PERFORMANCE-BASED
PRACTICAL DESIGN

Decision Process for Dynamic Operation of Part-Time Shoulder Use

National Operations Center of Excellence Webinar
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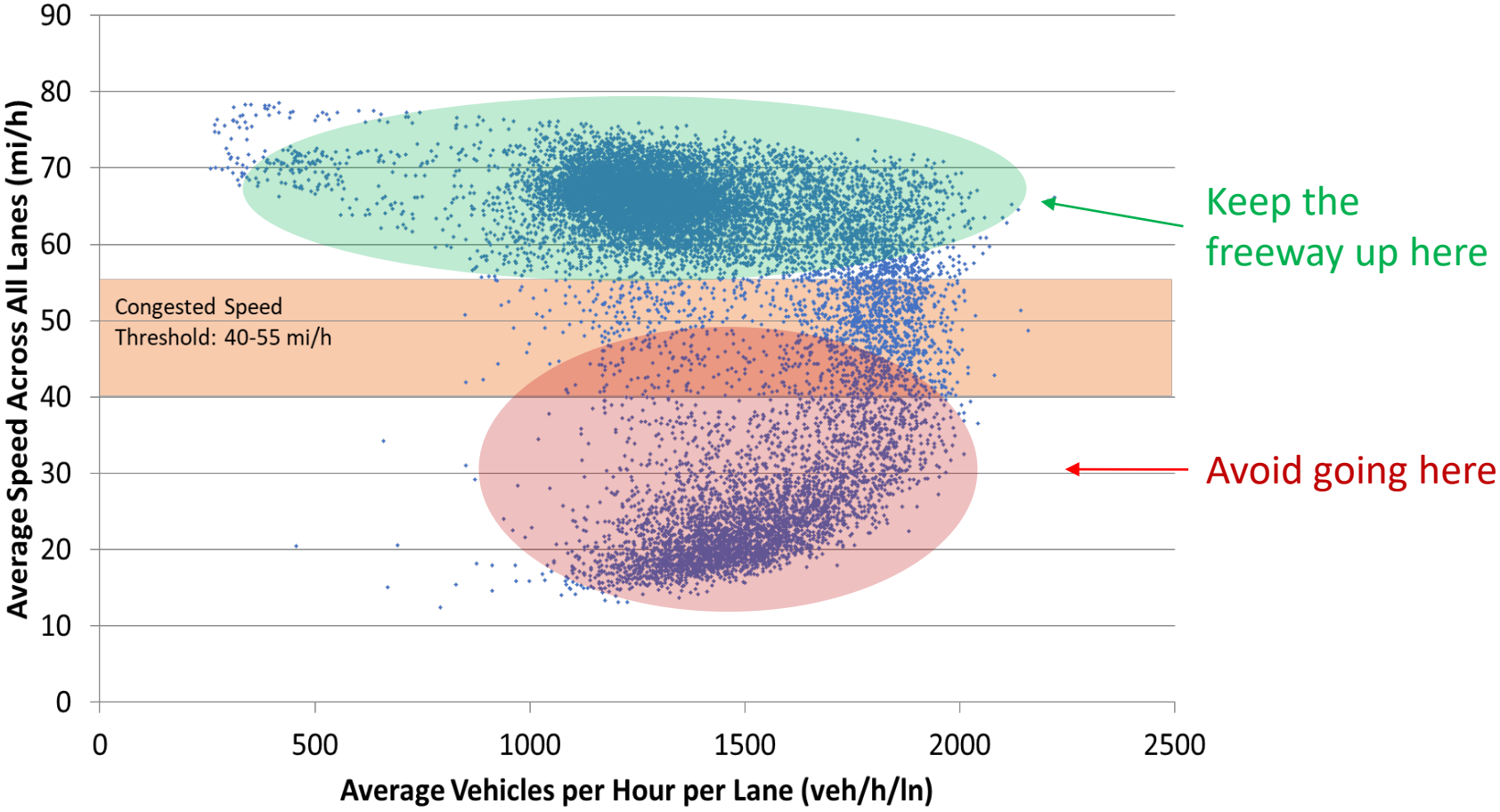
U.S. Department of Transportation
Federal Highway Administration

Office of Operations
Federal Highway Administration
1200 New Jersey Avenue SE
Washington, DC 20590

Project Objectives

- Inform agencies on Dynamic Part-Time Shoulder Use (D-PTSU) practices.
- Prepare document with “Decision Processes” for D-PTSU.
  - What factors should be considered before opening or closing a shoulder?
  - How can the optimal times to open and close the shoulder be determined?
  - Publication expected Summer 2019.

Reducing Congestion with D-PTSU



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Opening and Closing Considerations?

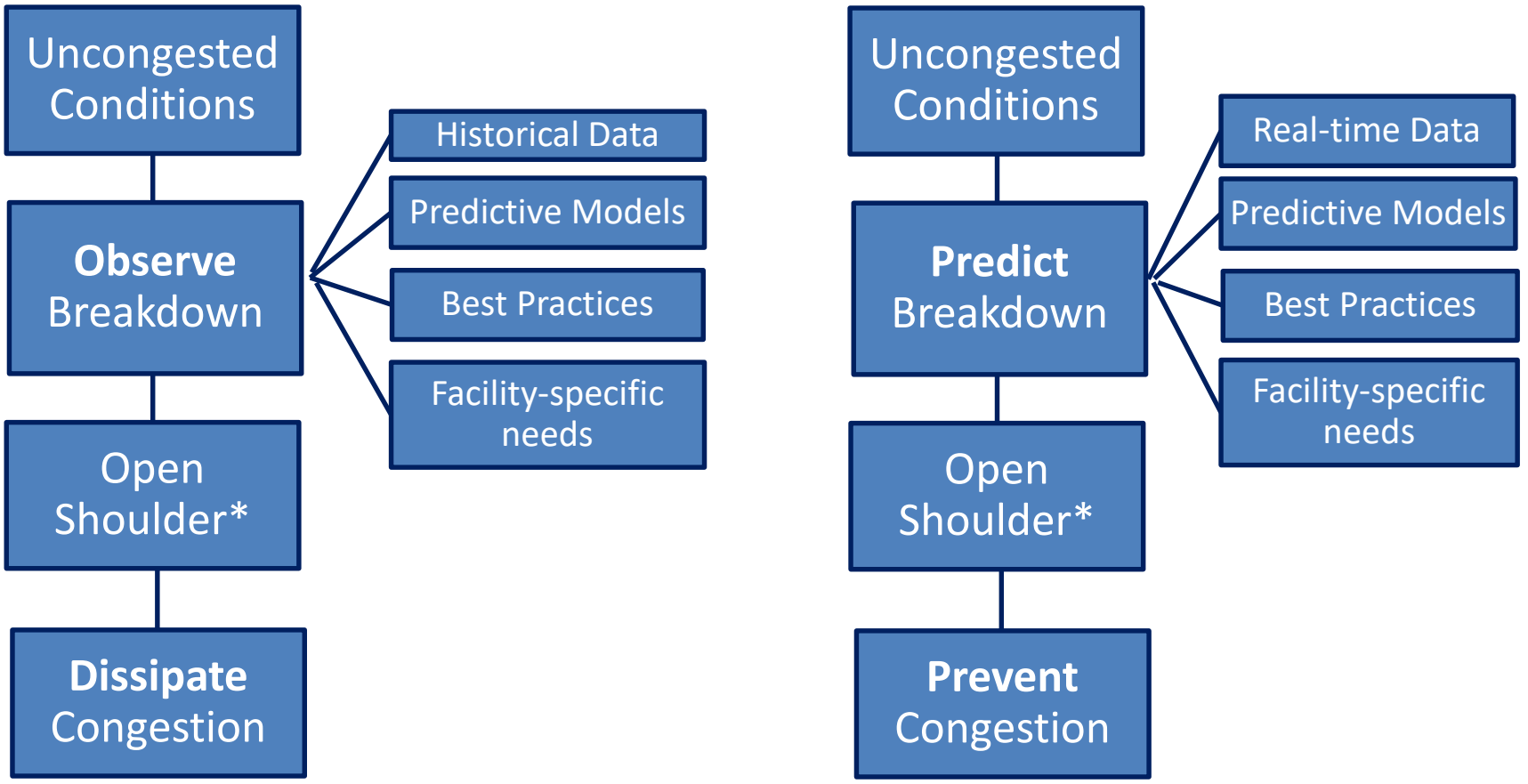
Engineering Considerations:

- Existing and future traffic performance metrics (e.g., speed, volume, occupancy).
- Air quality, noise impacts, and potential benefits.
- Facility characteristics, including upstream and downstream (lane drops, ramps, etc.).
- Typical daily traffic patterns and composition.
- Safety considerations and the importance of returning a shoulder use lane back to a traditional shoulder when not needed operationally.

Policy Considerations:

- Public acceptance, traveler expectations, and avoiding confusion with frequent opening and closing patterns.
- Maintenance considerations.
- Incident and emergency response scenarios.
- Enforcement considerations.
- Left versus right shoulder considerations.
- Availability of Advanced Traffic Management (ATM) and Intelligent Transportation System (ITS).

Concept of Operational-Based Considerations



*Assuming there are no issues with maintenance, law enforcement, environmental conditions, etc.

Levels of Part-Time Shoulder Use (PTSU)

Level	Title	Description
0	No PTSU	Shoulder is never opened
1	Static PTSU	Fixed hours of operation
2	Dynamic PTSU with core hours and scheduled variation	Shoulder is opened to traffic during recurring "core" hours and days of the week and may also be opened outside of those core hours in a scheduled, pre-determined manner for special events or seasonal variations.
3	Dynamic PTSU with core hours and unscheduled variation	Shoulder is opened to traffic during recurring "core" hours and days of the week and may also be opened outside of those core hours in response to real-time or anticipated traffic conditions.
4	Fully Dynamic PTSU	Shoulder is opened and closed purely in response to or in anticipation of traffic congestion, demand surges, events, incidents, weather, maintenance needs, incident management needs, and enforcement needs. There are no "core" hours and days of the week when the shoulder is always opened regardless of traffic conditions.

- Increasing real time responsiveness to traffic and open/close decisions.
- Increasing agency capabilities and maturity.

Concept of Operations

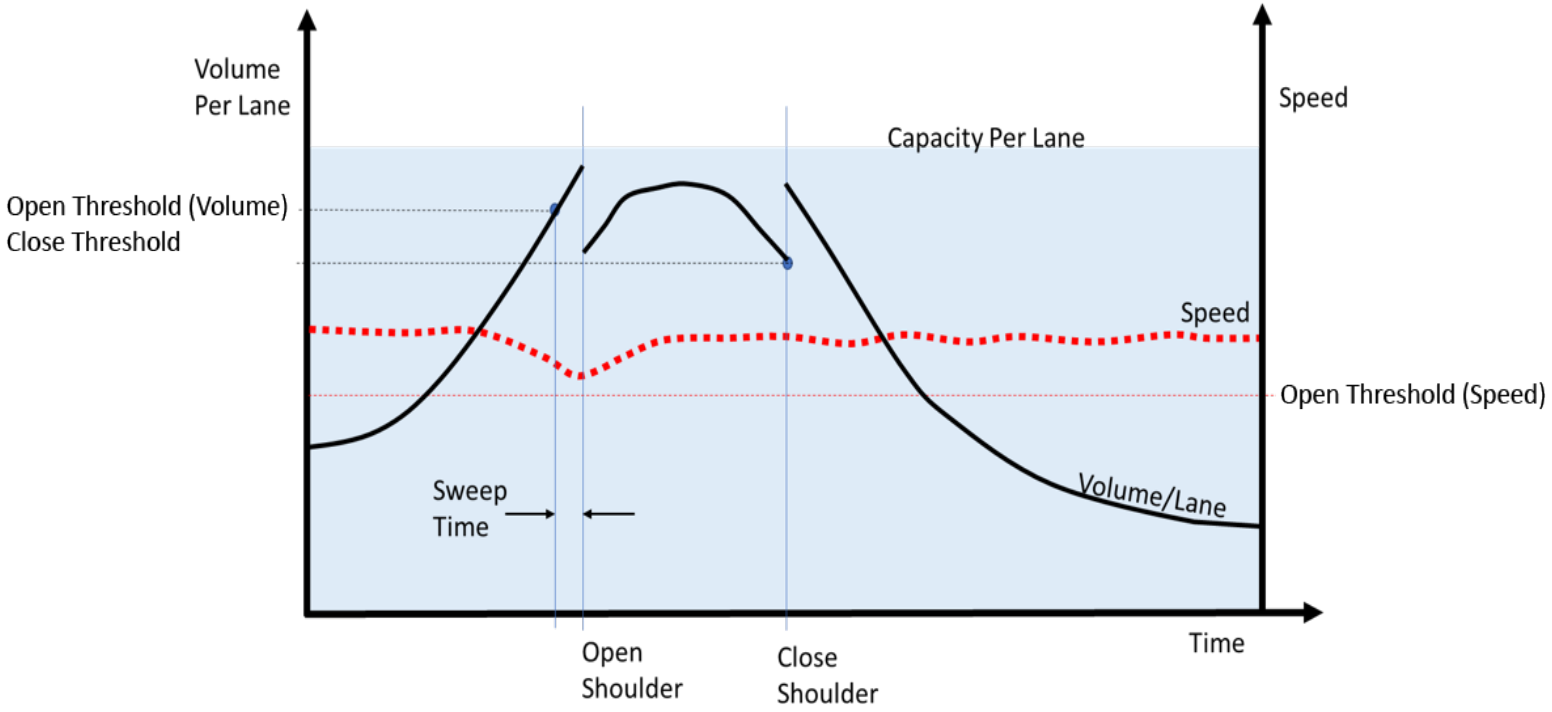
Concept of Operations (ConOps) documents for planning PTSU facilities:

- Objectives and performance measures.
- Assumptions and constraints.
- Processes and protocols.
- Related ATM treatments.
- Conceptual traffic design (i.e. sign layouts).

Basis of Open/Close Decisions

- Volume Thresholds:
  - More predictive.
  - As volume nears breakdown levels, open shoulder soon enough to prevent breakdown.
  - Requires sensor data.
  - Preferred, but can be challenging.
- Speed Thresholds:
  - More reactive.
  - As breakdown begins to occur and speed decreases, open shoulder and congestion should dissipate.
  - Could use probe data.
  - Always appropriate to use, even if “backup”.

Conceptual Volume and Speed-Based Decisions



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- Daily with real-time data.
- During planning and design of new PTSU facility with historical data.

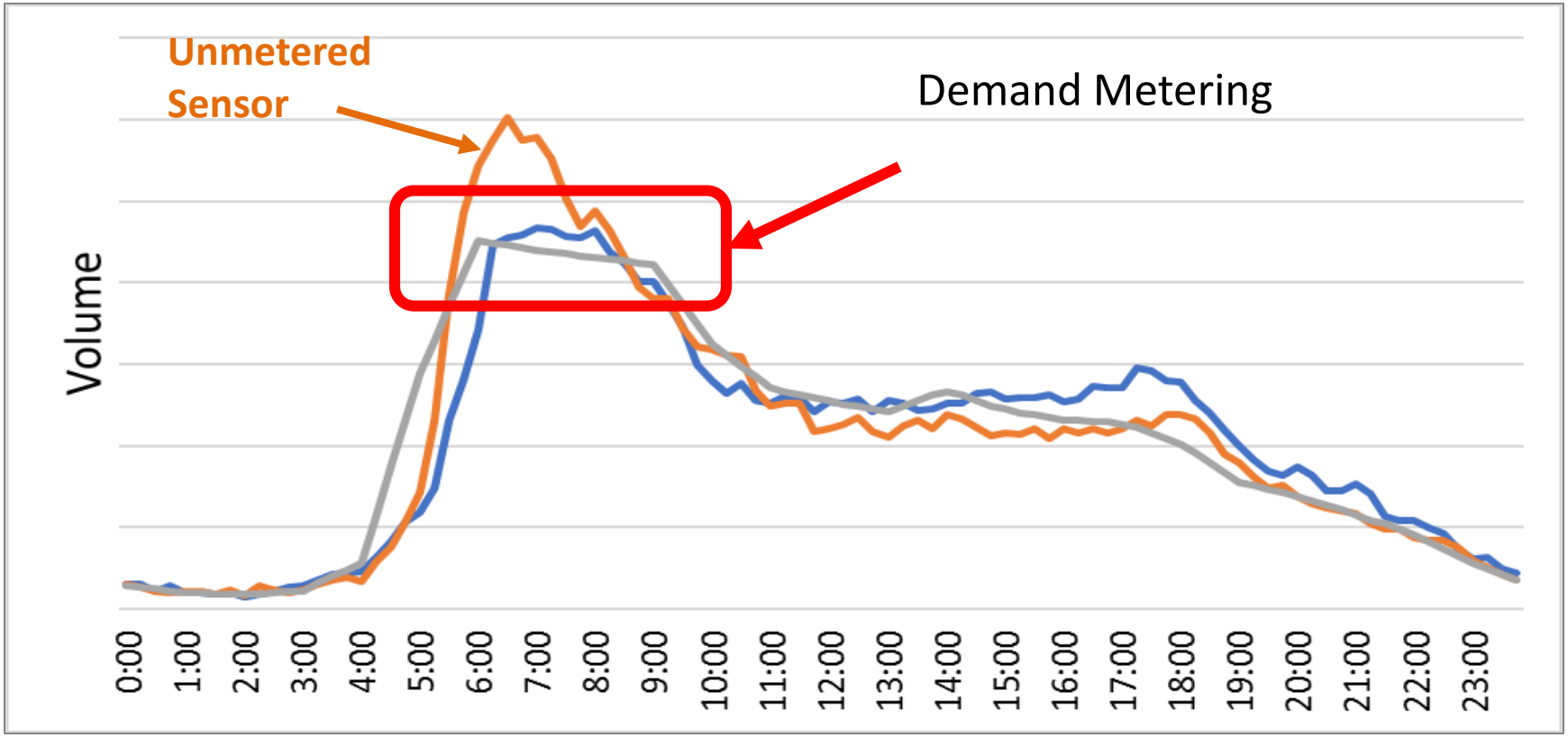
Techniques for Developing Opening Thresholds

- **Demand-to-Capacity Patterns** – Assess historical demand profiles to determine levels of congestion relative to the available facility base capacity, as well as the expected capacity with shoulder use.
- **Empirical Performance Data** – Determine frequency and pattern of breakdown events with whole year traffic data.
- **Macroscopic Optimization –** Using the Highway Capacity Manual (HCM) freeway facilities method/FREEVAL software, analyze different speed and volume thresholds for opening a specific facility.
- **Microscopic Refinement –** Similar to macroscopic optimization, but with a microsimulation model.
- **Monitoring and Adjustment –** Operators use experience to adjust thresholds above in real-time.

How to Use Thresholds

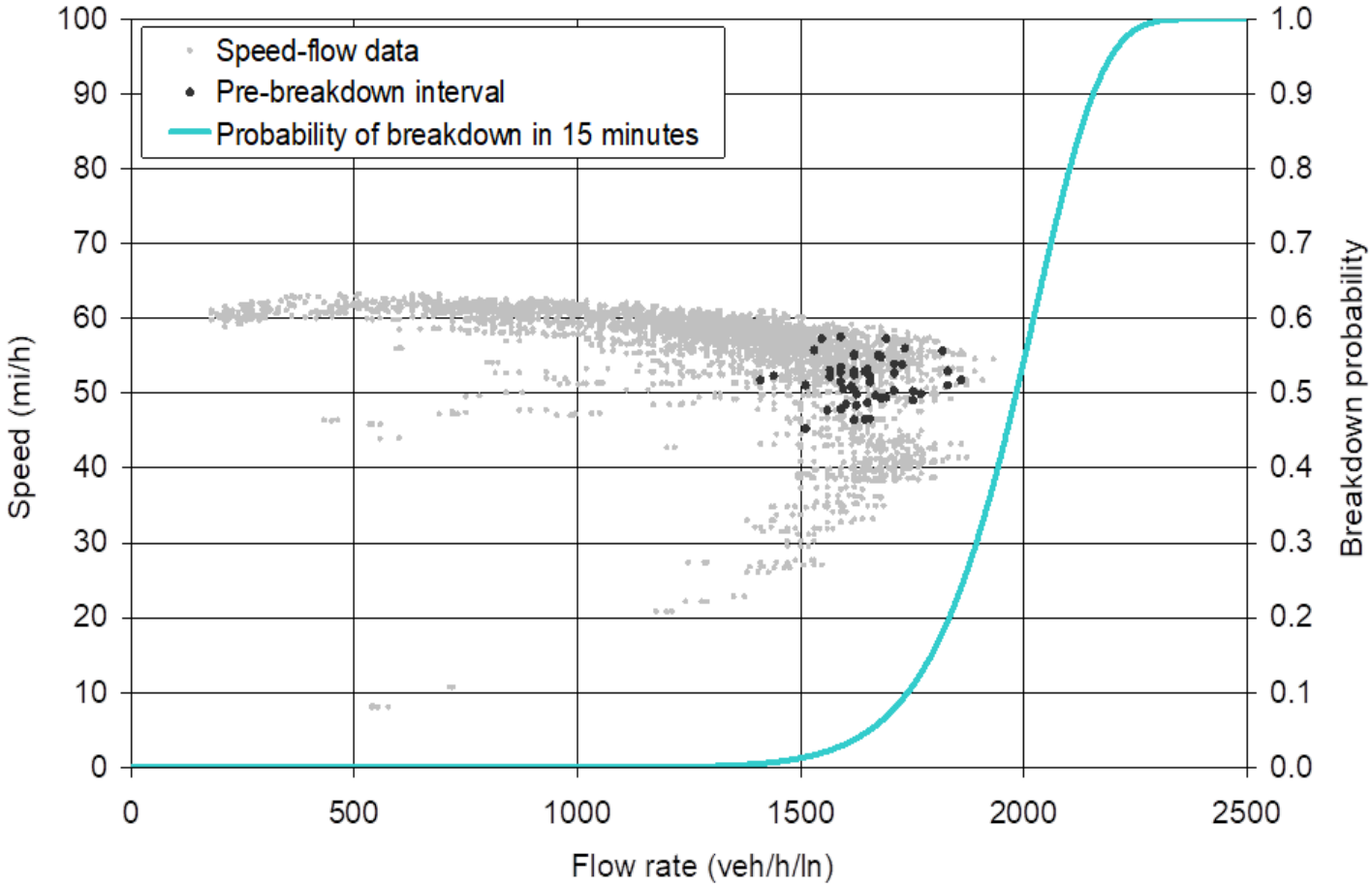
- Project Planning:
  - Screen corridors, assess potential benefits of PTSU.
  - Set hours of operation for Static Part-Time Shoulder Use (S-PTSU).
  - Set core hours of operation for D-PTSU.
- Real-time Operation of D-PTSU facility.

Demand to Capacity Patterns



Empirical Performance Data

I—580 Eastbound in California, one year of 6 AM – 10 AM weekday data.



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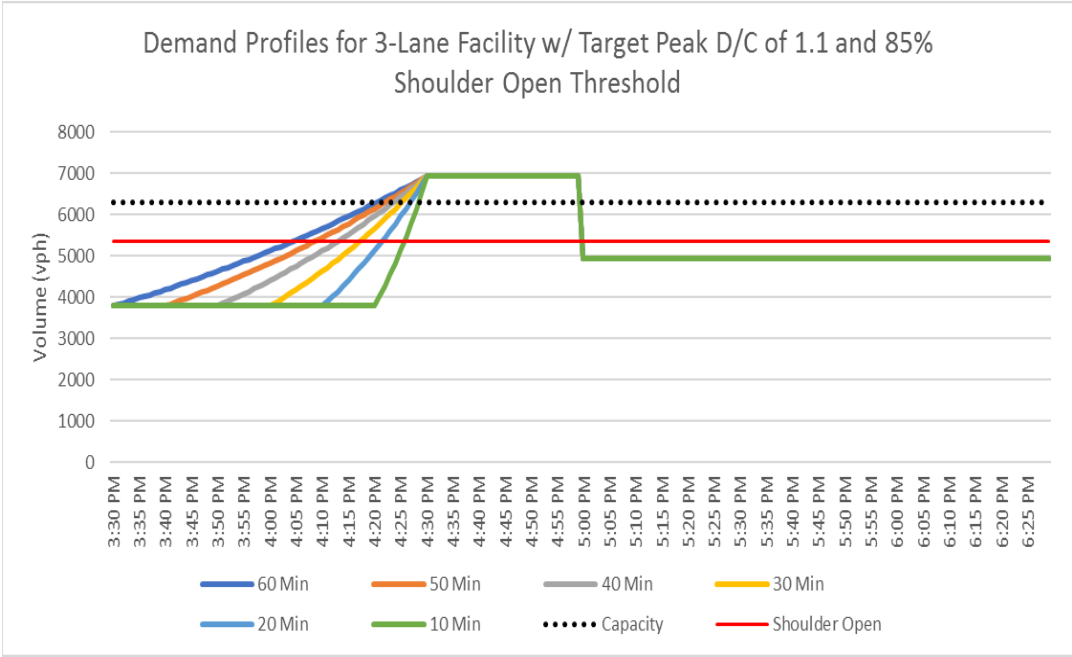
Macroscopic Optimization

- Generalized example focused on bottleneck caused by on-ramp. Key variables include:
  - Rate of volume increase.
  - Demand to (non-PTSU) capacity ratio.
  - Opening threshold.
  - Ramp geometry.
- FREEVAL:
  - 4725 scenarios.



Macroscopic Findings

- Rate of volume increase is key.
  - Determines time between opening decision being reached and capacity being reached.
  - Influences potential for false positive (unnecessary or early opening).
- Effect of site-specific variables can be tested.
  - Maximum ratio of demand over (non-PTSU) capacity.
  - Length of bottleneck.
- Specific decision parameters for general facilities can be developed.

Overall Findings

- Speed-focused thresholds:
  - Easier to implement.
  - Provides less “advanced warning” of congestion.
  - At 45 mph, breakdown nearly always occurs.
  - Some congestion may still occur during PTSU opening process and sweep time.
  - Most effective with sensor at bottleneck.
  - Specific speed thresholds will be more transferable site to site.
- Volume-focused thresholds:
  - Harder to implement.
  - Vary more site to site.
  - Higher likelihood of false positives – opening shoulder too soon or unnecessarily.
- Combinations are possible.

What's best for a given facility?

- Evaluate overall breakdown occurrence for one year of data.
- If breakdowns nonrecurring, **speed-focused thresholds appropriate**.
- If breakdowns are frequent and unpredictable (e.g., AM Peak, sometimes PM Peak, and sometimes on the weekends), **volume-focused thresholds appropriate**.
- If breakdowns are frequent and predictable during some time periods, S-PTSU or Level 1 D-PTSU may be adequate.
- If breakdowns are frequent and predictable all day, conversion of the shoulder to a full-time lane may be appropriate.

Case Study – Benefits of D-PTSU

I—66 Eastbound in Northern Virginia:

- S-PTSU from 1992 to 2015, shoulder opened in AM Peak.
- D-PTSU from 2015 to 2018, shoulder opened in AM Peak and as needed at other times.
- PTSU now removed, major widening underway.

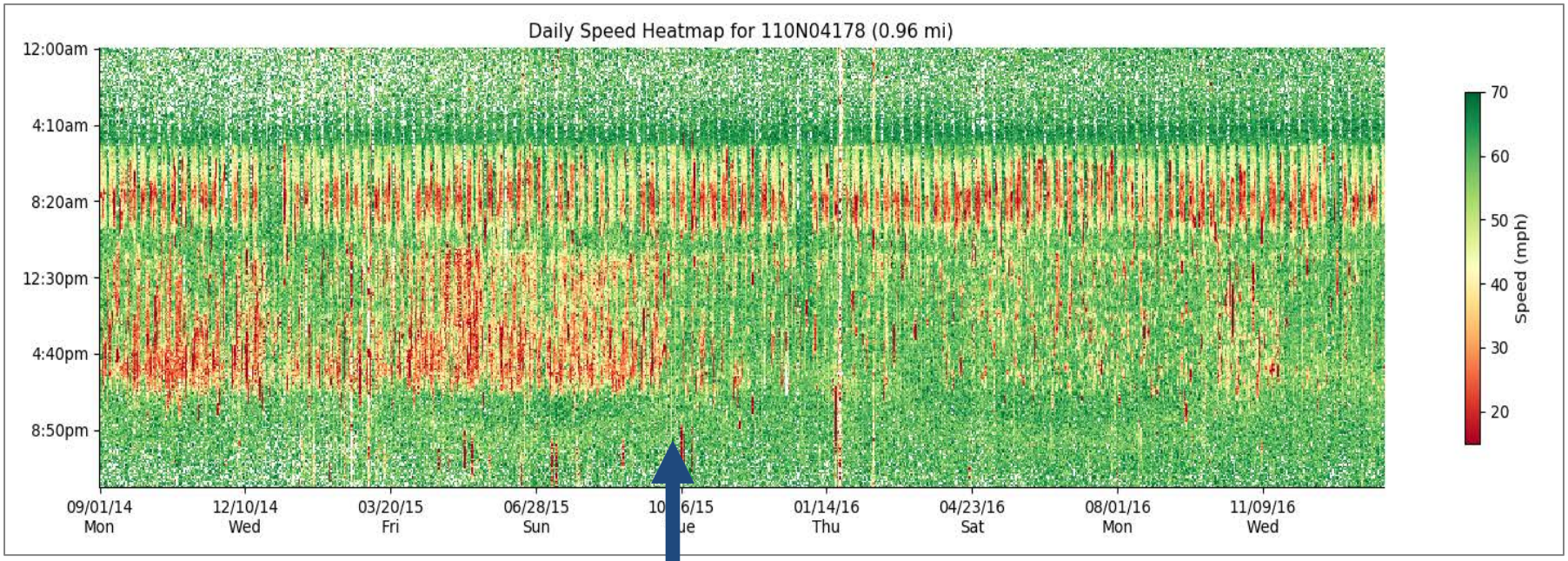
1992-2015

Source: Virginia Department of Transportation

2015-2018

Source: © 2016 Pete Jenior

Case Study – Benefits of D-PTSU (Con't)



S-PTSU converted to D-PTSU

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Outline of Project Report

- Chapter 1: Introduction.
- Chapter 2: What is D-PTSU?
- Chapter 3: Decision Support Framework for D-PTSU.
- Chapter 4: Thresholds for Opening the Shoulder.
- Chapter 5: Closing the Shoulder.

QUESTIONS?

Contacts

- Pete Jenior- pjenior@kittelson.com
- David Hale- david.k.hale@Leidos.com
- Jim Hunt- jim.hunt@dot.gov