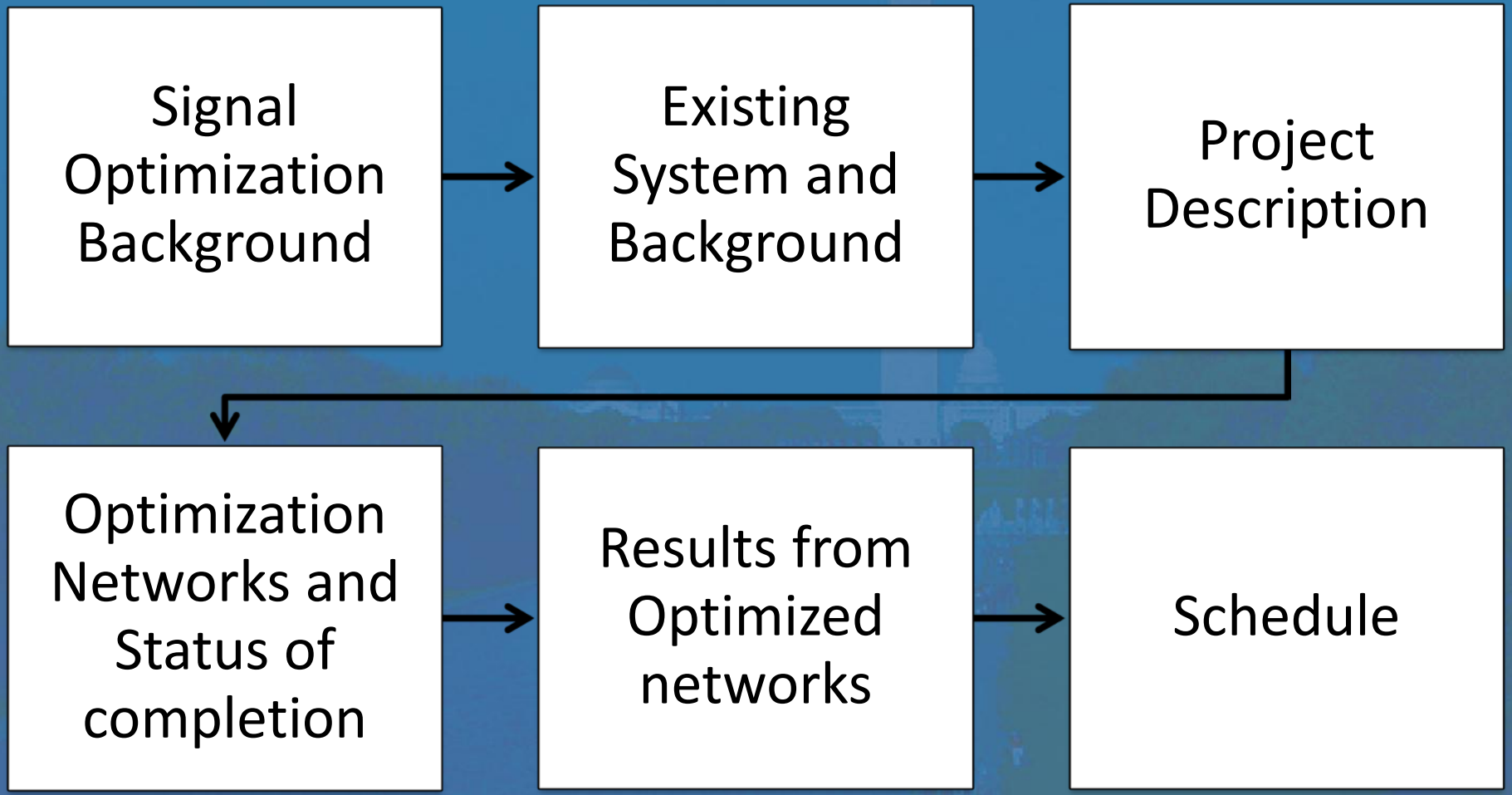
District of Columbia Traffic Signal Timing Optimization

Status Update

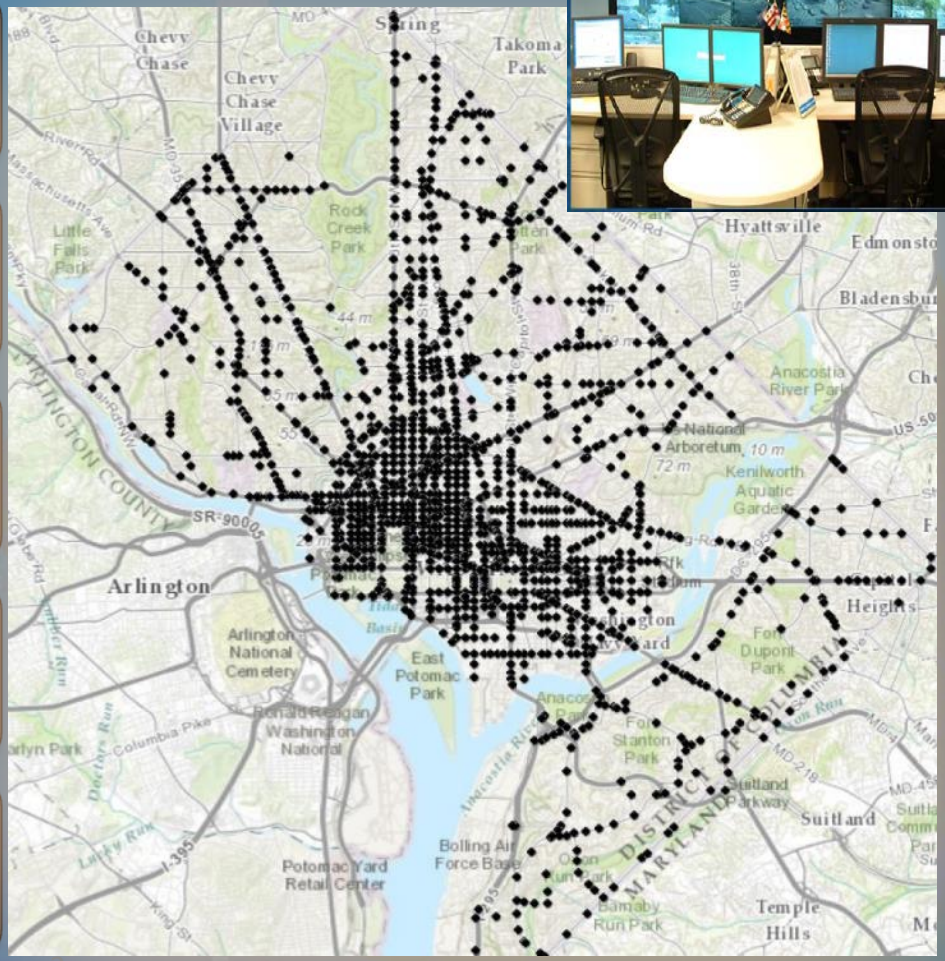
June, 2015

Agenda


Signal Optimization Background
Existing System and Background
Project Description
Optimization Networks and Status of completion
Results from Optimized networks
Schedule

Existing DC Signal System

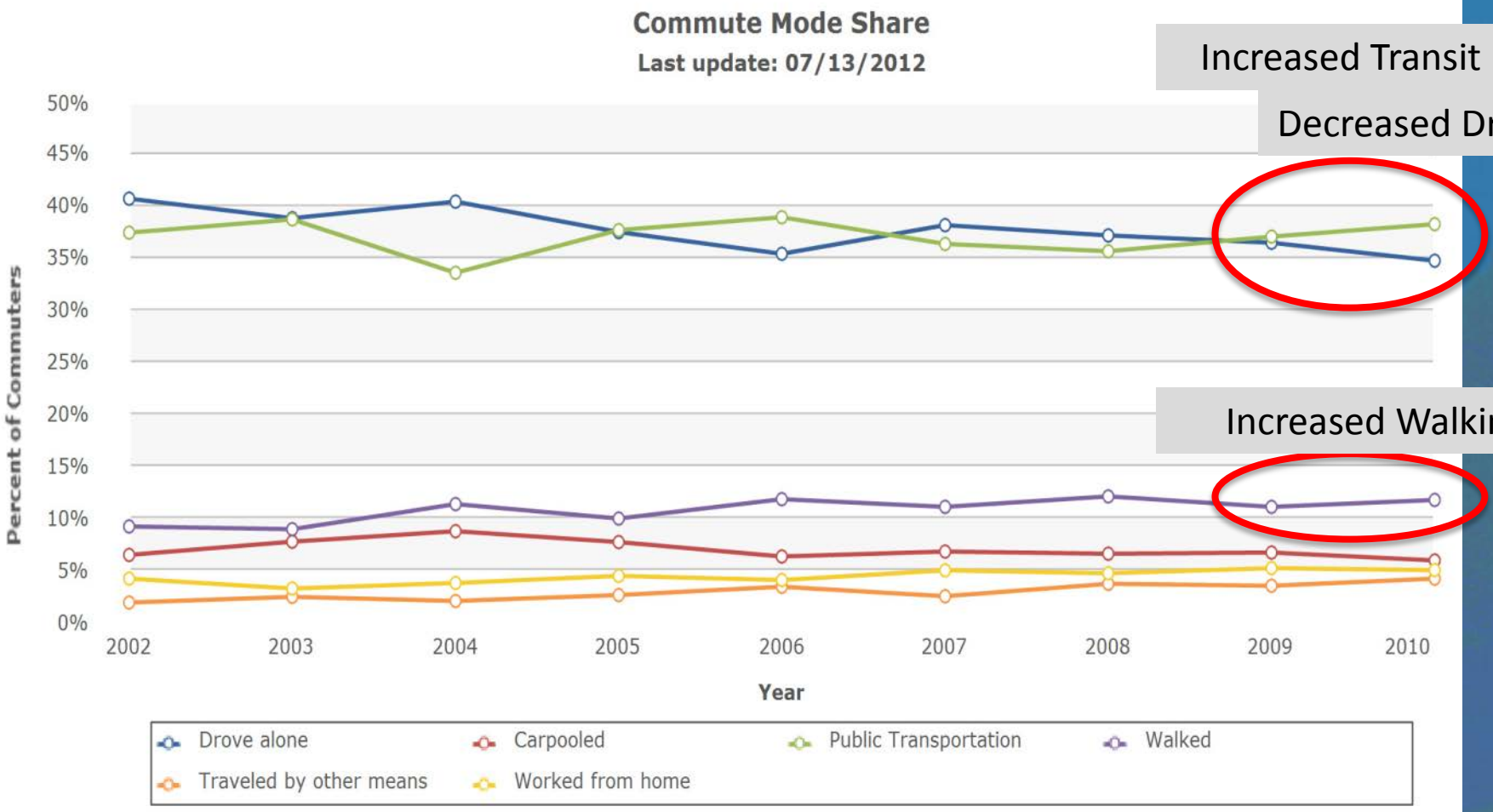
- 1600+ Traffic Signals
- Centralized Signal System with dedicated communication links
- 170-type traffic controllers
- Primarily fixed-time/pre-timed operations
- Nine (9) pre-programmed timing plans



Background

No comprehensive retiming since 2003	• Some timings unchanged for 30 years!
Inter-modal conflicts	• Cars, Bicycles, pedestrians, buses, streetcars, etc.
Redevelopment activities	• Nationals Park, City Center DC, Walmart, Costco etc.
Changing travel patterns & mode choices	• Bike share, Streetcar, Metro
Installation of new traffic signals	• 10+ every fiscal year
Outdated firmware	• Cannot implement new features like transit priority

Background



Increased Transit Use

Decreased Driving

Increased Walking

Source: GREEN DASHBOARD (Link)

Program Objective Function

"The central goal of the optimization project is to make DC traffic signals safer and friendlier for pedestrians, improve bus running times, and reduce traffic congestion and vehicular traffic emissions."

photo: pedbikeimages.org / Elvert Barnes

Optimization Challenges

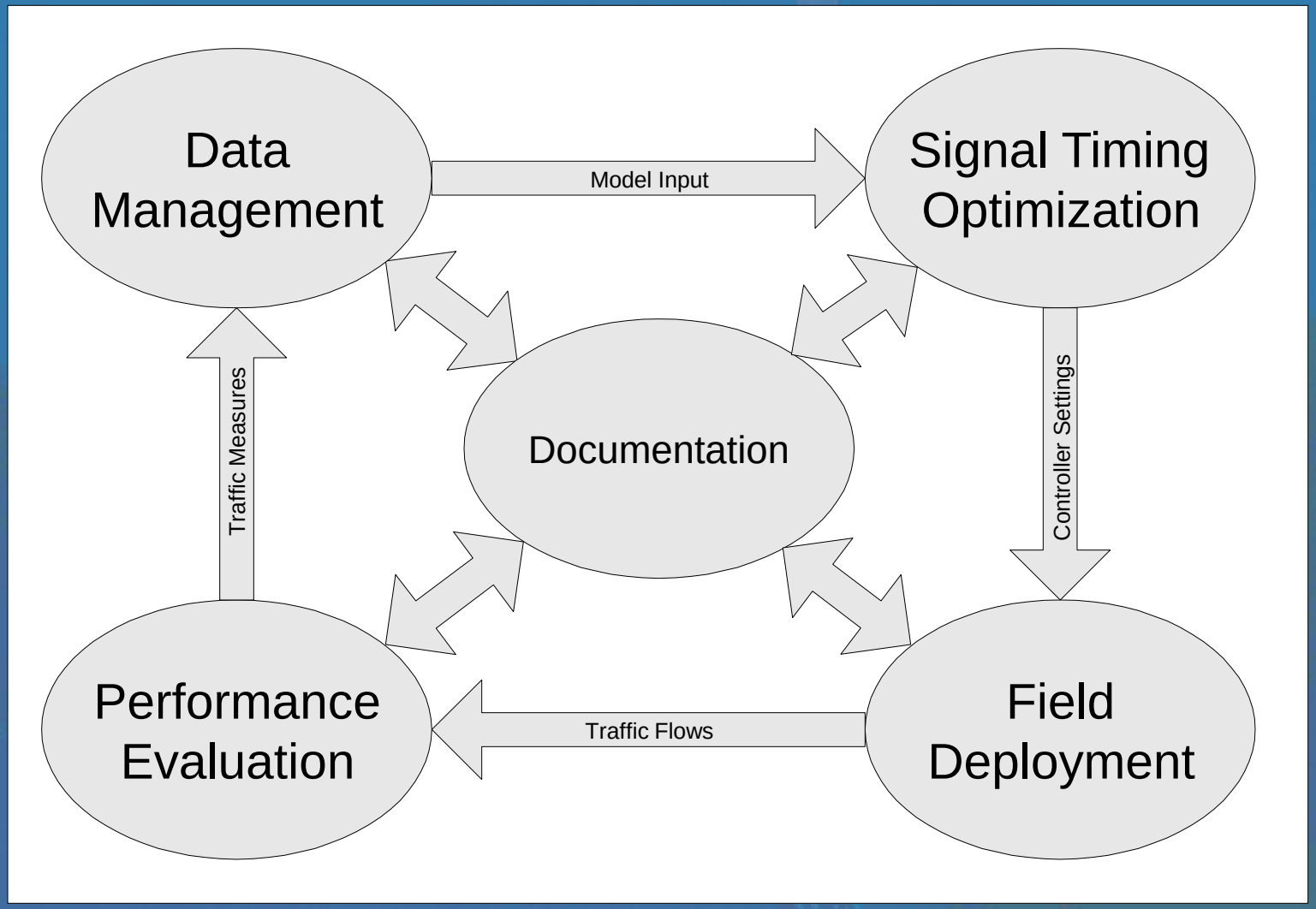
- Citizen complaints due to traffic pattern changes and conflict between modes
- Friction – Lack of left-turn lanes, bus blockages, parking maneuvers
- Presence of several diagonal streets
- Balancing and providing smooth traffic flow on major arterials in the grid network
- Parking enforcement issues
- Increased construction activities
- Special events

Project Approach

Two- Phase Implementation

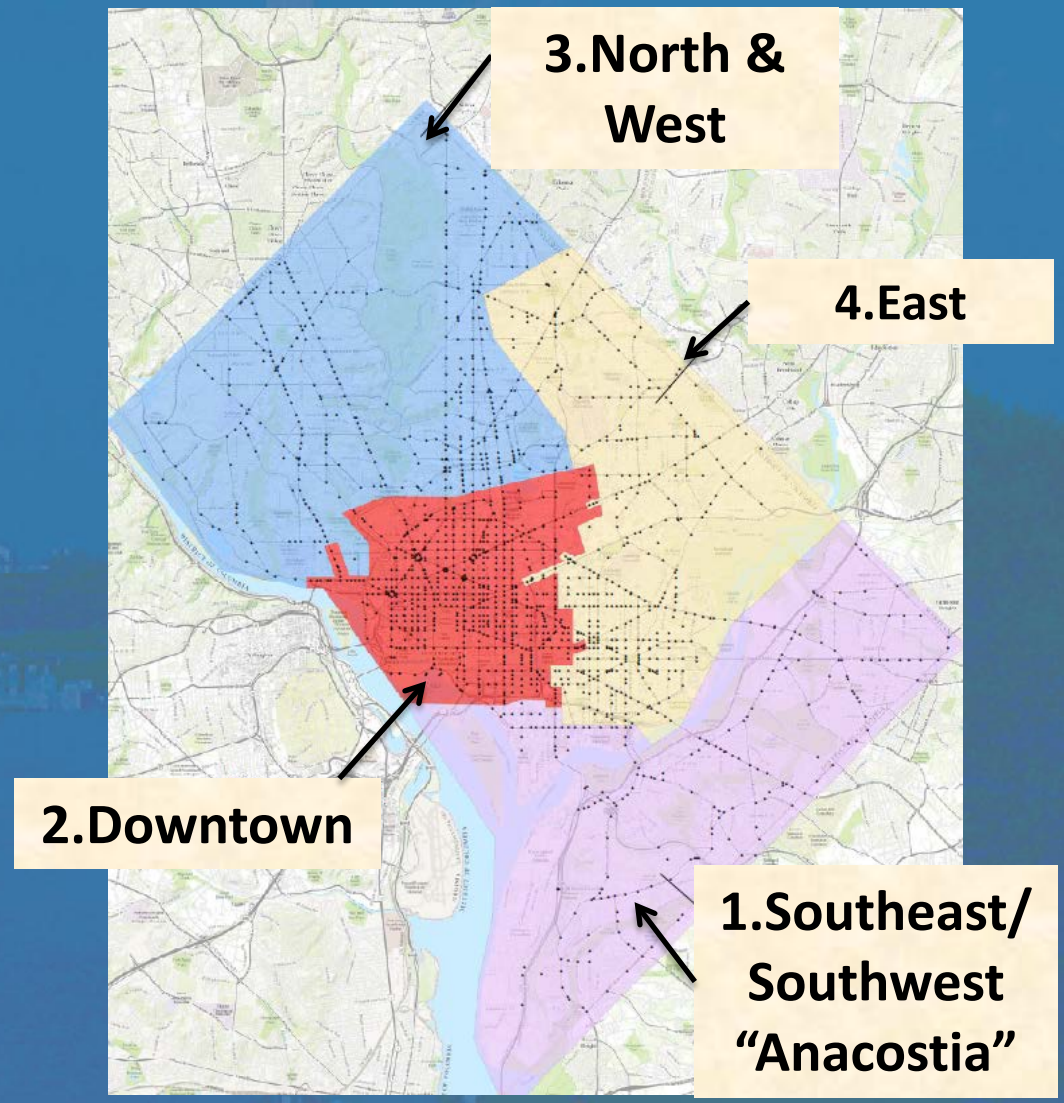
- *Phase 1*: MUTCD Compliance & system standardization; Firmware Upgrades.
- *Phase 2*: Data collection, model development, and optimization.

Project Approach – Phase 2



Project Approach – Phase 2

- Network Partitioning
  - 4 Networks
  - Range from 200 to 700 intersections
- Priority Corridor "Quick" Optimization
  - Georgia Avenue
  - Wisconsin Avenue
  - 16th Street
- Adaptive Corridors
  - Rhode Island Avenue
  - New York Avenue
  - Pennsylvania Avenue



Progress

Phase 1:

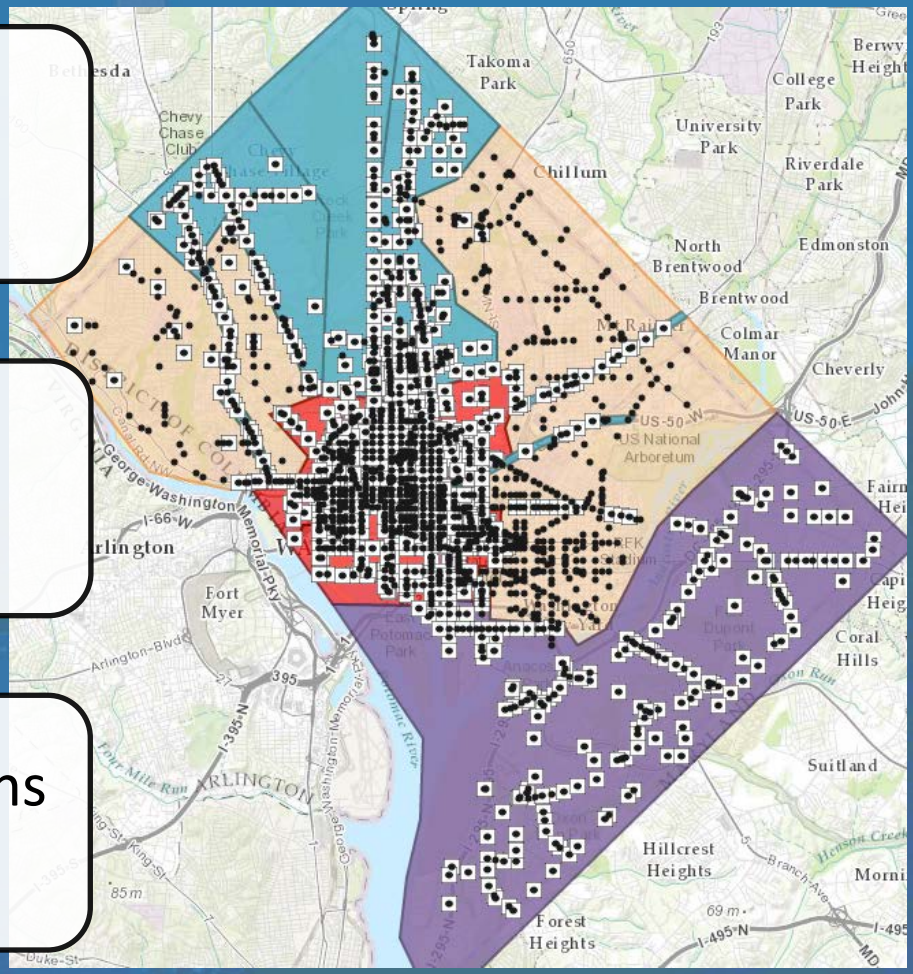
- 1048 Intersections (66%)

Phase 2:

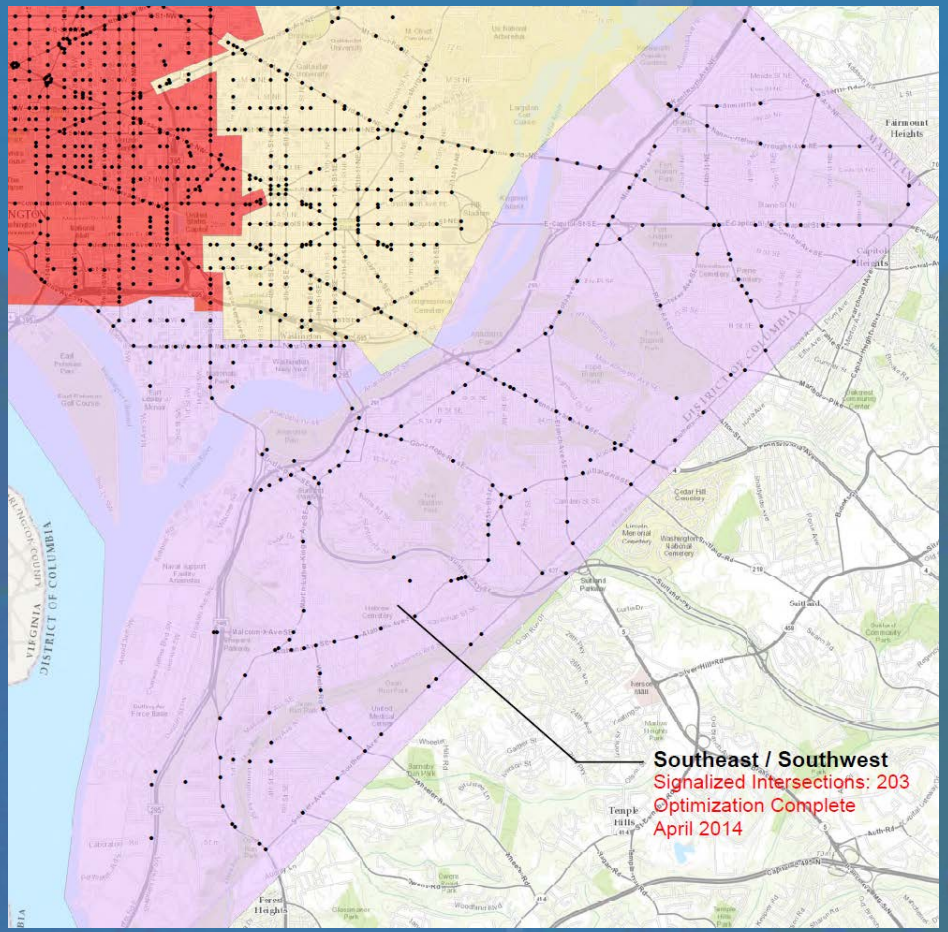
- 857 Intersections (54%)

Quick Optimization

- 129 Intersections (100%)

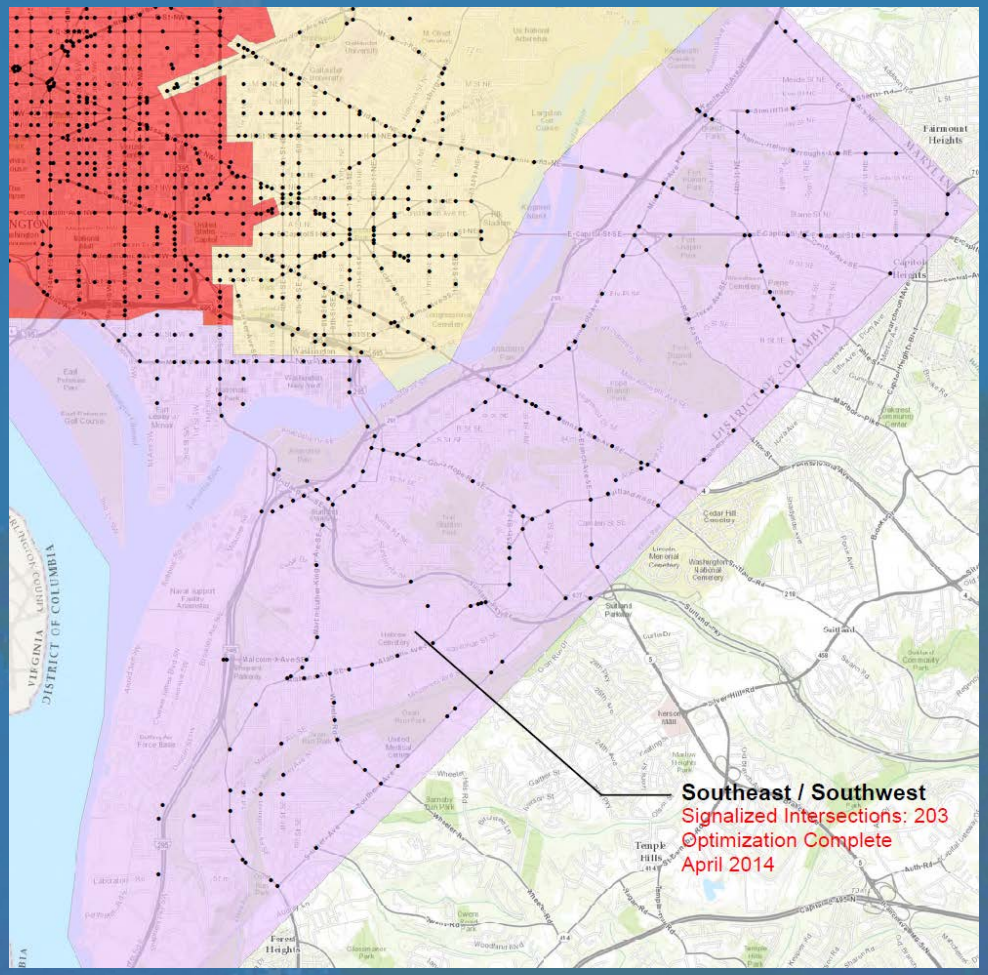


Network #1:
Southeast / Southwest "Anacostia"
(203 Intersections)

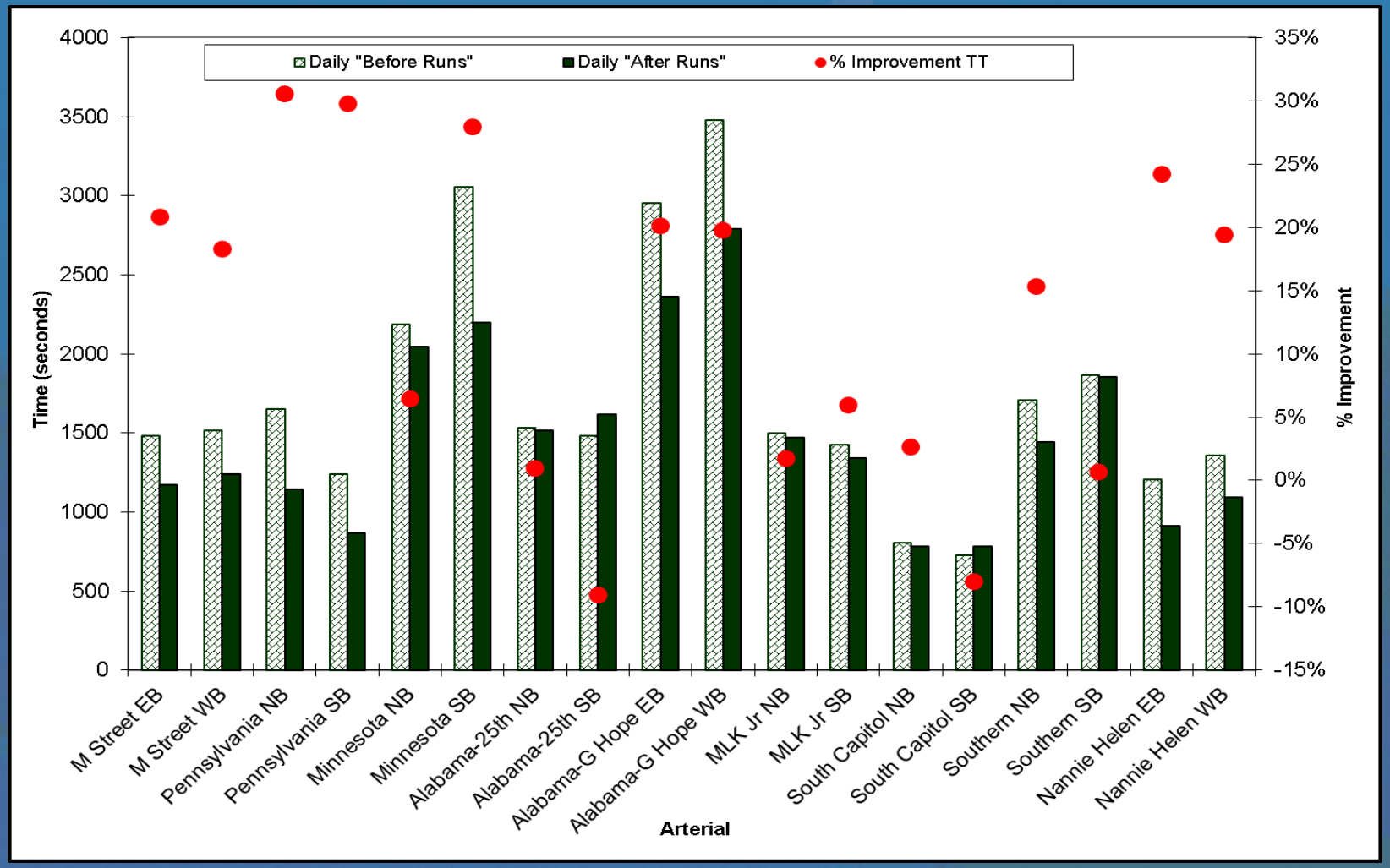


Anacostia Results

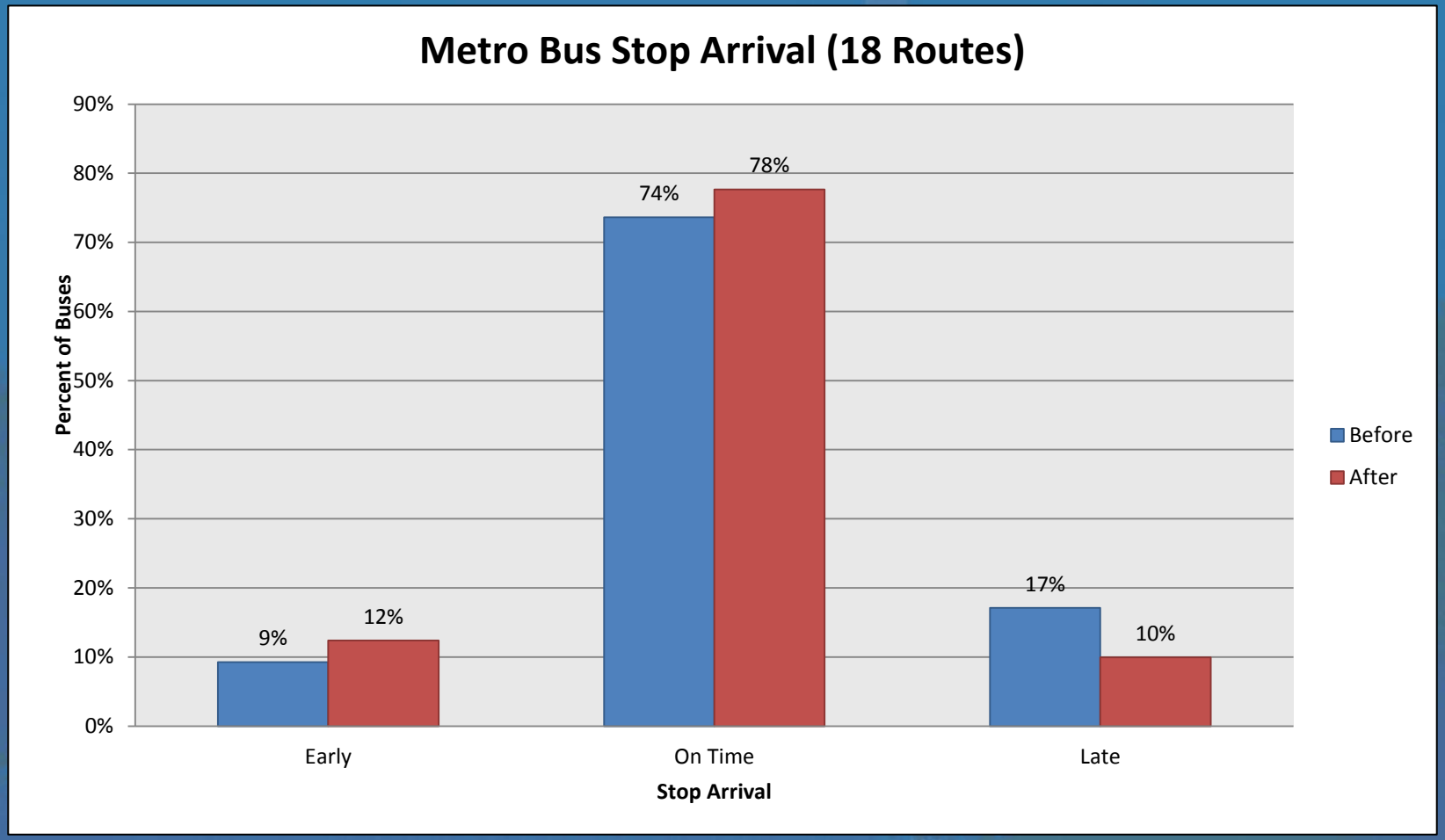
- Completed in March-April, 2014
- 5 timing plans
  - AM, Midday, PM, Weekend, Late Night
- Lowered cycle lengths
  - Over half during off-peaks
- Travel Time Runs
  - 13% network-wide travel time savings over all peaks
  - 34% reduction in delays
  - 23% reduction in stops



Anacostia Results – Travel Time



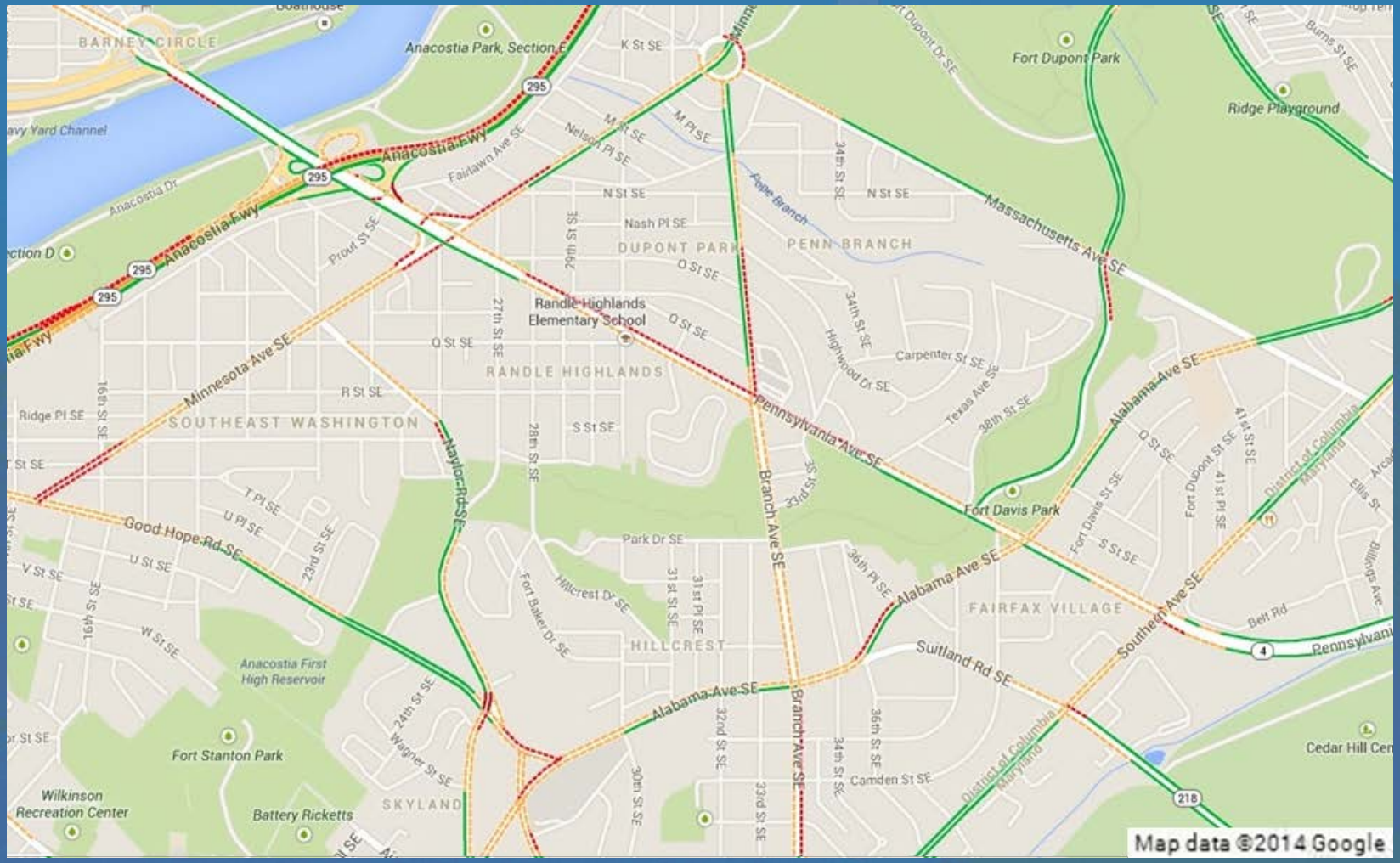
Anacostia Results – Bus Performance



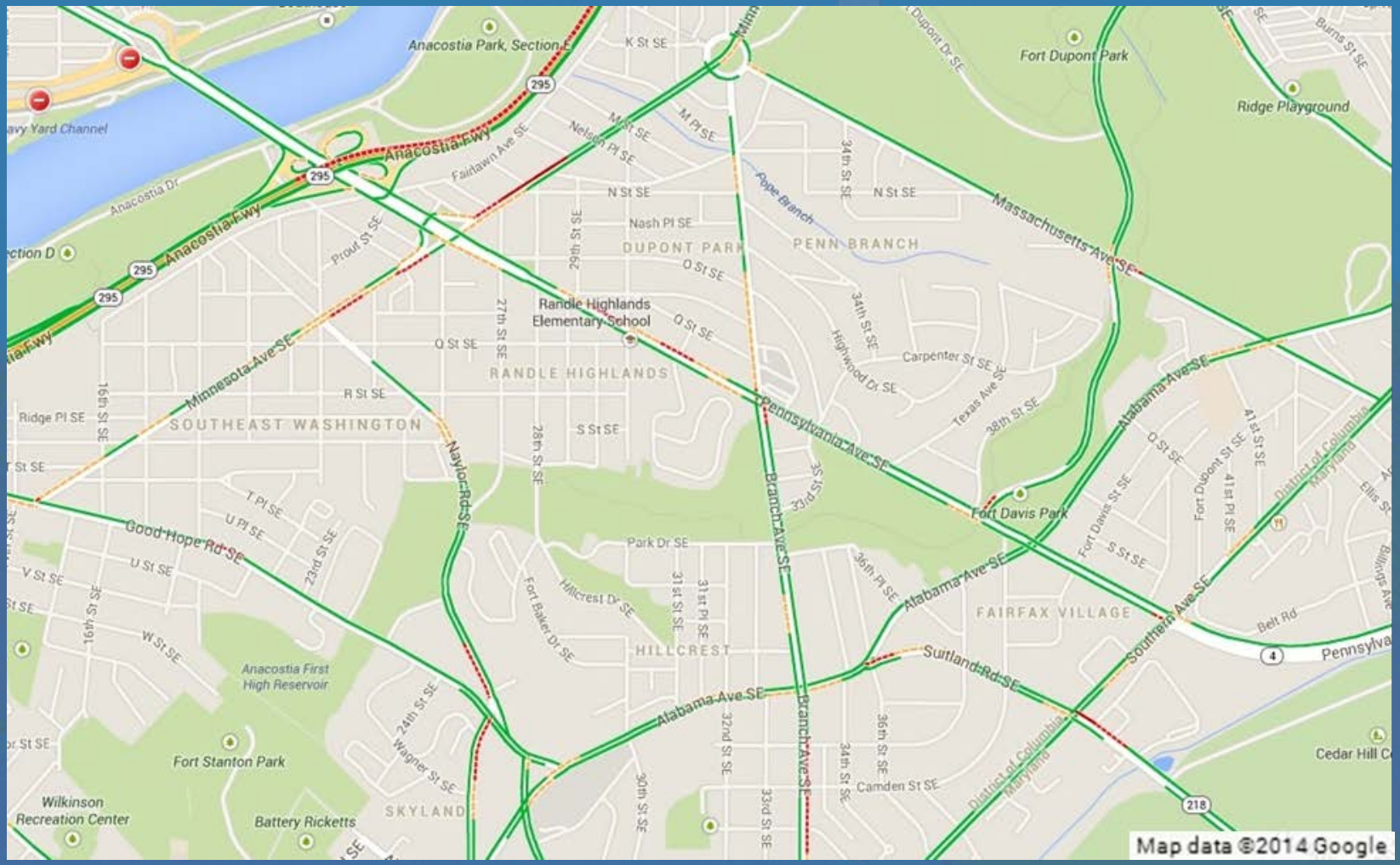
Anacostia Results – Benefit-Cost

	Delay (hours)	Stops	Fuel Consumption (gal)	CO Emissions (kg)	NOx Emissions (kg)	VOC Emissions (kg)
"Before"	4,963,500	271,501,660	9,265,100	647,646	126,008	150,102
"After"	3,476,780	238,149,260	8,035,600	561,676	109,284	130,172
Improvement	1,486,720	33,352,400	1,229,500	85,970	16,724	19,930
% Improvement	30%	12%	13%	13%	13%	13%
Annual Benefit	$40,186,042	$4,669,336	$4,795,050	$602,734	$237,353	$147,082
Total Annual Benefit	***$50,637,596.48***					
Cost	***$655,805.00***					
Benefit-Cost Ratio	***77:1***					

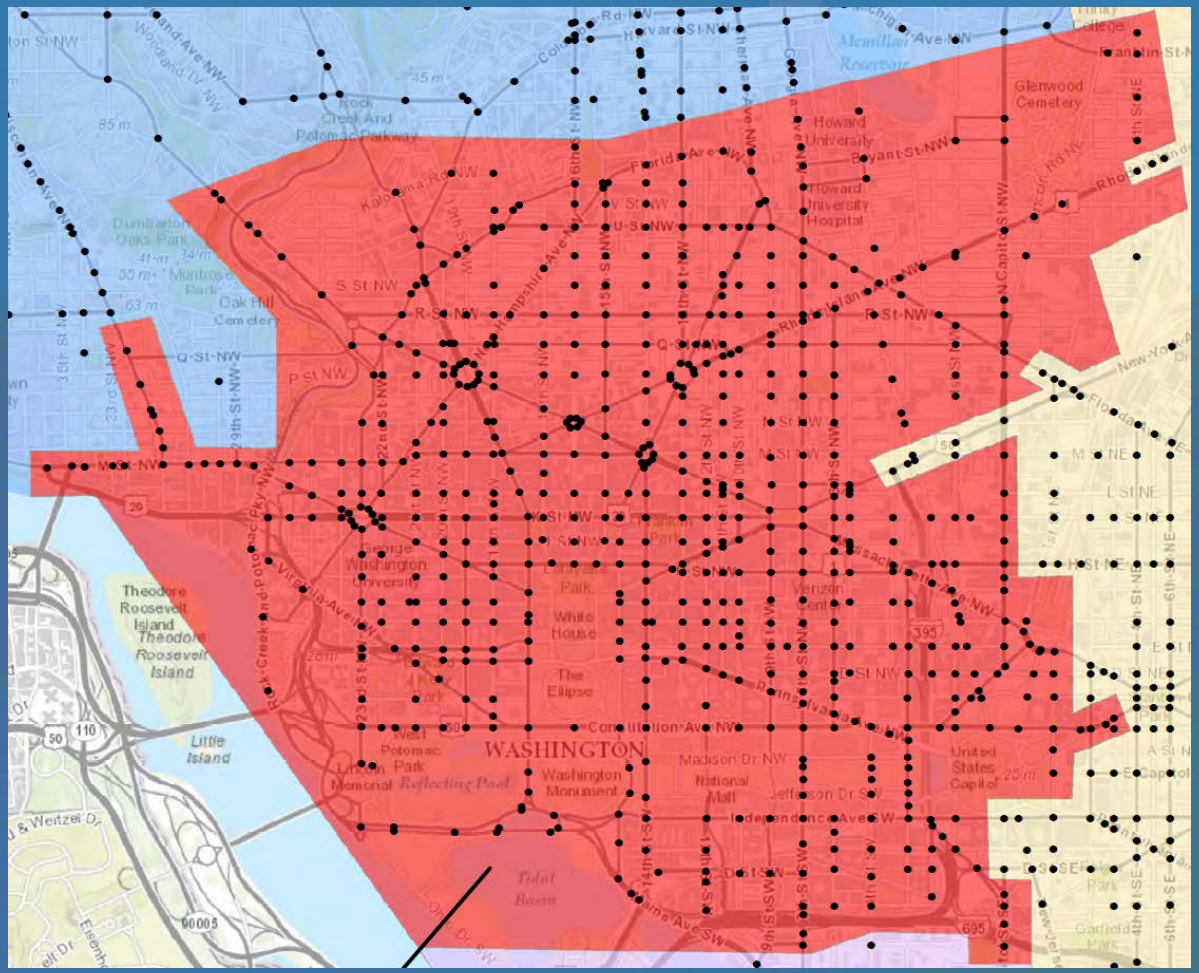
Anacostia Results – Anecdotal (Before)



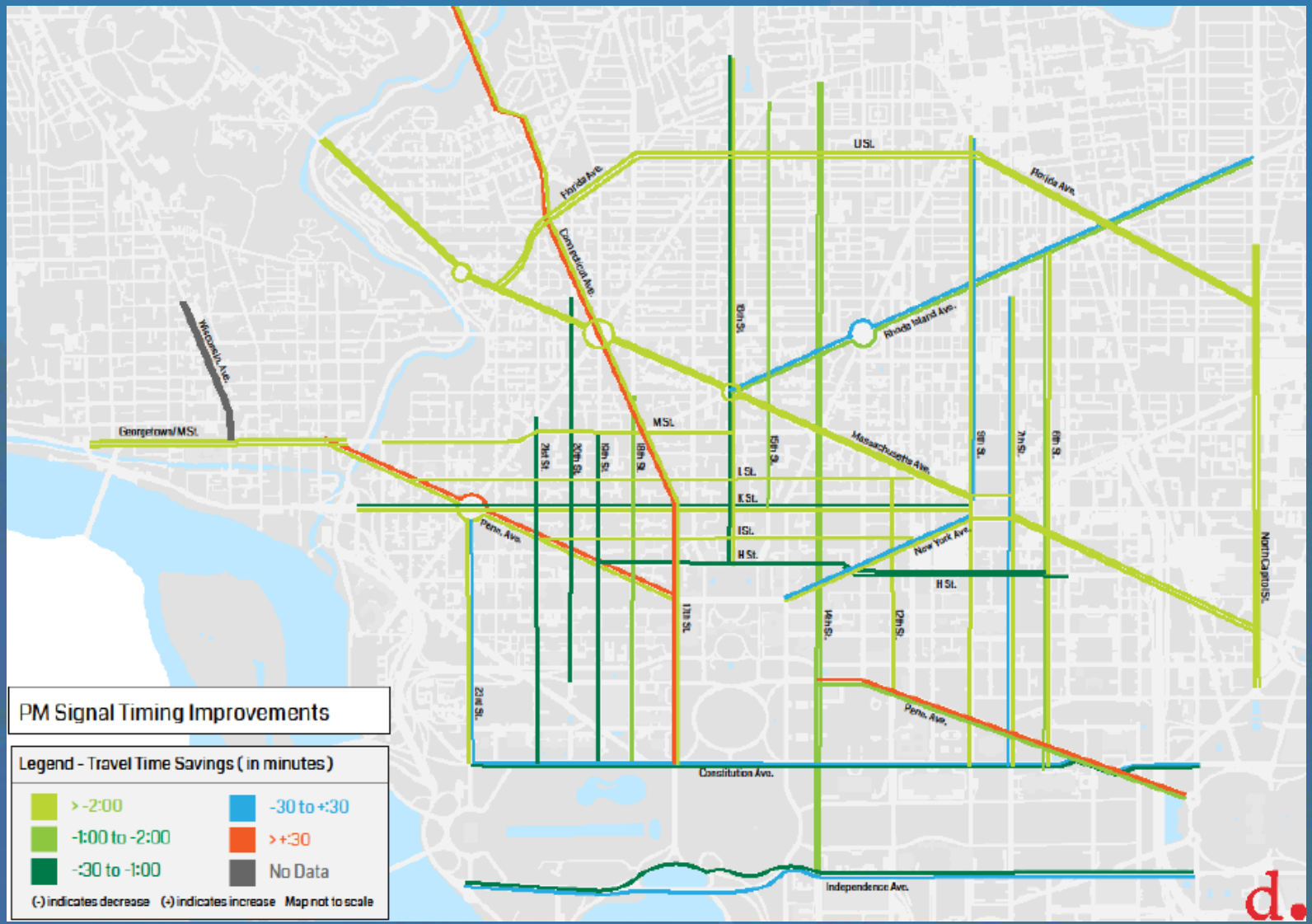
Anacostia Results – Anecdotal (After)



Network #2: Downtown (654 Intersections)



Downtown Results: Vehicle Travel Times



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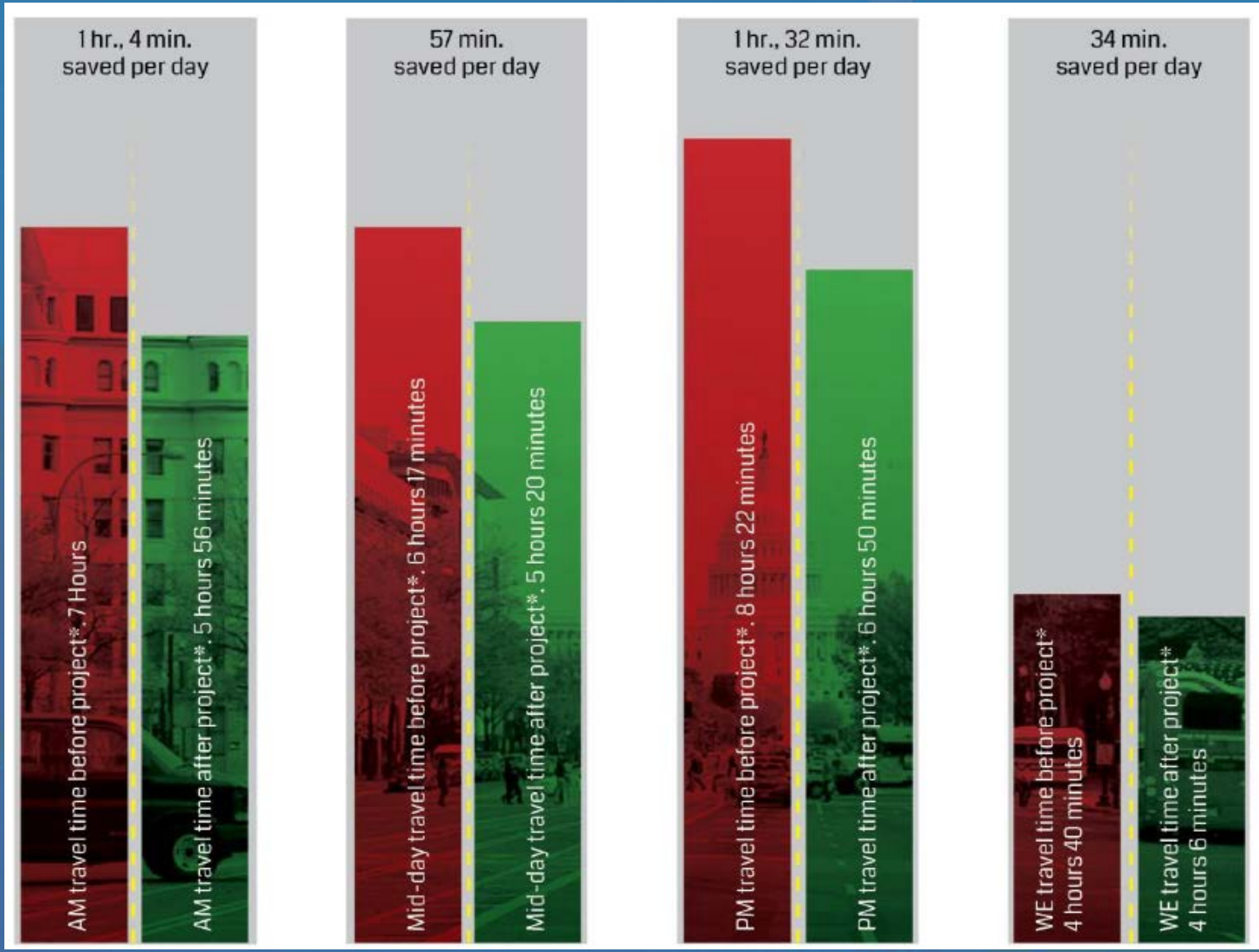
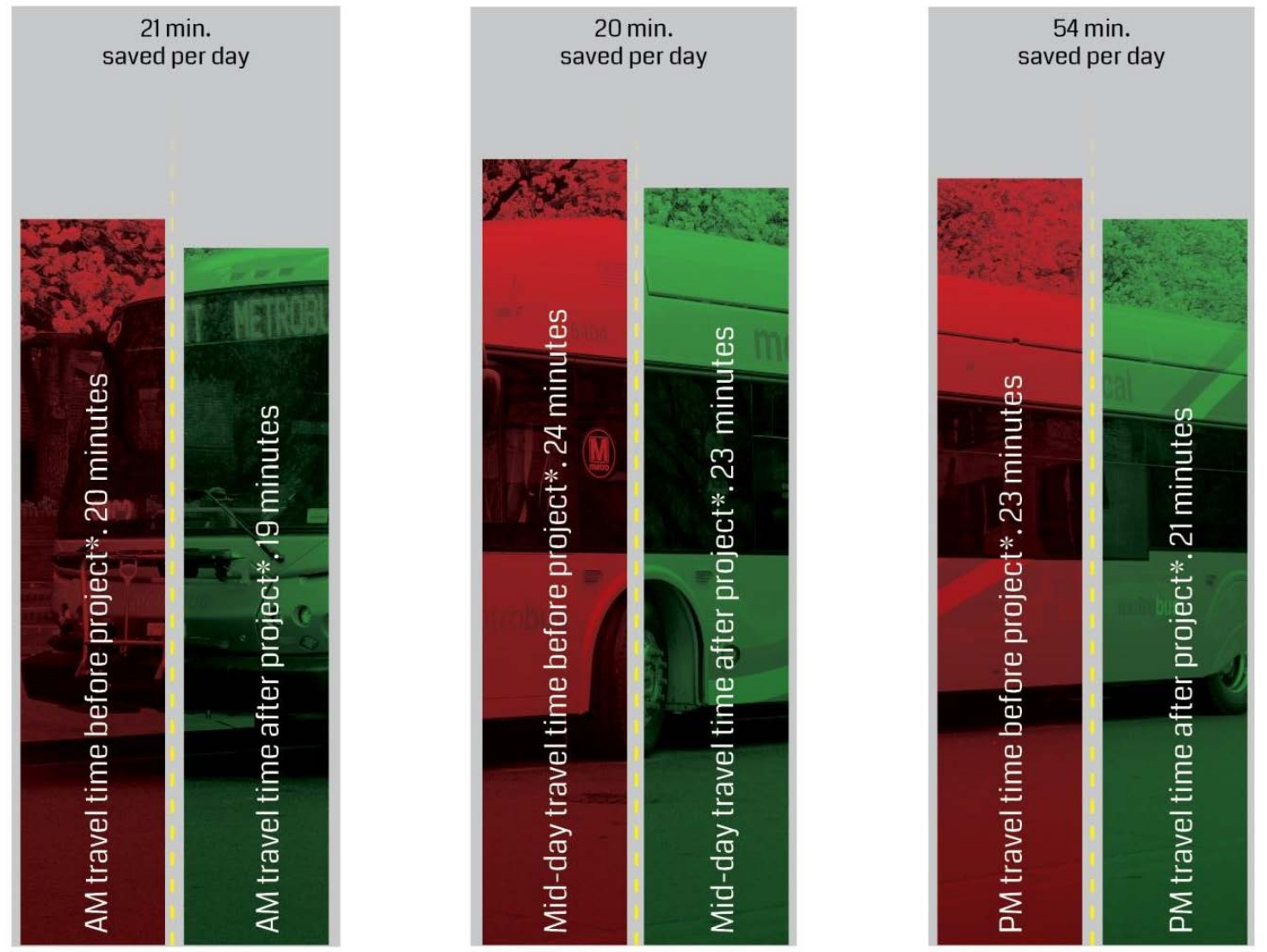


Downtown Results: Bus Travel Times



Downtown Results: Pedestrian Timing Improvements

- Flashing Don't Walk (FDW) intervals
  - Re-calculated based on 3.5 fps pedestrian walk speed.
  - Increased or remained the same at 82% (1,342) of the crosswalks.
- All Red (AR) intervals added at 42 intersections.
- Flashing Walk displays changed to solid Walk at 217 intersections.

Downtown Results: Bicycles

Pennsylvania Avenue Cycle Track	Before		After	
	Travel Time	Stops	Travel Time	Stops
AM Eastbound	7:30	5	6:20	5 ⟷
AM Westbound	8:30	7	7:30	3 ↓
MD Eastbound	8:10	8	7:20	5 ↓
MD Westbound	8:20	7	8:10	6 ↓
PM Eastbound	10:30	8	10:10	7 ↓
PM Westbound	7:45	7	8:10	5 ↓

Downtown Results – Benefit-Cost

	Delay (hours)	Stops	Fuel Consumption (gal)	CO Emissions (kg)	NOx Emissions (kg)	VOC Emissions (kg)
"Before"	12,043,080	843,614,040	18,957,840	1,325,660	257,800	307,500
"After"	9,299,640	751,443,180	16,570,280	1,158,400	225,400	268,580
Improvement	2,743,440	92,170,860	2,387,560	167,260	32,400	38,920
% Improvement	23%	11%	13%	13%	13%	13%
Annual Benefit	$74,155,183	$12,903,920	$7,162,680	$1,172,660	$ 459,821	$ 287,230
Total Annual Benefit	***$96,141,494***					
Cost	***$2,150,658***					
Benefit-Cost Ratio	***40:1***					

Downtown Results – Public Feedback

TRAFFIC > TRANSIT

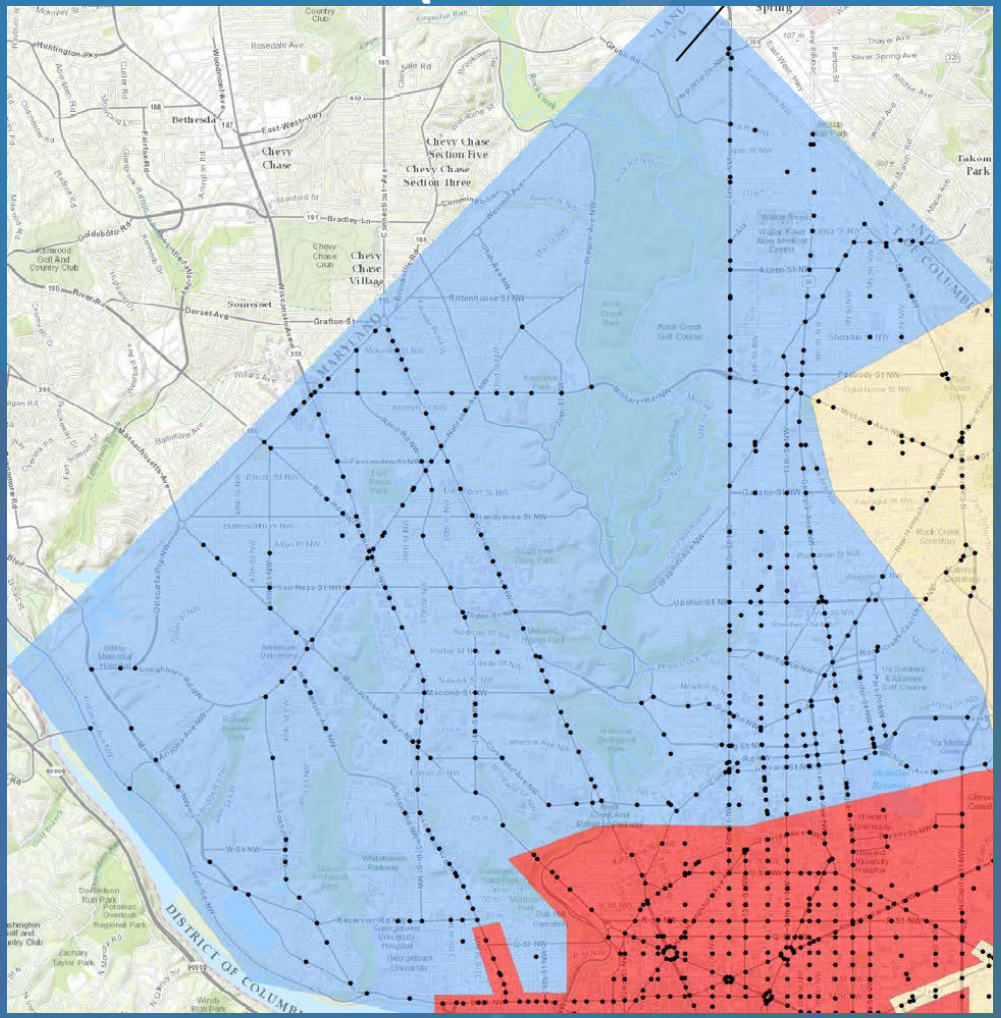
DDOT: Traffic Signal Timing Changes Save Drivers Time

By Marina di Marzo

Updated at 8:58 AM EDT on Tuesday, Jun 16, 2015

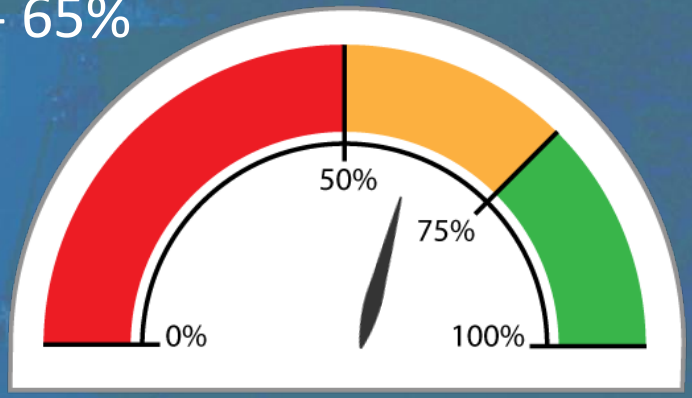
Changes to traffic signal timing are saving drivers time, according to the D.C. Department of Transportation.

Network #3:
North & West (386 Intersections)



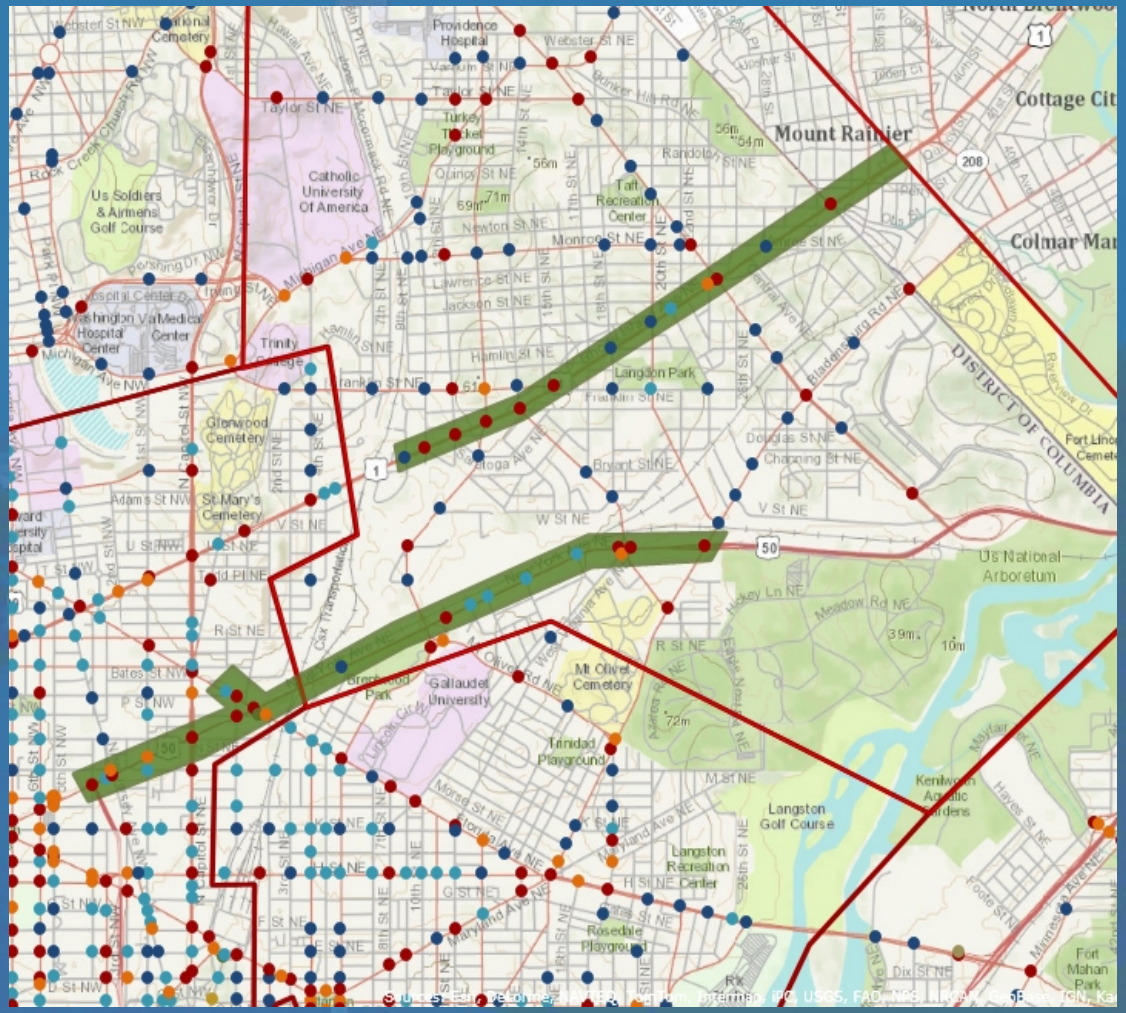
Status update

- Intersection Turning Movement Counts – 80%
- Field Data Collection – 70%
- Change and Clearance Interval Calculations – 70%
- TS Drawings – 70%
- Dial Sheets Phase 1 - 60%
- Phase 1 Implementations (MUTCD Compliance) – **69%**
- Synchro Coding – 50%
- Volume Balancing – 25%
- Before Travel Time and Delay Studies - 65%
- Signal Timing Optimization- 0%
- Dial Sheets Phase 2- 0%
- Field Implementation- 0%
- Fine Tuning- 0%
- Final Report- 0%



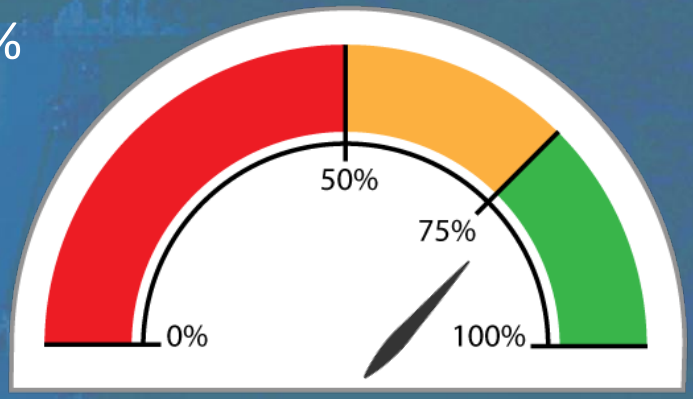
Pre-Adaptive Traffic Signal Technology

- New York Avenue –
  21 intersections
- Rhode Island Avenue –
  19 intersections

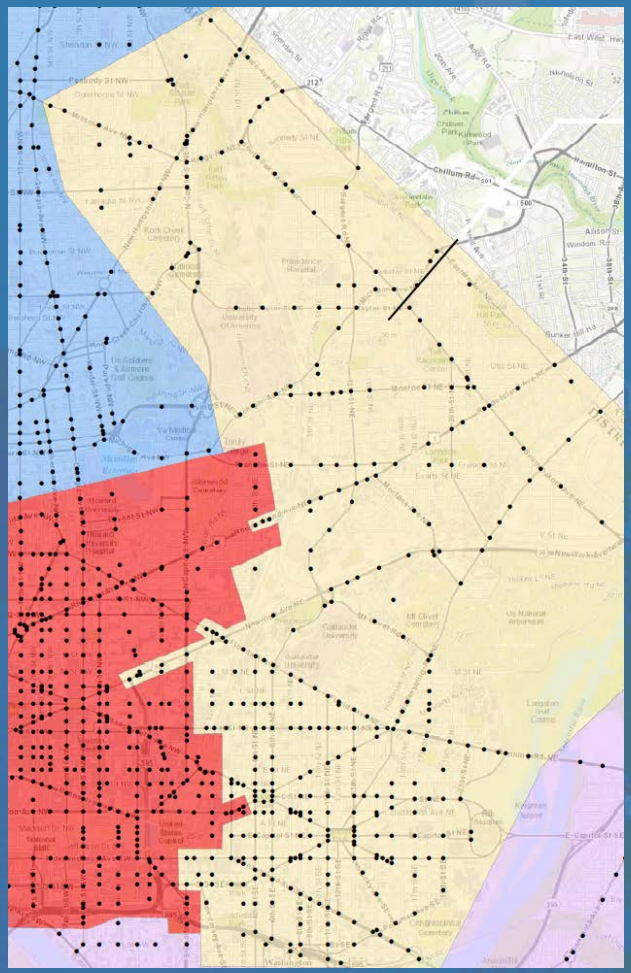


Status Update

- Intersection Turning Movement Counts – 100%
- Field Data Collection – 100%
- Change and Clearance Interval Calculations – 90%
- TS Drawings – 90%
- Dial Sheets Phase 1 - 90%
- Phase 1 Implementations (MUTCD Compliance) – **90%**
- Synchro Coding – 100%
- Volume Balancing – 100%
- Before Travel Time and Delay Studies - 100%
- Signal Timing Optimization- 100%
- Dial Sheets Phase 2- 0%
- Field Implementation- 0%
- Fine Tuning- 0%
- Final Report- 0%

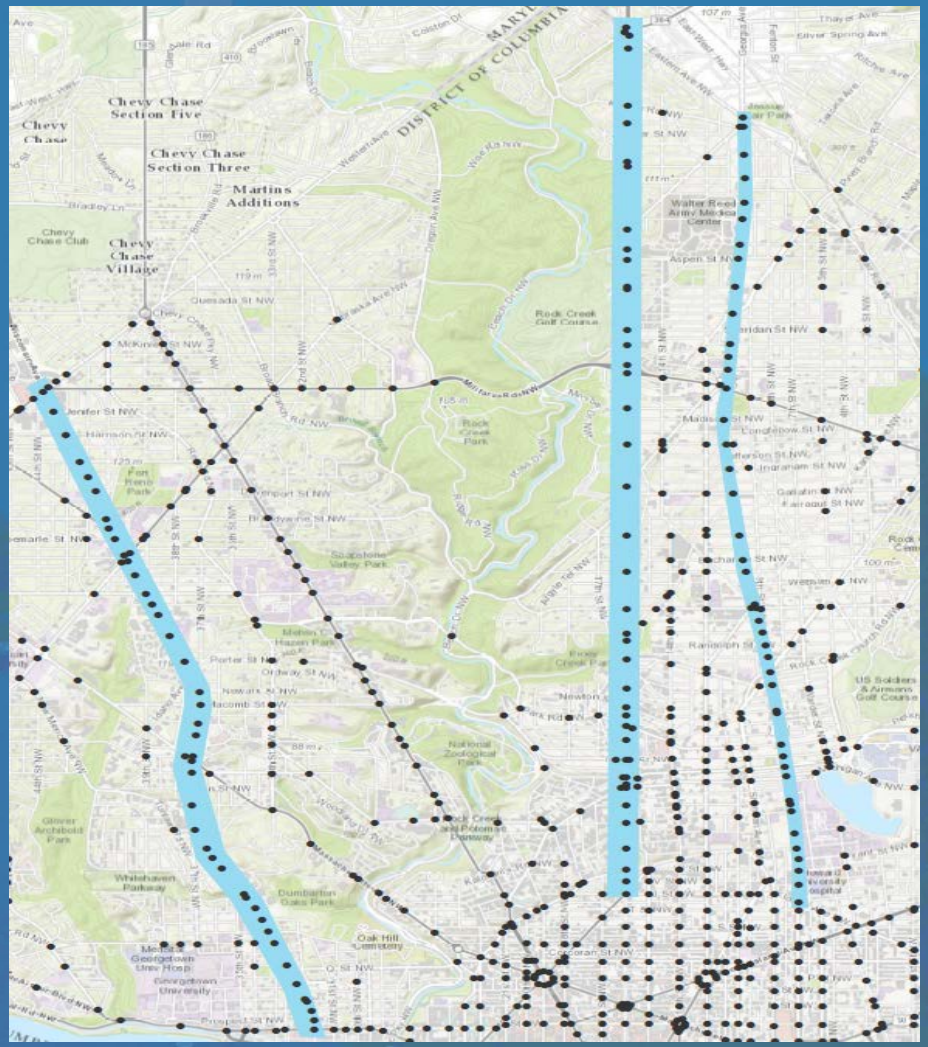


Network #4:
East (384 Intersections)



Bus Priority Corridors – Quick Optimization

- 16th Street –
  44 intersections
- Wisconsin Avenue –
  40 intersections
- Georgia Avenue –
  45 intersections



Status Update

- Intersection Turning Movement Counts – 100%
- Field Data Collection – 100%
- Change and Clearance Interval Calculations – 100%
- TS Drawings – 100%
- Dial Sheets Phase 1 - 100%
- Phase 1 Implementations (MUTCD Compliance) – 100%
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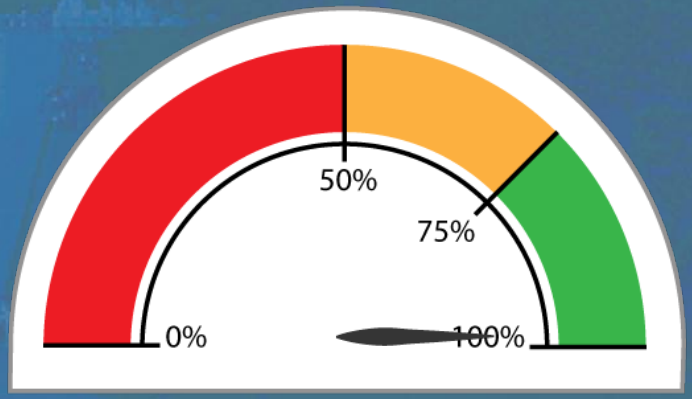


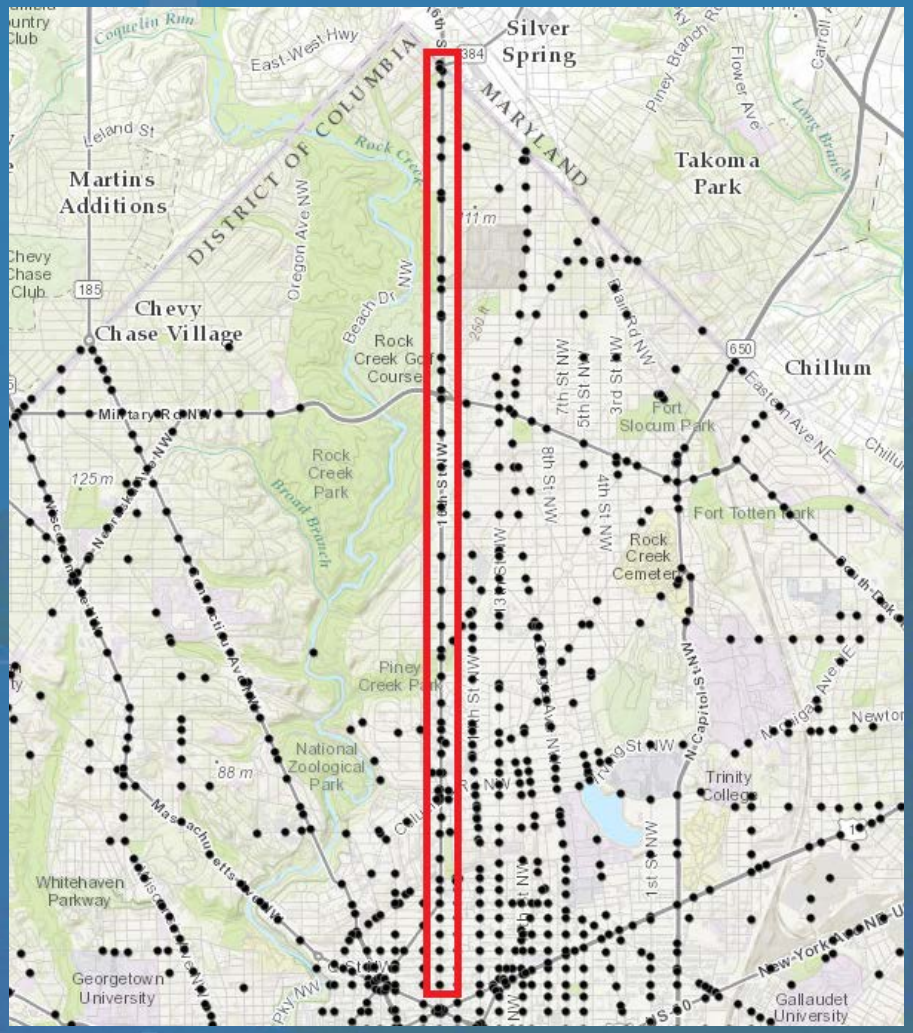
16th Street NW Corridor

47 Intersections

Limits:

Portal Drive (North)

P Street (South)



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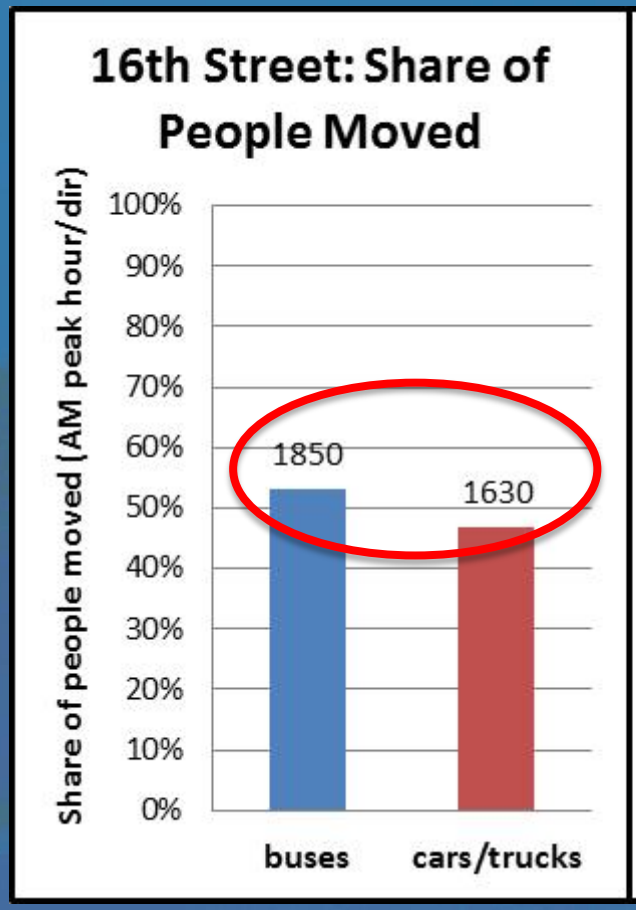
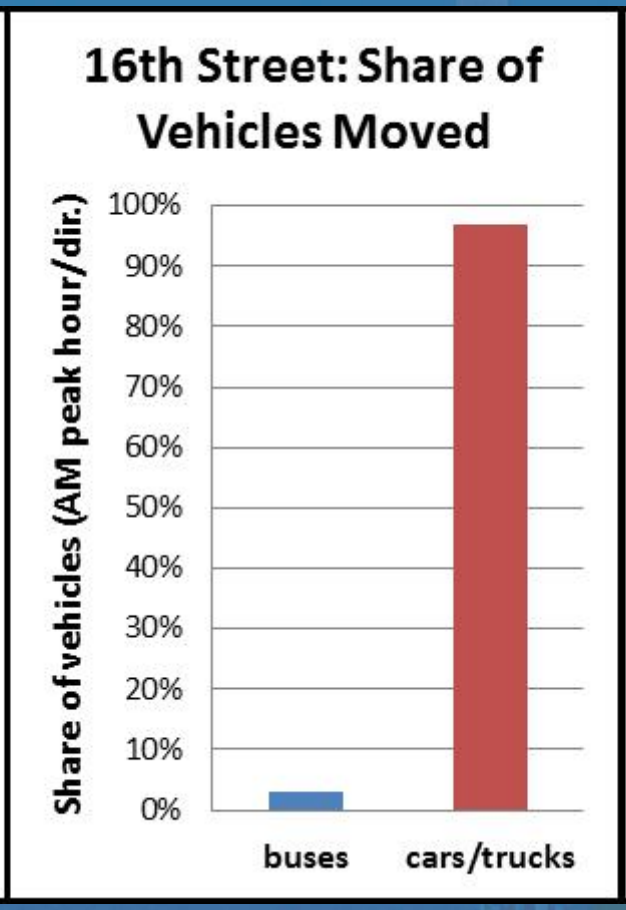
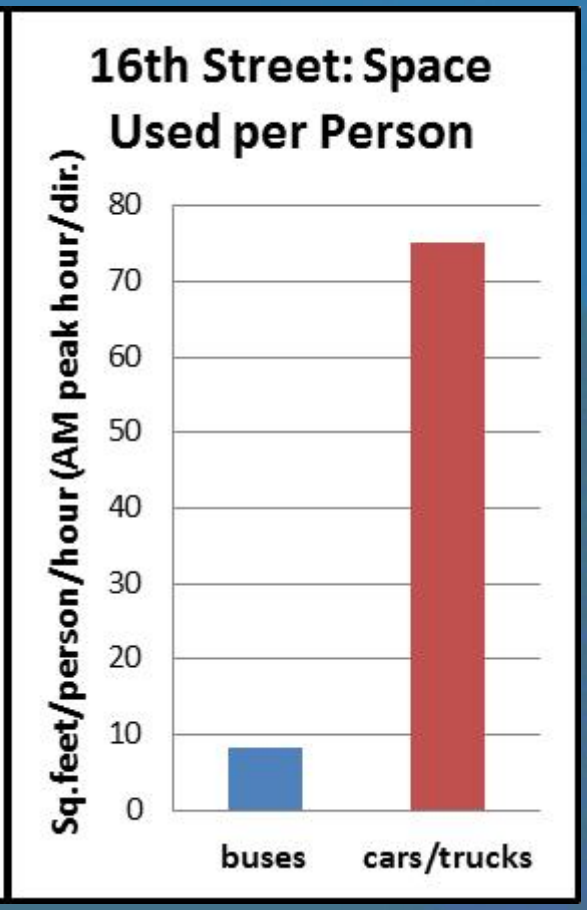
Background







Source: PlanItMetro (Link)

Background

move dc

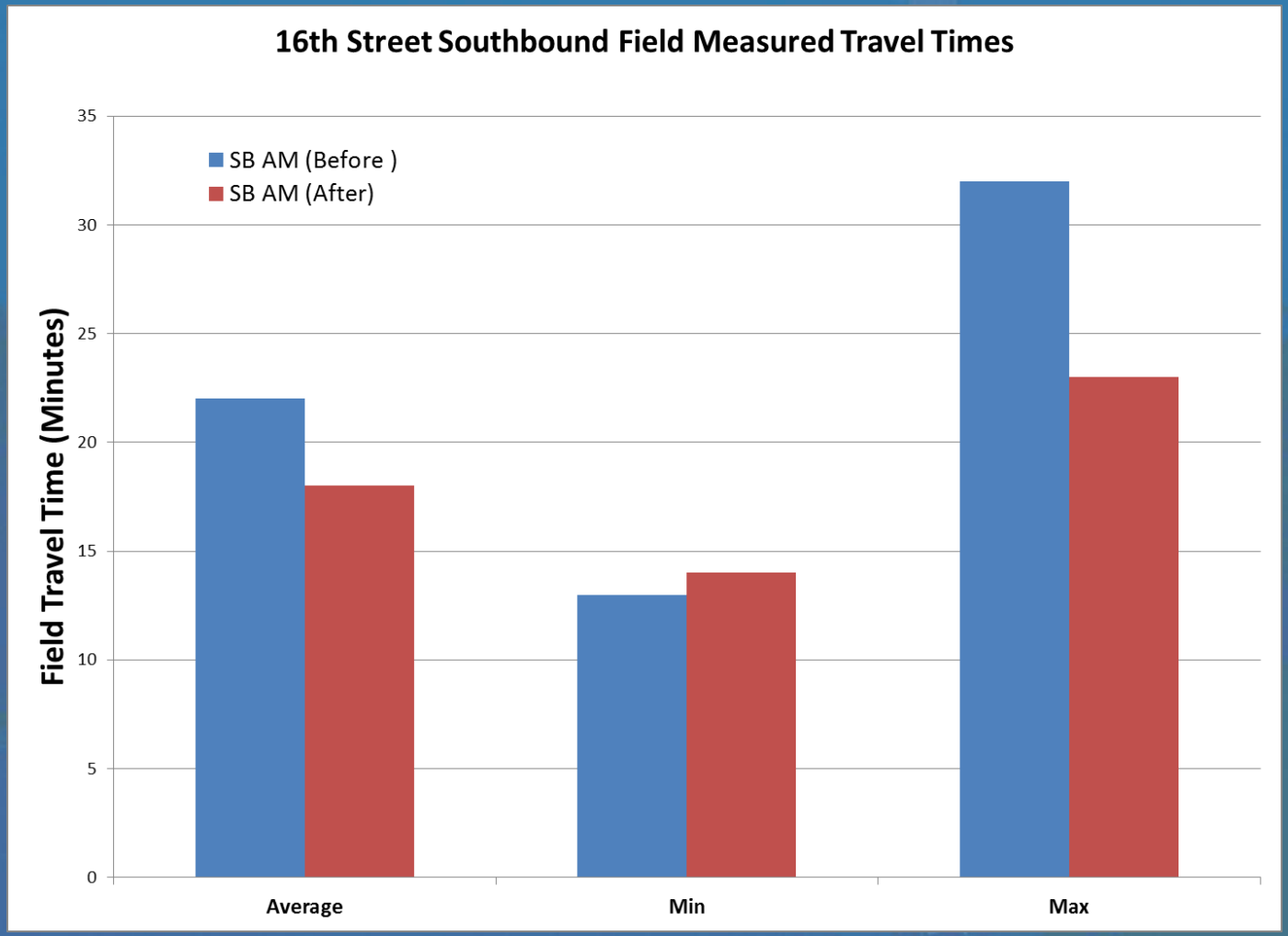
Committed to improving operations on the 16thStreet NW corridor.

Designated 16th Street NW as a transit priority corridor.

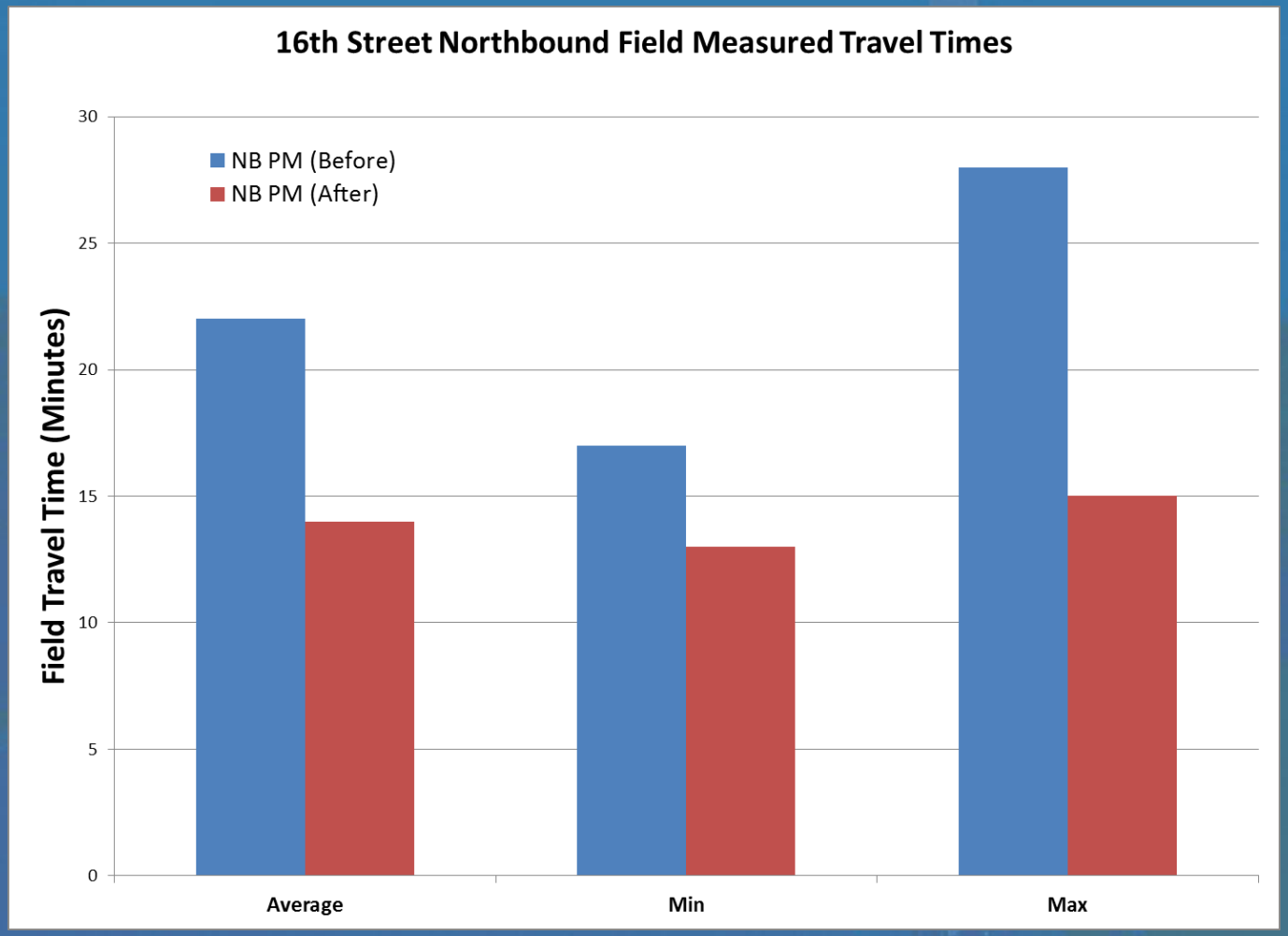
Quick Optimization Results

- Completed in July ’14
- Simulation models show significant savings
- Travel Time:
  - 18% (AM SB) and 51% (PM NB)
- Stops:
  - 42% (AM SB and PM NB)
- Delays:
  - 45% (AM SB) and 81% (PM NB)

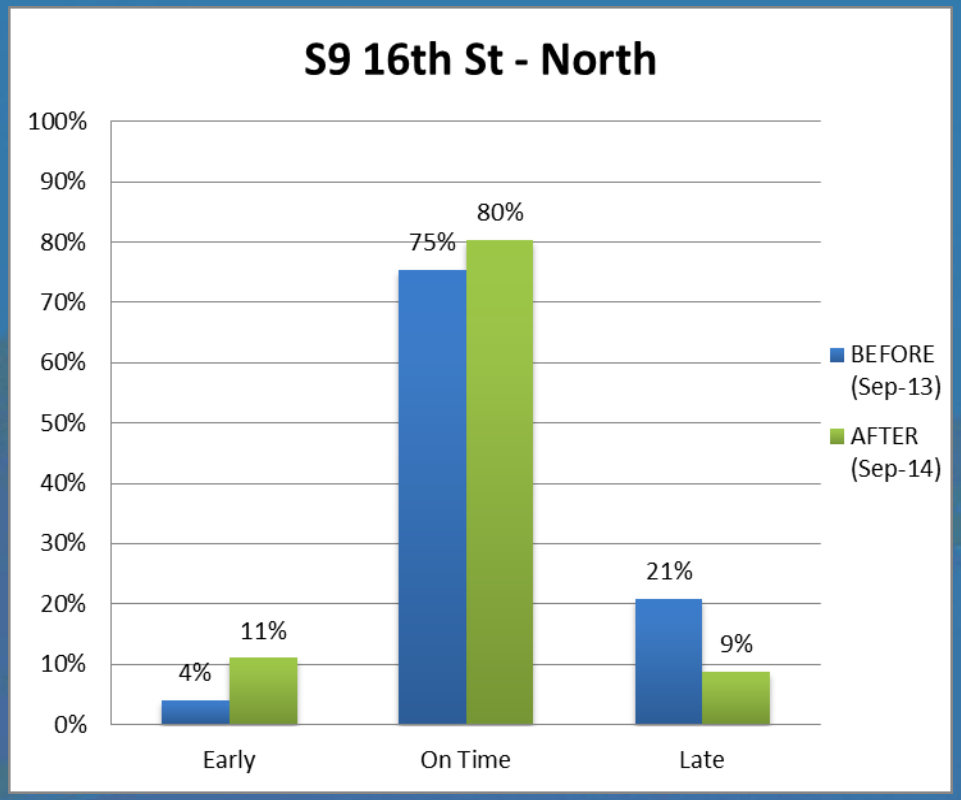
Quick Optimization Results – Field Travel Times

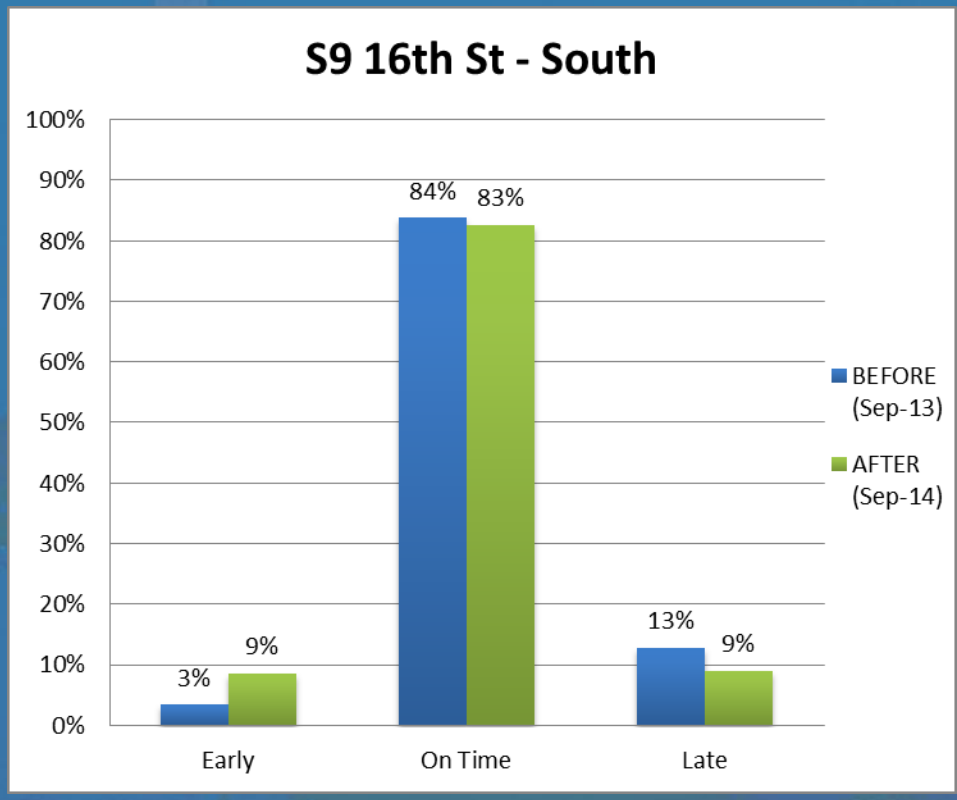


Quick Optimization Results – Field Travel Times

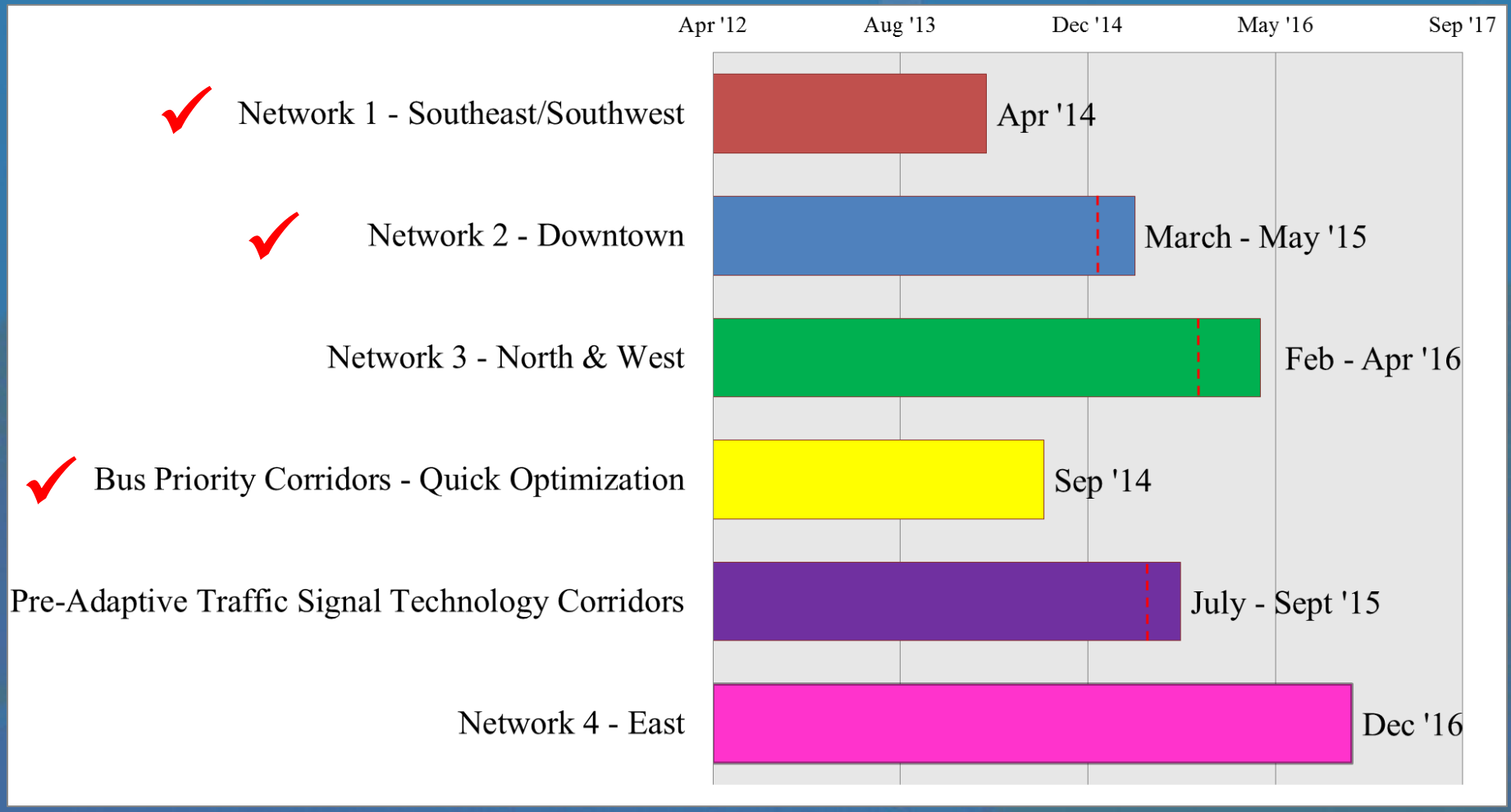


Bus Performance – S9





Schedule


Apr '12
Aug '13
Dec '14
May '16
Sep '17
✓ Network 1 - Southeast/Southwest
Apr '14
✓ Network 2 - Downtown
March - May '15
Network 3 - North & West
Feb - Apr '16
✓ Bus Priority Corridors - Quick Optimization
Sep '14
Pre-Adaptive Traffic Signal Technology Corridors
July - Sept '15
Network 4 - East
Dec '16

Questions?

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