
  - Reduced Hoist Time Leads To Increased 'Fix On Fail' Type Repairs
  - Reduced Vehicle Availability and Reliability.

- **Storage Over Capacity**
  - Parking In Bus Circulation Lanes & Exterior
  - Increased Jockeying Of Vehicles
  - Buses Late Out For Service – 5 To 10 Buses Per Garage Late Out For Service By More Than 20 Minutes Per Day
  - Maximum Fleet Size Reached
  - Maximum Safe Operating Capacity of Existing Bus Garages Reached

OVER CAPACITY

Impact to Service

- **2016**
  - Maximum Bus Fleet Size Reached
  - Overall Garages Reduced Reliability
    - Increase In Vehicle Breakdowns In Customer Service
  - Overall Garages Reduced Efficiency
  - Not Able To Meet Increase In Customers
    - Customer Wait Times Increase
    - Customers Bypassed Increase
    - Increase in Short-Turns
    - Reduce Customer Satisfaction
- **2017+**
  - No Increase In Bus Fleet
  - Overall Garages Further Reduce Reliability
  - Not Able To Meet Increase In Customers
    - Customers Wait Times Increase Dramatically
    - Customers Bypassed Increase Dramatically
    - Unable To Mitigate On Street Construction Projects
    - No New Service Initiatives (Express, Peak Improvements, etc.)
    - Dramatically Reduced Customer Satisfaction

OVER CAPACITY

Impact to Customers

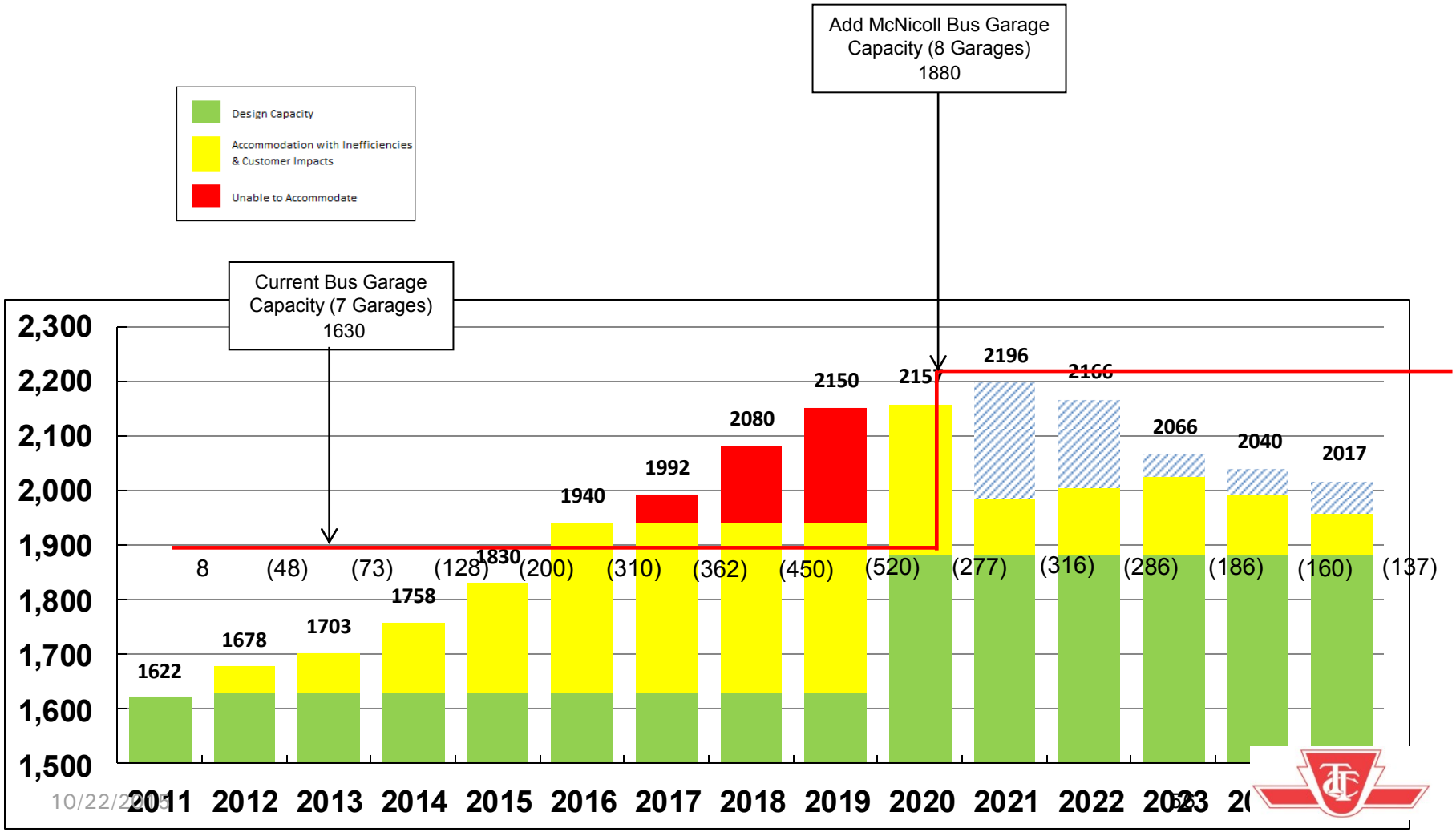
- Increased Customer Crowding on Buses
- Longer Wait Times
- Increased Gapping and Bunching
- Increased in Customers Changed Off and Loading
- Reduction in Customer Satisfaction

Followed By Ridership Reductions

2016-2025 BUS FLEET & FACILITY PLAN

OVER CAPACITY

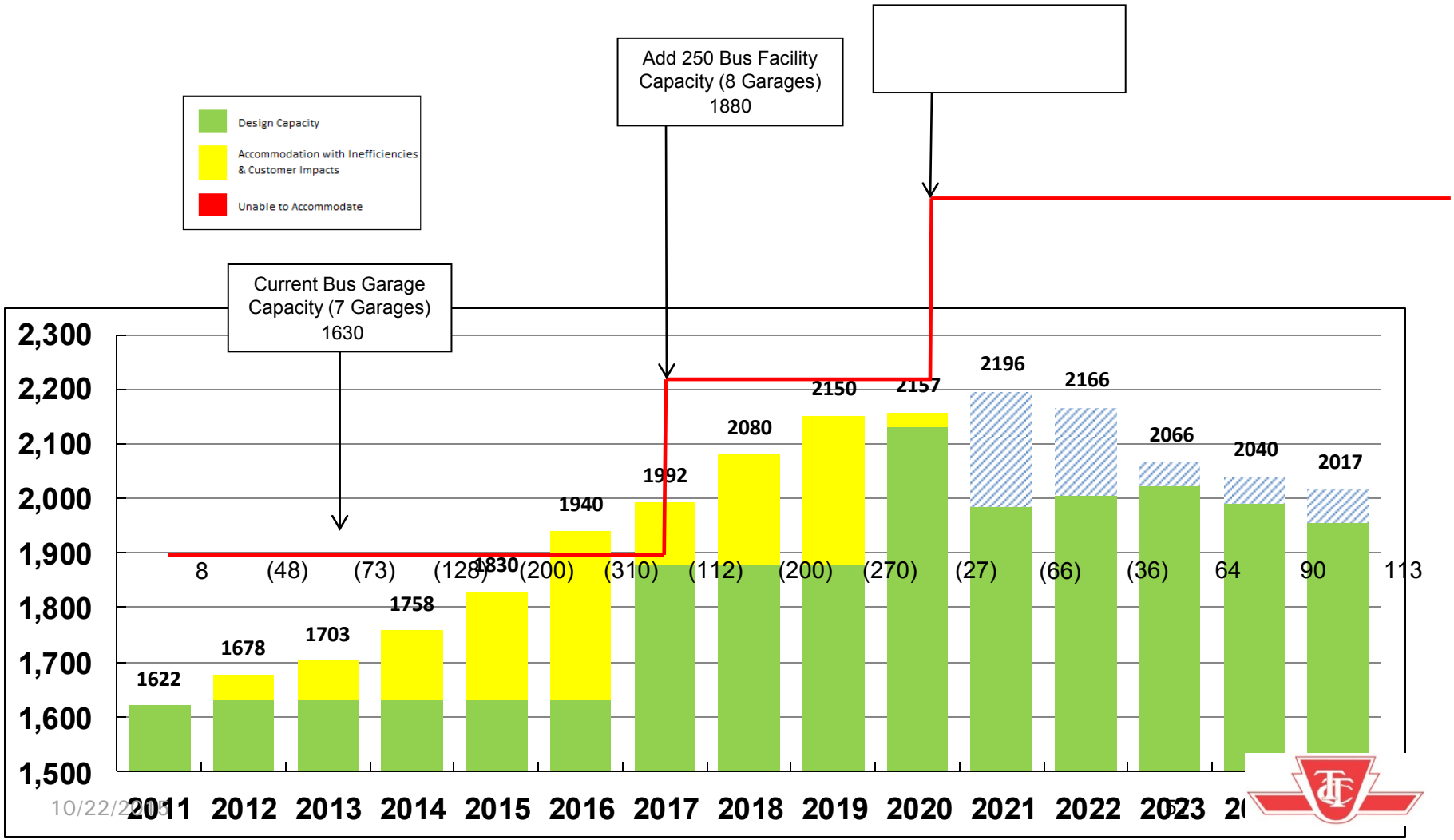
Bus Facility Plan - McNicoll Bus Garage 2020



2016-2025 BUS FLEET & FACILITY PLAN

OVER CAPACITY

Bus Facility Plan - Interim Garage 2017 & McNicoll Garage 2020



2016-2025 BUDGET PROPOSAL SUMMARY

RECOMMENDATION

2016-2024 Capital Budget:

1. Steady State Procurement (SSP) & Bus Spare Ratio — $177M
   - Accelerate SSP
   - Modernize Fleet & Accelerate SSP (224 New Buses)
   - Maintain 18% Bus Spare Ratio
2. Hybrid Buses — ($93M)
   - Retire 255 Hybrid Buses Early (2017-2021)
3. Bus Overhaul Schedule — ($48M)
   - Realign Diesel Overhaul Schedule & Eliminate Hybrid Overhaul Program

Net Impact — $ 36M

- Increase Over 10 Year Window

RECOMMENDATION

2016-2024 Operating Budget:

1. Vehicle Reliability:
   - Implement Reliability Centered Maintenance $7.7M

Net Impact **$7.7M**

- 0.04% Increase From Total 2015 Operating Budget

END