M-24 BOULEVARD DESIGN AND
THE BENEFITS OF THE MICHIGAN LEFT-TURN SYSTEM

Lori J. Pawlik, PE, PTOE • October 3, 2018 • OTEC
M-24 (Lapeer Road) Corridor
2015 Existing Conditions

• Major north-south corridor in Oakland County, Michigan
• 5.2-mile section with 14 signalized intersections/crossovers
• Four-lane narrow median highway at 55 miles per hour
• 36,700 vehicles/day & 1,500 – 2,200 trucks/day
• Land uses – industrial, commercial, residential, schools, Palace of Auburn Hills
Existing Safety and Operational Deficiencies

- Congestion and delays – failing levels of service
- Safety Concerns – 281 Crashes/Year
  - 2 Fatal, 17 Type A Incapacitating
- Mixture of single direction and bidirectional crossovers
- Major intersections – some direct left, some Michigan Left
- Highly directional traffic (AM – 75/25, PM – 36/64 split)
- Driveway, sight distances, pedestrian accommodations lacking
M-24 (Lapeer Road) Corridor Design

• Michigan Department of Transportation (MDOT) invested $35 million in rehabilitation

• Option not feasible to widen from two lanes in each direction to three; therefore, other mitigation measures were analyzed
  • *Michigan Left-Turn Boulevard* and other geometric improvements
  • Improved crossover storage and capacity
  • The addition of right-turn lanes
  • Pedestrian improvements
Michigan Left-Turn Operation

Developed in the 1960s to avoid the interlocking left-turn movements

Left-turns prohibited

To turn left, drive straight or turn right, then U-turn at crossover

Michigan Left-Turn Demonstration

https://www.michigan.gov/documents/mdot/MDOT_Roads-Travel_mich_left_213414_7.swf
Benefits of the Michigan Left-Turn Design

- **Increases safety** by reducing:
  - The number and severity of crashes for *all crashes* (30% to 60%)
  - *Rear-end left-turn* and *head-on left-turn crashes* (60% to 90%)
  - *Right angle crashes* (60%)

- **20 to 50% greater capacity** than direct left-turns, relieving congestion

- Easy to understand

- **Increased pedestrian safety and comfort**
  - Crossing one direction at a time, median refuge, longer time to cross
M-24 Corridor Improvements

Before

Direct Left-Turn Intersection

After

Michigan Left-Turn Boulevard Intersection

Truck Loon Dual Left-Turns Signalized

Truck Loon Dual Left-Turns Signalized
M-24 Corridor Improvements

**Before**
Bidirectional Crossover Operation

**After**
Directional Pair of Crossovers Operation
Silver Bell Road and M-24 Intersection Operations

Before

- LOS F during AM & PM peak hours
  - PM NB 233.7 sec
- Left-turns permitted EB, WB, NB & SB
- EB/WB misaligned – split/four phases
- 33.8 crashes/year & 5.4 injury crashes/year
  - Sideswipe and angle
Silver Bell Road and M-24 Intersection Operations

After

• LOS C and LOS B during AM & PM peak hours
• Michigan Left conversion, reduced conflicts
• Split/four-phase to two-phase signal
• Silver Bell – corrected alignment, dual right-turns
• Dual left-turns at signalized crossovers
• Pedestrian refuge
• 26.0 crashes/year and 7 injury crashes/year
Silver Bell Road and M-24 Intersection Operations

Before

After
Silver Bell Road and M-24
Westbound Silver Bell Approach

Before

After
Silver Bell Road and M-24
Southbound M-24 Approach

Before

After
Before

- LOS C & LOS E during AM & PM peak hours
- Left-turns permitted EB, WB & SB, but not NB
- Heavy school bus traffic WB, experiencing delays and long queues
- Three phase signal
- 23.8 crashes/year & 5 injury crashes/year
Scripps Road and M-24 Intersection Operations

After

- LOS D & LOS C during AM & PM peak hours
- Michigan Left conversion, reduced conflicts
- Three to two phases
- WB shared through and right-turn added to for heavy school bus and school traffic
- 7.0 crashes/year & no injury crashes
Scripps Road and M-24 Intersection Operations

Before

After
Clarkston Road and M-24 Intersection Operations

Before

• LOS E & LOS D during AM & PM peak hours
• Michigan Left boulevard; however, buses and trucks permitted to direct left-turn
  • Unexpected turns from these vehicle types
• Crossover to the north – operational issues
  • LOS E for left-turns (400 vph)
  • Inadequate distance and queuing through Clarkston
  • Inadequate turning radius for trucks
• 42.6 crashes/year & 6.8 injury crashes/year
Clarkston Road & M-24
Intersection Options to Accommodate Truck Turns

1. Six-lane boulevard
2. Five-lane standard roadway
3. Northbound to westbound loop
4. Superstreet – right-turns only from Clarkston
5. Roundabout
Clarkston Road and M-24 Intersection Operations

After

• **LOS C** during both AM & PM peak hours
• Six-lane boulevard with Michigan Left option requiring crossover to the north improvements
  • Trucks now prohibited at Clarkston
  • Crossover moved further north, dual left-turns, truck loon
• **40.0 crashes/year & 8.0 injury crashes/year**
Clarkston Road and M-24 Intersection Operations

Before

NB to SB Crossover

After

EB to SB Crossover

EVERYONE!
M-24 Construction Operations

- Lane closures allowed in peak periods, in non-peak direction only
- Modeled and prepared timings for each phase of construction
- Determined user costs for Liquidated Damages ($4,100/hr)
18 New Modernized Optimized Traffic Signals

- Box span layouts with near/far signal operation
- Fully-actuated operation and SCATS
- Reflective signal backplates
- Countdown pedestrian signals/pushbuttons
## Signal Optimization Study

### Annual Benefit to Cost = 5.72

<table>
<thead>
<tr>
<th>Field Study Results</th>
<th>AM Peak</th>
<th>Off Peak</th>
<th>PM Peak</th>
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</thead>
<tbody>
<tr>
<td>Travel Time Reduced by (seconds)</td>
<td>178.9</td>
<td>63.6</td>
<td>56.6</td>
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<tr>
<td>Delay Reduced by (seconds/vehicle)</td>
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<td>Speed Increased by (mph)</td>
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<td>Daily Vehicle-Hours of Travel Reduced by:</td>
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<td>Daily Fuel Consumption Reduced by:</td>
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⭐ Actual Travel Time Runs Before and After – 151.8 Seconds Reduction
Significant improvements
- Clarkston Rd
- Scripps Rd
- Silver Bell Rd
Initial crash review shows reduction at two intersections that were reconfigured.

**Corridor Crash Rate/Mile**
- Before = 4.04, After = 3.56
- After = 0.70, After = 0.67

**Total crashes – 90% confidence**

**Injury crashes – not statistically significant**

### Before

<table>
<thead>
<tr>
<th>Street</th>
<th>Total</th>
<th>Injury</th>
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<tbody>
<tr>
<td>Clarkston Rd</td>
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<td>Commercial Dr</td>
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<td>Stadium Dr</td>
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</tr>
<tr>
<td>Scripps Rd</td>
<td>23.8</td>
<td>5.0</td>
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<tr>
<td>Silver Bell Rd</td>
<td>33.8</td>
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<tr>
<td>Brown Rd/Dutton Rd</td>
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<td>4.4</td>
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### After

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<thead>
<tr>
<th>Street</th>
<th>Total</th>
<th>Injury</th>
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</thead>
<tbody>
<tr>
<td>Clarkston Rd</td>
<td>40.0</td>
<td>8.0</td>
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<tr>
<td>Commercial Dr</td>
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<td>Stadium Dr</td>
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<tr>
<td>Scripps Rd</td>
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<td>Silver Bell Rd</td>
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<tr>
<td>Brown Rd/Dutton Rd</td>
<td>22.0</td>
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“I would like to pass my compliments to those who designed and executed the M-24 improvements between I-75 and Lake Orion last year. I travel that stretch of road every day and the improvement in my morning and evening drives has been significant. Often I can go from Dhaner Road all the way to where M-24 turns into Opdkye without stopping once. This is truly a wonder and I appreciate the expertise in concept, design, and execution which accomplished this.”