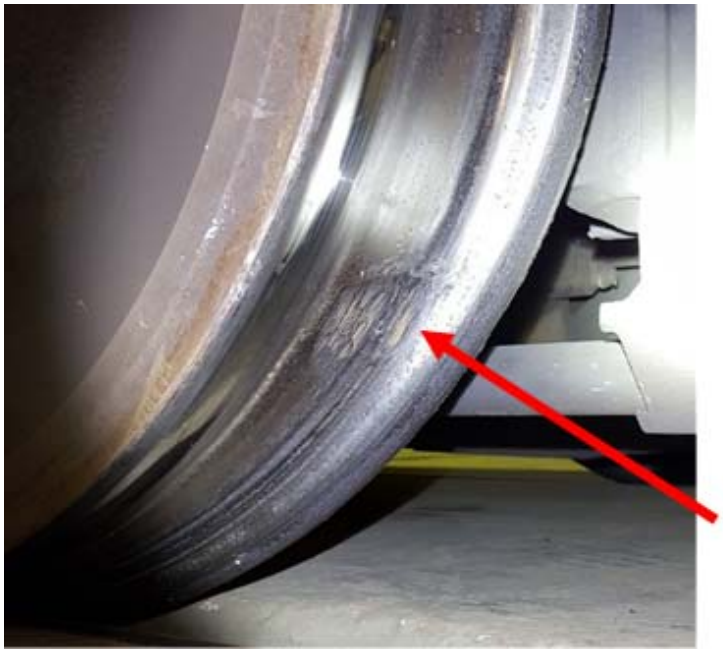
Subway Line 2 Wheel Flats

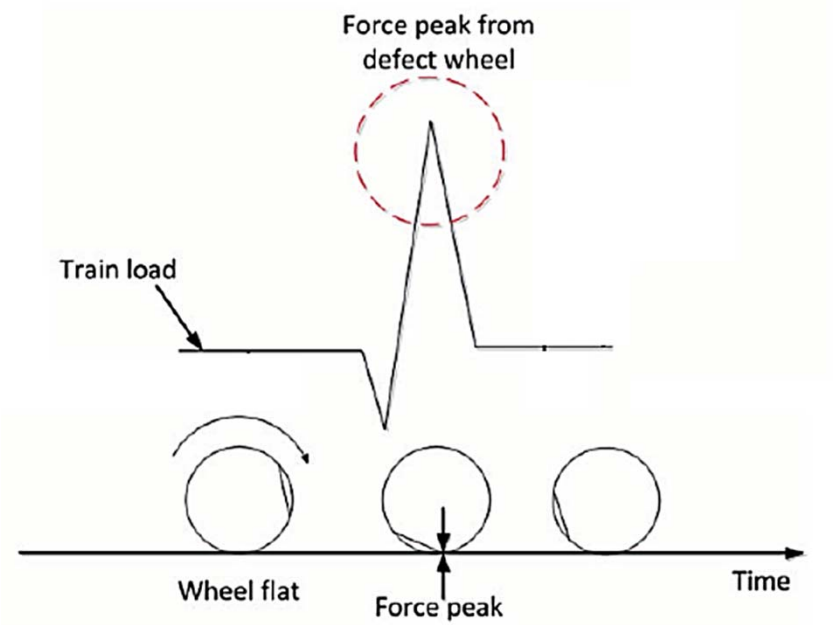
Status Update

Toronto Transit Board Meeting
July 10, 2019

Richard Wong – Acting Chief of Vehicles
Fort Monaco – Chief of Infrastructure

Wheel Flats





- Wheel Flats Have A “Thumping” Sound & Generates Vibration
- Larger The Flat:
  - Louder the Thumping Sound
  - Greater the Vibration

Wheel Flats

- Expected In Rail Industry
- Average Backlog
  - 15 Cars or 2.5 Trains (4% of Total Fleet)

- More Common In Autumn (Seasonal Trend)
- Increase in Backlog
  - 30 Cars or 5 Trains (8% of Total Fleet)

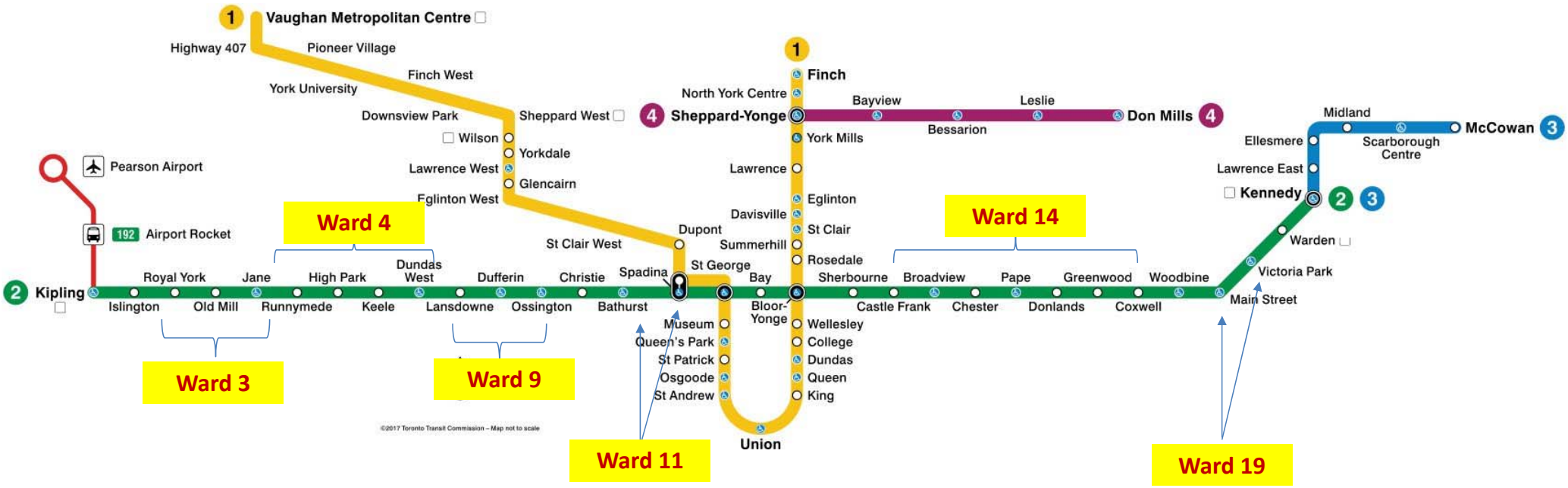
LINE 2 SERVICE REQUIREMENTS

- 45 Trains – Required for Service
- October 2018 – 90% of Fleet had Moderate to Severe Flats
- Impact to Service & to Community

Impact To Community

- Starting in October 2018, an **extraordinary increase** in subway noise and vibration complaints received across Line 2.
- This situation was not limited to one specific section of the subway network.
- Wheel flats were not a prominent source of complaints prior to October 2018.

Impact To Community



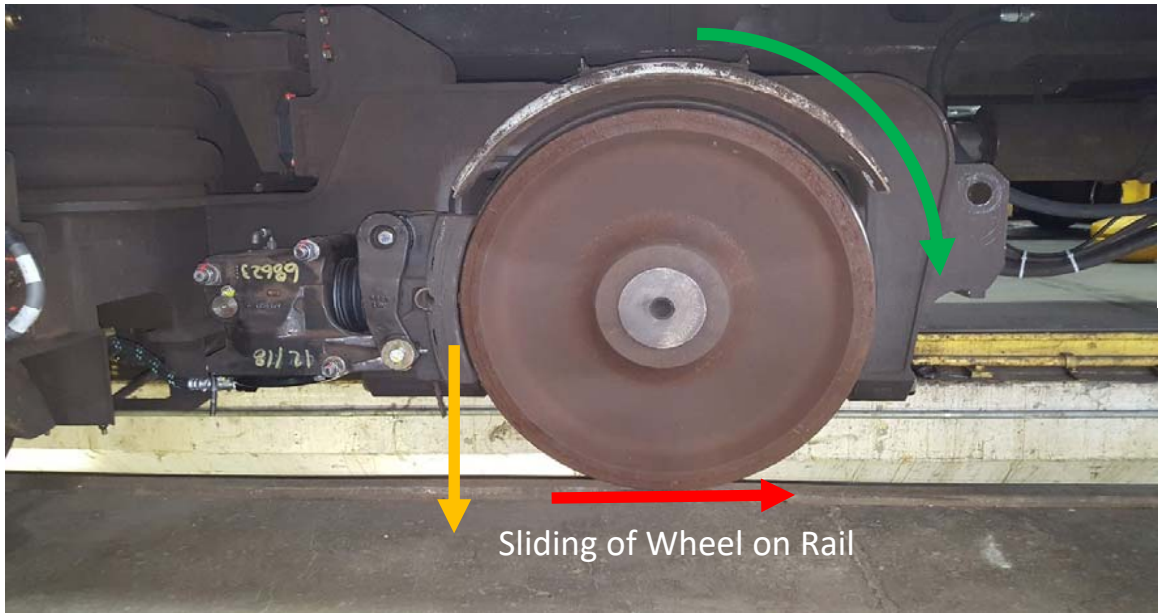
6 Wards Affected By Noise & Vibration
More than 200 Complaints Received By Affected Residents

Communications with Residents

- Some residents welcomed or requested a visit by TTC staff to observe subway operations in their home.
- Wheel flat information was posted on the TTC website.
- Updates including a fact sheet and overview PDF was also posted online.
- Updates were provided to affected residents and local councillors.

Flats – Causes of Wheel Flats

- Metal on metal sliding action:
  - *Low traction* rail conditions and
  - *Emergency Brake (EB) application*



Loss of traction and no wheel rotation (EB Brake) will results in wheel sliding along the track to create flat spots

Causes of Low Traction

- Wet rail, leaves, snow, and over-lubrication can cause areas of low traction.

Causes of Emergency Brake (EB) Applications

- **Operator Induced**
- **Speed Control System (SCS) Induced:**
  - Spin/Slide (Similar to traction control in automobiles)
  - Over Speed (Similar to speed governor in automobiles)
  - Signal Violation (Similar to collision avoidance system in automobiles)

Flats - Wheel Monitoring System

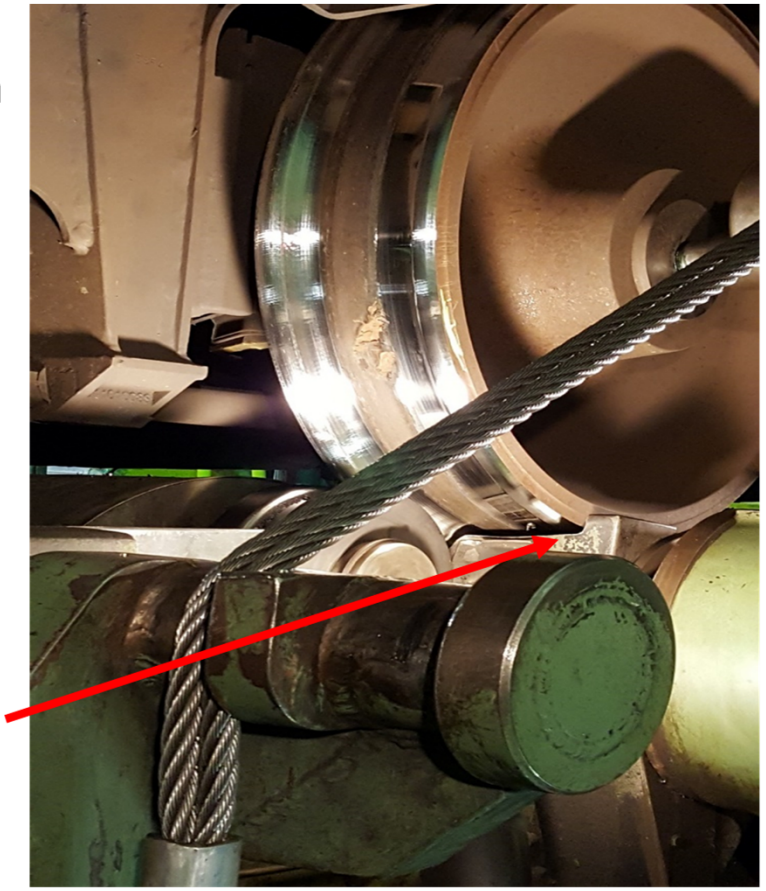
AURA Wheel Flat Detection System

- Installed on Line 2 in 2012 and Line 1 in 2015
- Early warning detection system
- AURA identifies axles and color codes according to severity of wheel flat (RED = Most Severe)
- Trains with red flats are the most severe and are removed from service

Repairs for Wheel Flats

- Wheels are ‘machined true’ to remove flats and return them to round
- Maximum of 6 axles (12 wheels) can be cut per 8 hr shift
- New wheel diameter = 28”
- Condemnation diameter = 25.375”
- Average Life = 4 Years (T1 Fleet)
- TTC has 2 wheel turning machines for subway vehicles located at Greenwood Carhouse and Wilson Carhouse

Wheel Cutting Machine



Investigation

- Investigation commenced January 2019
- Multi-disciplined investigative team due to wheel/track/operator interface
- Departments involved:
  - *Rail Cars & Shops (Vehicle Maintenance)*
  - *Subway Infrastructure (Track)*
  - *Subway Transportation (Operators)*
- Lead Investigator – National Research Council of Canada (NRCC)
- Investigation:
  - *Data driven*
  - *Inspection of assets*
  - *Process of elimination*

Investigation

Vehicles:

- ✓ *Inspection of wheels*
- ✓ *Inspection of brake pads*
- ✓ *Testing of acceleration & brake rates*
- ✓ *Review of data for propulsion faults*
- ✓ *Review of data for EB applications*

Track:

- ✓ *Inspection of rail*
- ✓ *Inspection of way side lubricators*
- ✓ *Inspection of speed control system*

Action Items

Vehicles:

- ✓ *Investigation – re-design of master controller*
- ✓ *Replacement of brake pads*
- ✓ *Installation of vibration sensors on bogies/trucks*

Operators:

- ✓ *Supervisor audits*
- ✓ *Reminder campaigns*

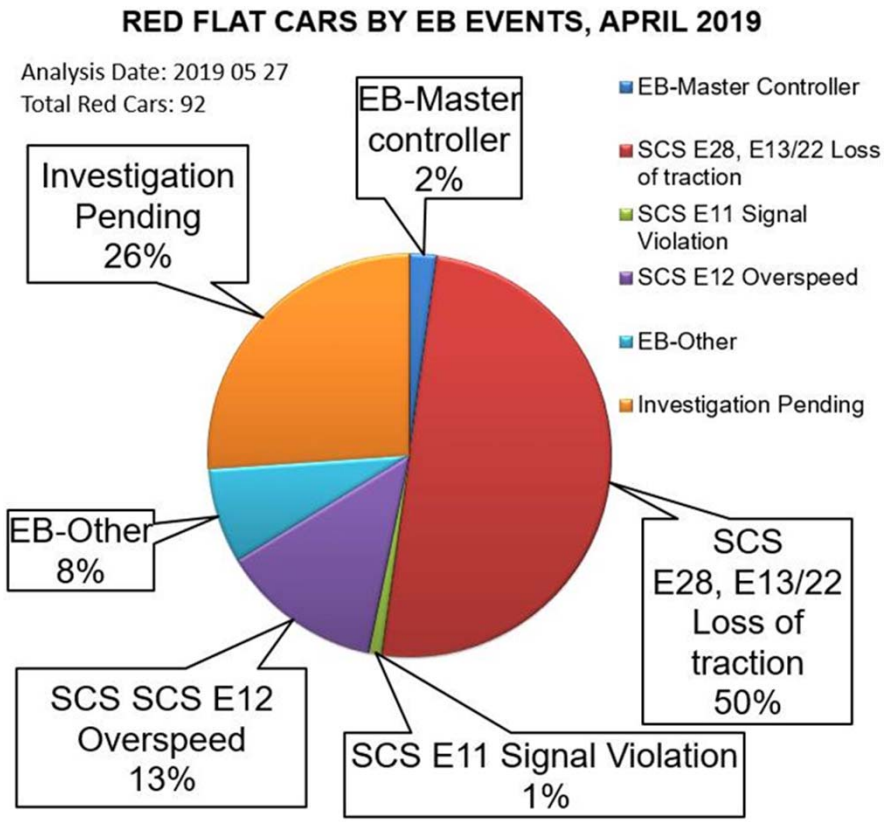
Track:

- ✓ *Cleaning of rail*
- ✓ *Turning off of lubricators – to eliminate grease as significant contributor*
- ✓ *Testing of top of rail friction modifier*
- ✓ *Added SCS and Un-Equipped Mode (UEM) tags*
- ✓ *Implementation restricted speed zones*

Other:

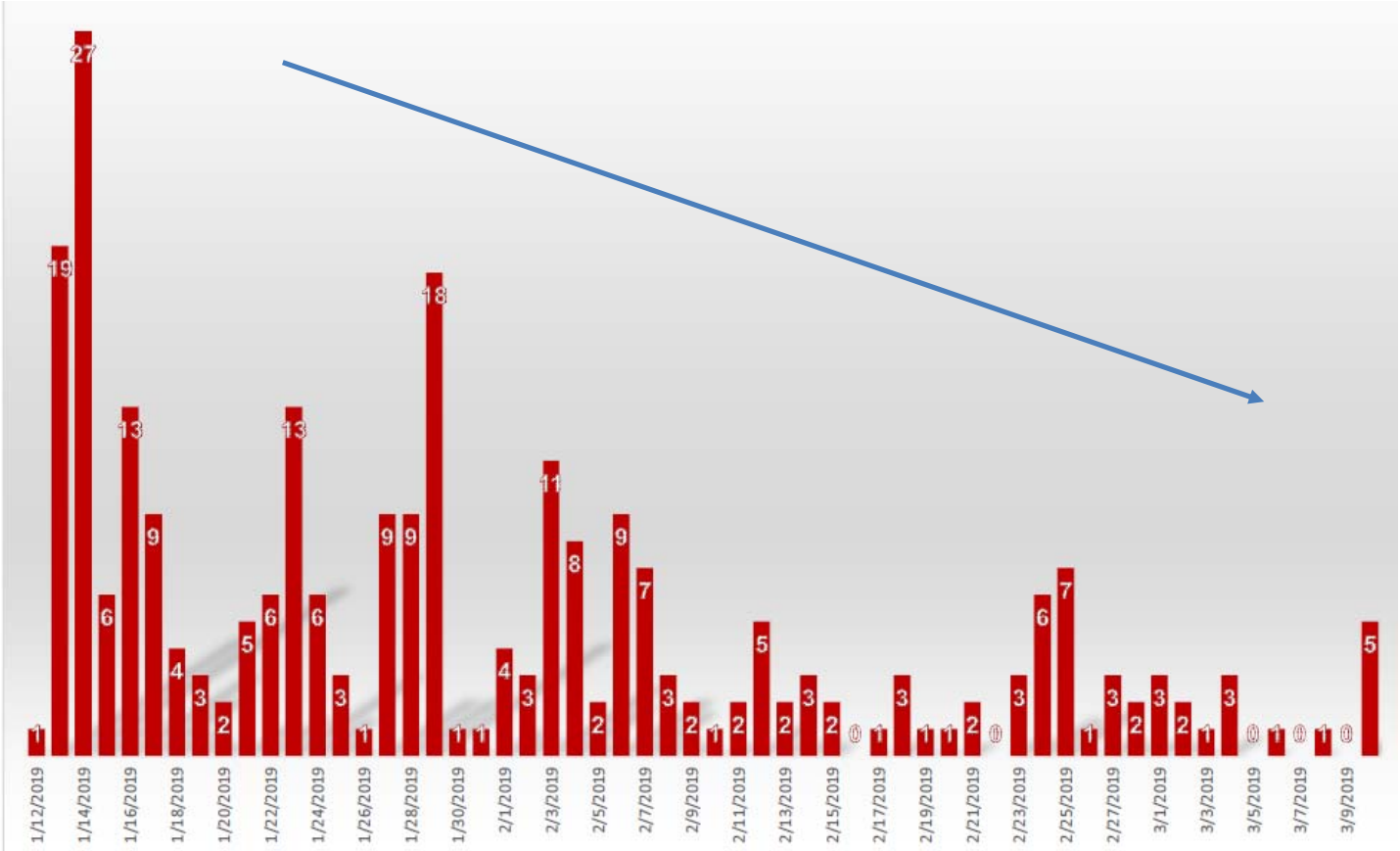
- ✓ *Consulted with peer agencies*
- ✓ *Hired Network Rail to assist with investigation*

Observations & Results – EB Applications



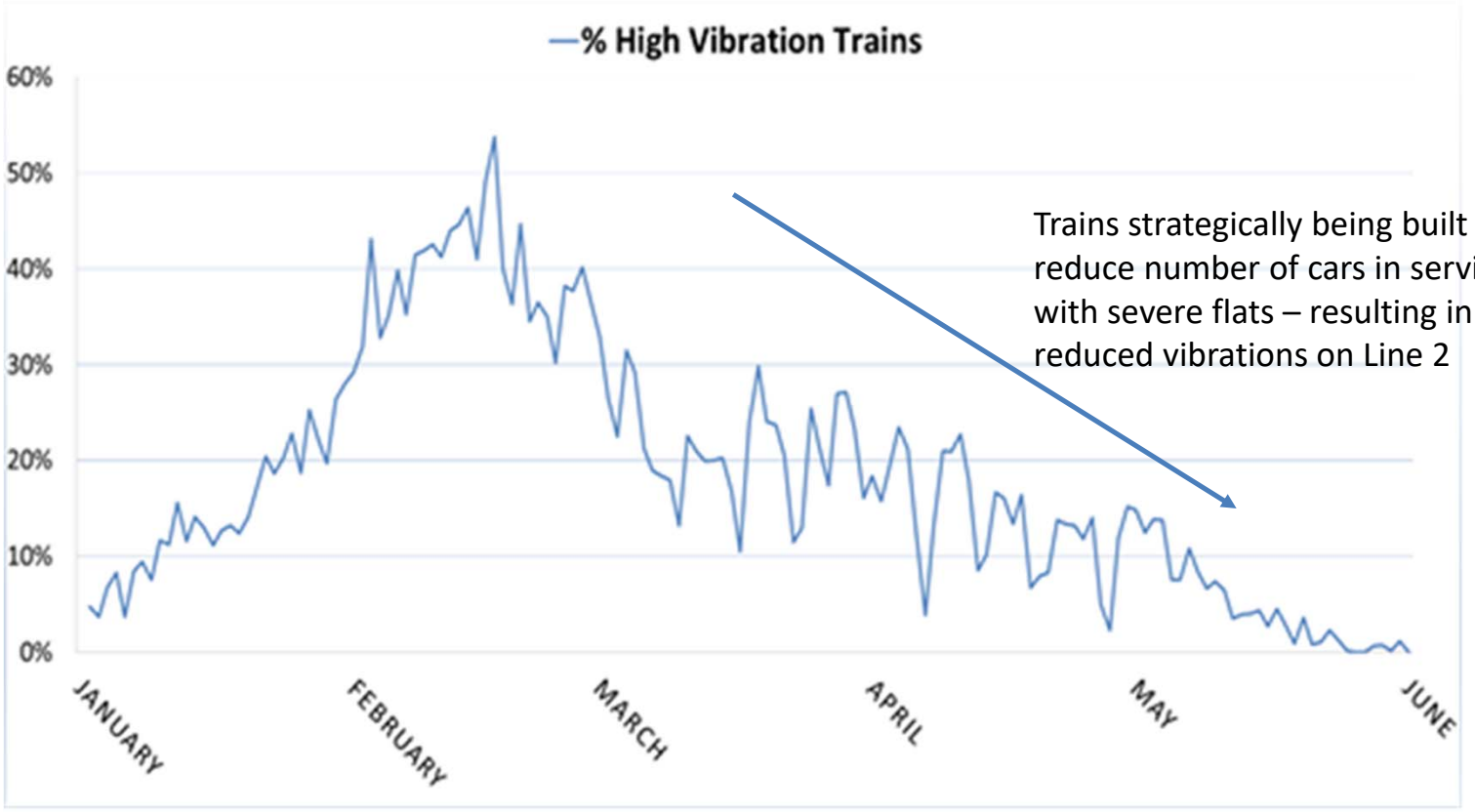
- EB applications monitored and reduced on some SCS codes
- Subway Infrastructure Engineering investigating potential improvements to SCS software

Observations & Results _ Wheel Flats

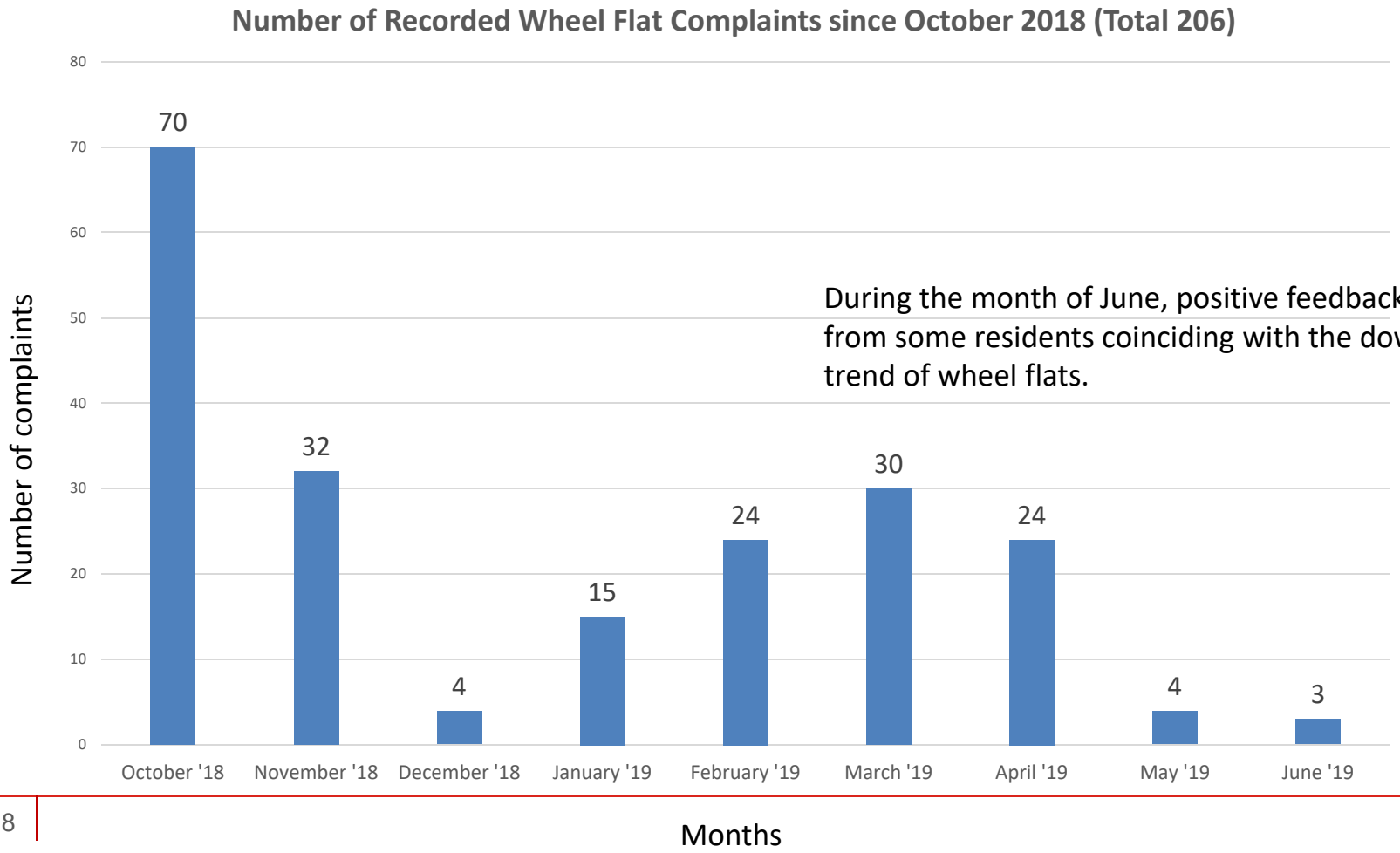


- Downward trend in wheel flats – 16 cars as of July 9, 2019
- No trains in service with moderate or severe flats

Observations & Results _ Vibration from Trains on Line 2



Observations & Results - Community



During the month of June, positive feedback received from some residents coinciding with the downward trend of wheel flats.

Action Plan

- Continue with action items already implemented
  - *Testing of brake pad materials*
  - *Installation of mobile sensors on bogies/trucks for additional data collection*
  - *Cleaning of rail*
  - *Replacement of lubricators and testing of top of rail friction modifiers*
  - *Operate in accordance to weather conditions*
  - *Add additional SCS tags*

- Evaluate feasibility of recommended action items provided by NRC
- Continue investigating potential design improvements to:
  - *Master Controller*
  - *Speed Control System*

Questions?