



**Federal Aviation  
Administration**

# **Cleveland/Detroit Metroplex Optimization of Airspace and Procedures**

Study Team Final Report

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By

Cleveland/Detroit Metroplex Study Team

# Table of Contents

<b>1</b>	<b>Background</b>	<b>1</b>
<b>2</b>	<b>Purpose of the Metroplex Study Team</b>	<b>2</b>
<b>3</b>	<b>Cleveland/Detroit Metroplex Study Team Analysis Process</b>	<b>3</b>
3.1	Five Step Process	3
3.2	Cleveland/Detroit Study Area Scope	5
3.3	Assumptions and Constraints	6
3.4	Assessment Methodology	6
3.4.1	Track Data Selected for Analyses	7
3.4.2	Analysis and Design Tools	9
3.4.3	Determining the Number of Operations and Modeled Fleet Mix	10
3.4.4	Determining Percent of RNAV Capable Operations by Airport	12
3.4.5	Profile Analyses	13
3.4.6	Cost to Carry (CTC)	13
3.4.7	Benefits Metrics	13
3.5	Key Considerations for Evaluation of Impacts and Risks	15
<b>4</b>	<b>Identified Issues and Proposed Solutions</b>	<b>16</b>
4.1	Design Concepts	16
4.2	CLE Procedures	19
4.2.1	CLE Arrivals	20
4.2.2	CLE Departures	34
4.2.3	CLE SAT Departures Issues	43
4.2.4	Summary of Potential Benefits for CLE	44
4.3	DTW Procedures	45
4.3.1	DTW Arrivals	45
4.3.2	DTW Departures	72
4.3.3	Summary of Potential Benefits for DTW	85
4.4	D21 Airspace Issues	86
4.5	T-Route Notional Designs	87
4.6	Military Issues	88
4.6.1	180 <sup>th</sup> FW Issues	88
4.6.2	KMTC Issues	89
4.7	Industry Issues	90
4.8	Out of Scope Issues	90
4.9	Additional D&I Considerations	91
<b>5</b>	<b>Summary of Benefits</b>	<b>92</b>
5.1	Qualitative Benefits	92
5.1.1	Near-Term Impacts	92

5.1.2	Long-Term Impacts to Industry	93
5.2	Quantitative Benefits	93
<b>Appendix A</b>	<b>Acronyms</b>	<b>95</b>
<b>Appendix B</b>	<b>PBN Toolbox</b>	<b>99</b>

## List of Figures

Figure 1. Sample Analysis: Lateral and Vertical Baselines	14
Figure 2. Benefits, Impacts, and Risks of the Departure Proposals	18
Figure 3. Benefits, Impacts, and Risks of the Arrival Proposals	19
Figure 4. Current CLE CHARDON STAR and Proposed CLE NE STAR en route view	21
Figure 5. Current CLE CHARDON STAR and Proposed CLE NE STAR terminal view	22
Figure 6. Current KEATN STAR and Proposed CLE SE STAR en route view	24
Figure 7. Current KEATN STAR and Proposed CLE SE STAR terminal view	25
Figure 8. Current ZABER and Proposed CLE SW STAR en route view	27
Figure 9. Current ZABER and Proposed CLE SW STAR terminal view	28
Figure 10. Current HIMEZ and Proposed CLE NW STAR en route view	30
Figure 11. Current HIMEZ and Proposed CLE NW STAR terminal view	31
Figure 12. Current FAILS ONE STAR and Proposed CLE SAT STARS	33
Figure 13. Current PDR flight tracks and Proposed CLE NE 1 and 2 SIDs	35
Figure 14. Current PDR flight tracks and Proposed CLE SE SID	37
Figure 15. Current PDR flight tracks and Proposed CLE S SID Benefits	39
Figure 16. Current ALPHE THREE, AMRST THREE and OBRLN THREE and Proposed CLE W1, W2 and W3 SIDs terminal view	41
Figure 17. Current ALPHE THREE, AMRST THREE and OBRLN THREE and Proposed CLE W1, W2 and W3 SIDs en route view	42
Figure 18. Proposed SAT PDRs	44
Figure 19. Current SPICA TWO and Proposed DTW NE 1 and NE 2 NORTH STARS en route view	48
Figure 20. Current SPICA TWO and Proposed DTW NE 1 and NE 2 NORTH STARS terminal view	49
Figure 21. Current SPICA TWO and Proposed DTW NE 1 and NE 2 SOUTH/WEST STARS en route view	51
Figure 22. Current SPICA TWO and Proposed DTW NE 1 and NE 2 SOUTH/WEST STARS terminal view	52
Figure 23. Current GEMNI THREE and WEEDA ONE Proposed DTW SE 1 and SE 2 SOUTH STARS en route view	54
Figure 24. Current GEMNI THREE and WEEDA ONE and Proposed DTW SE 1 and SE 2 SOUTH STARS terminal view	55
Figure 25. Current GEMNI THREE and WEEDA ONE Proposed DTW SE 1 and SE 2 NORTH/WEST STARS en route view	57

Figure 26. Current GEMNI THREE and WEEDA ONE and Proposed DTW SE 1 and SE 2 NORTH/WEST STARs terminal view	58
Figure 27. Current MIZAR THREE Proposed DTW SW 1 and SW 2 NORTH STARs en route view	61
Figure 28. Current MIZAR THREE Proposed DTW SW 1 and SW 2 NORTH STARs terminal view	62
Figure 29. Current MIZAR THREE Proposed DTW SW 1 and SW 2 SOUTH/WEST STARs en route view	64
Figure 30. Current MIZAR THREE Proposed DTW SW 1 and SW 2 SOUTH/WEST STARs terminal view	65
Figure 31. Current POLAR THREE Proposed DTW NW 1 and NW 2 SOUTH STARs en route view	67
Figure 32. Current POLAR THREE Proposed DTW NW 1 and NW 2 SOUTH STARs terminal view	68
Figure 33. Current POLAR THREE Proposed DTW NW 1 and NW 2 NORTH/WEST STARs en route view	69
Figure 34. Current POLAR THREE Proposed DTW NW 1 and NW 2 NORTH/WEST STARs terminal view	70
Figure 35. DTW SAT STARs	72
Figure 36. Current STCLR SIX and PALCE SEVEN SIDs and Proposed DTW N 1, N 2 and N 3 SIDs terminal view	74
Figure 37. STCLR and PALCE SEVEN and Proposed DTW N 1, N 2 and N 3 SIDs en route view	75
Figure 38. Current ERRTH THREE, MOONN FOUR, STCLR SIX and AKRON THREE SIDs and Proposed DTW E 1, E 2 and E 3 SIDs terminal view	77
Figure 39. ERRTH THREE, MOONN FOUR, STCLR SIX and AKRON THREE SIDs and Proposed DTW E 1, E 2 and E 3 SIDs en route view	78
Figure 40. Current STCLR SIX, ROD THREE, RID FIVE, FWA FOUR and PALCE SEVEN SIDs and Proposed DTW S 1, S 2 and S 3 SIDs terminal view	80
Figure 41. STCLR SIX, ROD THREE, RID FIVE, FWA FOUR and PALCE SEVEN SIDs and Proposed DTW S 1, S 2 and S 3 SIDs en route view	81
Figure 42. Current PALCE SEVEN SID and Proposed DTW W 1, W 2 and W 3 SIDs	83
Figure 43. DTW SAT Departures Preferred Routing	85
Figure 44. Notional Separation within D21	87
Figure 45. Notional T-Route Designs	88
Figure 46. Notional TOL N STAR	89

## List of Tables

Table 1. Observed Traffic Days	8
Table 2. Modeling Traffic Samples	9
Table 3. Cleveland/Detroit Modeled Fleet Mix	11
Table 4. Primary Runway Configurations for Cleveland/Detroit	12
Table 5. RNAV Equipage by Airport	12
Table 6. Issues Disposition Summary	16
Table 7. Proposed CLE NE STAR Annual Benefits	23
Table 8. Proposed CLE SE STAR Annual Benefits	26
Table 9. Proposed CLE SW STAR Annual Benefits	29
Table 10. Proposed CLE NW STAR Annual Benefits	32
Table 11. Proposed CLE NE 1 and 2 SID Annual Benefits	36
Table 12. Proposed CLE SE SID Annual Benefits	38
Table 13. Proposed CLE S SID Annual Benefits	40
Table 14. Proposed CLE W1, W2 and W3 SIDs Annual Benefits	43
Table 15. Total Annual Fuel Burn Benefits for CLE	45
Table 16. Proposed DTW NE 1 NORTH, NE 1SOUTH/WEST, NE 2 NORTH and NE 2 SOUTH/WEST STARs Annual Benefits	53
Table 17. Proposed DTW SE 1 SOUTH, SE 1 NORTH/WEST, SE 2 SOUTH and SE 2 NORTH/WEST STARs Annual Benefits	59
Table 18. Proposed DTW SW 1 NORTH, SW 1 SOUTH/WEST, SW 2 NORTH and SW 2 SOUTH/WEST STARs Annual Benefits	66
Table 19. Proposed DTW NW 1 SOUTH, NW 1 NORTH/WEST, NW 2 SOUTH and NW 2 NORTH/WEST STARs Annual Benefits	71
Table 20. Proposed DTW N 1, N 2 and N 3 SIDs Annual Benefits	76
Table 21. Proposed DTW E 1, E 2 and E 3 SIDs en route view Annual Benefits	79
Table 22. Proposed DTW S 1, S 2 and S 3 SIDs Annual Benefits	82
Table 23. Proposed DTW W 1, W 2 and W 3 SIDs Annual Benefits	84
Table 24. Total Annual Fuel Burn Benefits for DTW	86
Table 25. Total Annual Fuel Benefits Associated with Distance, Profile, and Filed Mile Changes	94

# 1 Background

In September 2009, the Federal Aviation Administration (FAA) received the Radio Technical Commission for Aeronautics Task Force 5 (RTCA) Final Report on Mid-Term NextGen Implementation. The final report contained top priorities for the implementation of NextGen initiatives. These initiatives include the formation of teams leveraging FAA and Industry Performance Based Navigation (PBN) expertise and experience to expedite implementation of optimized airspace and procedures.

Metroplex was developed in direct response to the recommendations from Task Force 5 to provide a systematic, integrated, and expedited approach to implementing PBN procedures and associated airspace changes. This process focuses on a geographic area, rather than a single airport and from planning to post-implementation, will have an expedited life-cycle of approximately three years.

Metroplex projects are centered on two types of collaborative teams:

- Metroplex Study Teams (MST) provides a comprehensive, front-end strategic look at each major metroplex.
- Using the results of the MST, Design and Implementation (D&I) Teams provide a systematic, effective approach to the design, evaluation and implementation of PBN-optimized airspace and procedures.

## **2 Purpose of the Metroplex Study Team**

The principle objective of the MST is to identify operational issues and propose PBN procedures and/or airspace modifications ultimately optimizing the operations within the study area. These efficiencies include utilizing existing aircraft equipment by adding Area Navigation (RNAV) procedures, optimizing descent and climb profiles to eliminate or reduce level-offs, and adding more direct RNAV routing in both the en route and terminal environments. The products of the MST will be used to scope future detailed design efforts.



## **3 Cleveland/Detroit Metroplex Study Team Analysis Process**

### **3.1 Five Step Process**

The Cleveland/Detroit MST followed a five step analysis process:

1. Collaboratively identify and characterize existing issues:
  - a) Review current operations
  - b) Solicit input to obtain an understanding of the broad view of operational challenges in the metroplex
2. Propose conceptual procedure designs that will address the issues and optimize the operation:
  - a) Use an integrated airspace and PBN “toolbox” (Appendix B)
  - b) Obtain technical input from operational stakeholders
  - c) Explore potential solutions to the identified issues
3. Quantitatively and qualitatively identify the expected benefits of the notional designs:
  - a) Assess the Rough Order of Magnitude (ROM) impacts of conceptual designs
  - b) Use objective and quantitative assessments as required
4. Identify considerations and risks associated with the proposed changes:
  - a) Describe high-level considerations (e.g., if additional feasibility assessments are needed)
  - b) Risks (e.g., if waivers may be needed)
5. Document results

Steps 1 and 2 are worked collaboratively with local facilities and operators through a series of outreach meetings. Step 3 is supported by the Metroplex National Analysis Team (NAT). The methodology used for the quantitative analysis is described in Section 3.4. The NAT is a centralized analysis and modeling resource that is responsible for data collection, visualization, analysis, simulation, and modeling. Step 4 is conducted with the support of the Metroplex Specialized Experts (SE). The SEs provide “on-call” expertise from multiple FAA lines of

business, including environmental, safety, airports, and specific programs like Traffic Management Advisor (TMA).

The Cleveland/Detroit MST process and schedule are shown below:

- Kickoff meeting: January 28, 2014 at Cleveland Air Route Traffic Control Center (ARTCC)
  - Discuss concepts and proposed schedules
  - Establish facility points of contact
  - Make data requests
- Administrative weeks:
  - January 29 – January 31
  - February 3 – February 7
- First Outreach: Existing Operations and Planning
  - FAA Facilities: February 11-12 at Cleveland ARTCC
  - Industry Stakeholders: February 13 at Cleveland ARTCC
- MST work (Issue Matrix and Notional Design Development): February 18 – March 21
- Second Outreach: Enhancement Opportunities
  - FAA Facilities: March 25 - 26 at Cleveland ARTCC
  - Industry Stakeholders: March 27 at Cleveland ARTCC
- MST work (focus on solutions, costs, and benefits): March 31 – April 25

- Final Outreach: Summary of Recommendations
  - FAA Facilities: April 30 at Cleveland ARTCC
  - Industry Stakeholders: May 1 at Cleveland ARTCC
- Documentation: Final report, final briefing, and Study Team package
  - MST work (complete all documentation): May 5 - 16
  - Report due May 16

There were three rounds of outreach meetings with local facilities, industry, and other stakeholders, including Department of Defense, business and general aviation, airports, and others. The First Outreach focused on issue identification, the Second Outreach on conceptual solutions, and the Final Outreach on summarizing the analyses of benefits, impacts, and risks. Assessments at this stage in the Metroplex process are expected to be high-level. More detailed analyses of benefits, impacts, costs and risks are expected after the D&I phase has been completed.

### **3.2 Cleveland/Detroit Study Area Scope**

The Cleveland/Detroit Metroplex consists of those facilities and airspace that contain the primary flows of traffic serving the Cleveland-Hopkins International Airport (CLE), Detroit Metropolitan Wayne County Airport (DTW), their respective satellite airports and adjacent facilities that interact with CLE/DTW primary traffic flows. The principal ATC facilities serving the Cleveland metroplex are Cleveland Air Traffic Control Tower (ATCT) and the Cleveland Air Route traffic control Center (ARTCC). The principal ATC facilities serving the Detroit metroplex are Detroit TRACON (D21), Detroit ATCT and Cleveland ARTCC.

- Cleveland Area Airports
  - Cleveland-Hopkins International Airport (CLE)
  - Cuyahoga County Airport (CGF)
  - Burke Lakefront Airport (BKL)
- Detroit Area Airports
  - Detroit Metropolitan Wayne-County Airport (DTW)
  - Oakland County International Airport (PTK)
  - Willow Run Airport (YIP)

### **3.3 Assumptions and Constraints**

Metroplex is an optimized approach to integrated airspace and procedures projects; thus, the proposed solutions center on PBN procedures and airspace redesign. The MST is expected to document those issues that cannot or should not be addressed by airspace and procedures solutions. These issues are described in Section 4 of this report.

The Metroplex expedited timeline and focused scope bound airspace and procedures solutions to those that can be achieved without requiring an Environmental Impact Statement (EIS) (e.g., only requiring an Environmental Assessment [EA] or qualifying for a Categorical Exclusion [CATEX]) and are within current infrastructure and operating criteria. The MST may also identify airspace and procedures solutions that do not fit within the environmental and criteria boundaries of a Metroplex project. These other recommendations then become candidates for other integrated airspace and procedures efforts.

### **3.4 Assessment Methodology**

Both qualitative and quantitative assessments were made to gauge the potential benefits of proposed solutions. The qualitative assessments are those that the MST could not measure but would result from the implementation of the proposed solutions. These assessments included:

- Impact on air traffic control (ATC) task complexity
- Ability to laterally or vertically segregate flows
- Impacts of flow segregation on adjacent facilities
- Ability to enhance safety
- Improved connectivity to en route structure
- Reduction in pilot-controller transmissions to minimize frequency congestion
- Improved track predictability and repeatability
- More efficient fuel planning
- Reduced reliance on ground-based navigational aids (NAVAIDs)
- Increased systemic efficiencies

An example of qualitative assessment is task complexity. Task complexity can be lessened through the application of structured PBN procedures versus the use of radar vectors, but quantifying that impact is difficult. Reduced communications between pilot and controller, as

well as reduced potential for operational errors, are examples of metrics associated with controller task complexity that were not quantified.

For the quantitative assessments, the MST identified changes in track lengths, flight times, time in level flight, and fuel burn. Potential benefits were measured by comparing current flights to the MST proposed procedures using a Monte Carlo method<sup>1</sup> to approximate aircraft behavior based on distributions from historic radar tracks. Fuel burn for these aircraft was calculated from MITRE's validated implementation of the European Organization for the Safety of Air Navigation (EUROCONTROL) Base of Aircraft Data (BADA) Total Energy fuel burn model. The quantitative analyses compared full-time use of current procedures under baseline conditions with full-time use of the procedures proposed by the MST.

### **3.4.1 Track Data Selected for Analyses**

During the study process, a representative set of radar traffic data was utilized in order to maintain a standardized operational reference point. For determining the number, length, and location of level-offs for the baseline of operational traffic, radar track data from twelve high-volume (80<sup>th</sup>-90<sup>th</sup> percentile) days, operating under mostly visual meteorological conditions (VMC) in 2012 and 2013, were utilized. These days were selected using the Airport Specific Performance Metrics (ASPM) operational counts and weather data. In addition to the high operations days, two winter days and one DTW west operations day were chosen to ensure all aspects of the operation were considered. Table 1 shows the analysis days utilized by the CLE/DTW MST.

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<sup>1</sup> Monte Carlo methods are a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results

**Table 1. Observed Traffic Days**

DATE	DTW		CLE		ZOB	
	Ops	% Rank	Ops	% Rank	Ops	% Rank
7/31/2013	1,350	94.50%	567	70.80%	7,247	98.00%
6/19/2013	1,347	93.90%	591	91.70%	7,189	97.20%
6/18/2013	1,345	93.40%	584	86.20%	7,105	94.70%
8/2/2013	1,339	92.00%	591	91.70%	6,773	83.20%
7/11/2013	1,337	91.40%	598	95.80%	7,402	99.10%
8/19/2013	1,337	91.40%	577	79.30%	6,740	80.70%
6/11/2013	1,336	90.90%	594	93.40%	7,033	92.80%
7/15/2013	1,336	90.90%	588	89.50%	6,749	81.50%
7/17/2013	1,326	89.20%	580	83.50%	7,127	95.60%
6/6/2013	1,319	88.70%	590	91.20%	6,986	91.70%
8/22/2013	1,306	88.10%	589	90.30%	6,943	90.60%
11/26/2012	1,299	84.80%	584	86.20%	6,368	60.70%
1/14/2013	1,170	42.80%	522	53.80%	5,744	36.20%
2/14/2013	1,168	40.90%	584	86.20%	6,427	63.10%
12/21/2012	1,167	40.30%	528	57.10%	5,811	37.60%

The historical radar track data were used to visualize the flows and identify where short-cuts were routinely applied, as well as where flight planned routes were more rigorously followed. The track data were also used as a baseline for the development of conceptual solutions, including PBN routes and procedures. In many cases, the MST overlaid the historical radar tracks with PBN routes or procedures to minimize the risk of significant noise impact and an associated EIS.

In addition to the track data used for issue visualization and procedure design, four weeklong periods of data during different times of the year were chosen for the modeling of benefits. This ensured the fuel burn analysis captured any day-to-day fluctuation in operations. Table 2 displays the four samples of data used for the CLE/DTW MST benefits analysis.

**Table 2. Modeling Traffic Samples**

Periods Sampled
1/14/13 – 1/20/13
4/2/13 – 4/8/13
7/31/13 – 8/6/13
9/12/13 – 9/18/13

Difficulties arise while identifying seven consecutive days of similar high traffic rates while avoiding major anomalies such as TMIs, airport construction or significant weather events. As a result, these periods were chosen for the 70<sup>th</sup> percentile or greater at CLE and the 80<sup>th</sup> percentile or greater at DTW.

### **3.4.2 Analysis and Design Tools**

The following tools were employed by the MST and the NAT in the process of collecting and analyzing flight track data for designing notional procedures within the Cleveland/Detroit Metroplex:

- Performance Data Analysis and Reporting System (PDARS)
  - Historical traffic flow analysis using merged datasets to analyze multi-facility operations
  - Customized reports to measure performance and air traffic operations (i.e., fix loading, hourly breakdowns, origin-destination counts, etc.)
  - Identification and analysis of level flight segments
  - Graphical replays to understand and visualize air traffic operations
- Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS)
  - Comparison of actual flown routes to proposed routes when developing cost/benefit estimates
  - Conceptual airspace and procedure design

- Air Traffic Airspace Lab (ATALAB) National Offload Program (NOP) data queries
  - Quantification of traffic demand over time for specific segments of airspace
- Aviation System Performance Metrics
  - Identification of runway usage over time
- National Traffic Management Log (NTML)
  - Identification of occurrence and magnitude of TMIs
- Enhanced Traffic Management System (ETMS)<sup>2</sup>
  - Traffic counts by aircraft group categories for annualizing benefits
  - Examination of filed flight plans to determine impact of significant re-routes
- Leviathan (A series of metrics computed for every flight in the NAS based on radar track data, weather information, and flight plans)
  - Flow analysis for reference packages
  - Data for baselines for modeling
- Flight Pattern Distribution Generator (FPDG)
  - Build arrival and departure distributions
  - Determine fuel burn

### **3.4.3 Determining the Number of Operations and Modeled Fleet Mix**

Due to the compressed schedule of the MST, there was not sufficient time to model the entire fleet mix for each airport. A representative fleet mix was developed for each traffic flow at CLE and DTW, based on the most common aircraft types on that flow but excluding prop and turboprop flights. The airport-wide modeled fleet mix is shown in Table 3 below.

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<sup>2</sup> ETMS has been renamed Traffic Flow Management System (TFMS)



**Table 3. Cleveland/Detroit Modeled Fleet Mix**

<b>CLE</b>		<b>DTW</b>	
<b>Aircraft Type</b>	<b>Weighted Distribution</b>	<b>Aircraft Type</b>	<b>Weighted Distribution</b>
<b>E145</b>	<b>71%</b>	<b>CRJ2/7/9</b>	<b>55%</b>
<b>B73x</b>	<b>13%</b>	<b>A319/20/21</b>	<b>16%</b>
<b>CRJ2/7/9</b>	<b>9%</b>	<b>E145</b>	<b>13%</b>
<b>A319/20/21</b>	<b>7%</b>	<b>B75x</b>	<b>6%</b>
<b>A306</b>	<b>1%</b>	<b>B73x</b>	<b>5%</b>
<b>MD8x</b>	<b>&lt;1%</b>	<b>MD8x</b>	<b>2%</b>
<b>B752</b>	<b>&lt;1%</b>	<b>B772</b>	<b>1%</b>
		<b>B744</b>	<b>1%</b>
		<b>B76x</b>	<b>&lt;1%</b>

To determine the number of aircraft on each flow, four weeks of Threaded Track<sup>3</sup> data were analyzed. One week was chosen from each season. The annual counts of aircraft on each flow were then estimated by taking the total counts for the four weeks and multiplying by 13.0446. The percentages of time in the two primary runway configurations for each modeled airport were determined by looking at a year’s worth of data, and are shown in Table 4 below.

<sup>3</sup> A Threaded Track is a synthetic trajectory fused from a range of trajectory sources throughout the flight envelope. Sources include: NOP, ASDE-X, TFMS

**Table 4. Primary Runway Configurations for Cleveland/Detroit<sup>45</sup>**

Airport	Flow	Arrival Runways	Departure Runways	% Time in Flow	Comment
DTW	North	3R, 4L, 4R	3L/R, 4L/R	26%	N/A
DTW	South	21L, 22L/R	21R, 22L	74%	Infrequent West Dep on 27L/R
CLE	East	6L/R, 10	6L/R	38%	N/A
CLE	West	24L/R, 28	24L/R	62%	N/A

### 3.4.4 Determining Percent of RNAV Capable Operations by Airport

The principle objective of the Cleveland/Detroit MST was to identify and address operational issues and propose PBN procedures and airspace modifications. The PBN Dashboard was used to determine the percent of operations at each airport that would benefit from these new procedures.

Table 5 lists the RNAV equipage percentages assumed for the modeled Cleveland/Detroit airports.

**Table 5. RNAV Equipage by Airport**

Airport	% of Total Operations RNAV-equipped
CLE	98%
DTW	99%

<sup>4</sup> Source: Aviation System Performance Metrics, CY2011

<sup>5</sup> The PBN Dashboard is an online tool that reports this percentage through analysis of two sources: the equipment suffix from TFMS and the percentage of PBN-equipped aircraft by type from a Part 121 avionics database. Due to the incomplete nature of the data sources used, the percentages of RNAV-equipped operations are assumed to be conservative.

### **3.4.5 Profile Analyses**

To determine the current level-offs of arrivals in the Cleveland/Detroit Metroplex, the MST examined Leviathan merged Threaded Track data from the four weeks discussed previously. The MST identified the altitudes where level-offs occurred and the average length in nautical miles (NM) that aircraft were in level flight at each altitude. The MST also used TARGETS to calculate the length of the current published routes and actual flown tracks. Baseline routes were constructed based on these traffic characteristics and compared to the proposed routes. The reduction in level-offs and the distance savings were then converted into fuel savings by using the FPDG BADA total energy model, taking into account the modeled aircraft fleet mixes at the metroplex airports. The fuel savings were then annualized, assuming a fuel price per gallon of \$3.03 based on fuel costs for January 2013 through December 2013 from Research and Innovative Technology Administration (RITA) Bureau of Transportation Statistics. The resulting benefit numbers were the basis for the potential fuel benefit.

### **3.4.6 Cost to Carry (CTC)**

Aircraft fuel loading is based on the planned flight distance and known level-offs. Furthermore, airlines must carry extra fuel to compensate for the weight of the total fuel required to fly a route. This extra fuel is known as the Cost-to-Carry (CTC). For this analysis, based on feedback from the MST industry representatives, CTC was assumed to be 8% for CLE and 10% for DTW. This means that for every 100 gallons of fuel loaded, CTC is 8 gallons for CLE and 10 gallons for DTW.<sup>6</sup>

### **3.4.7 Benefit Metrics**

The benefits metrics were generated using the following process:

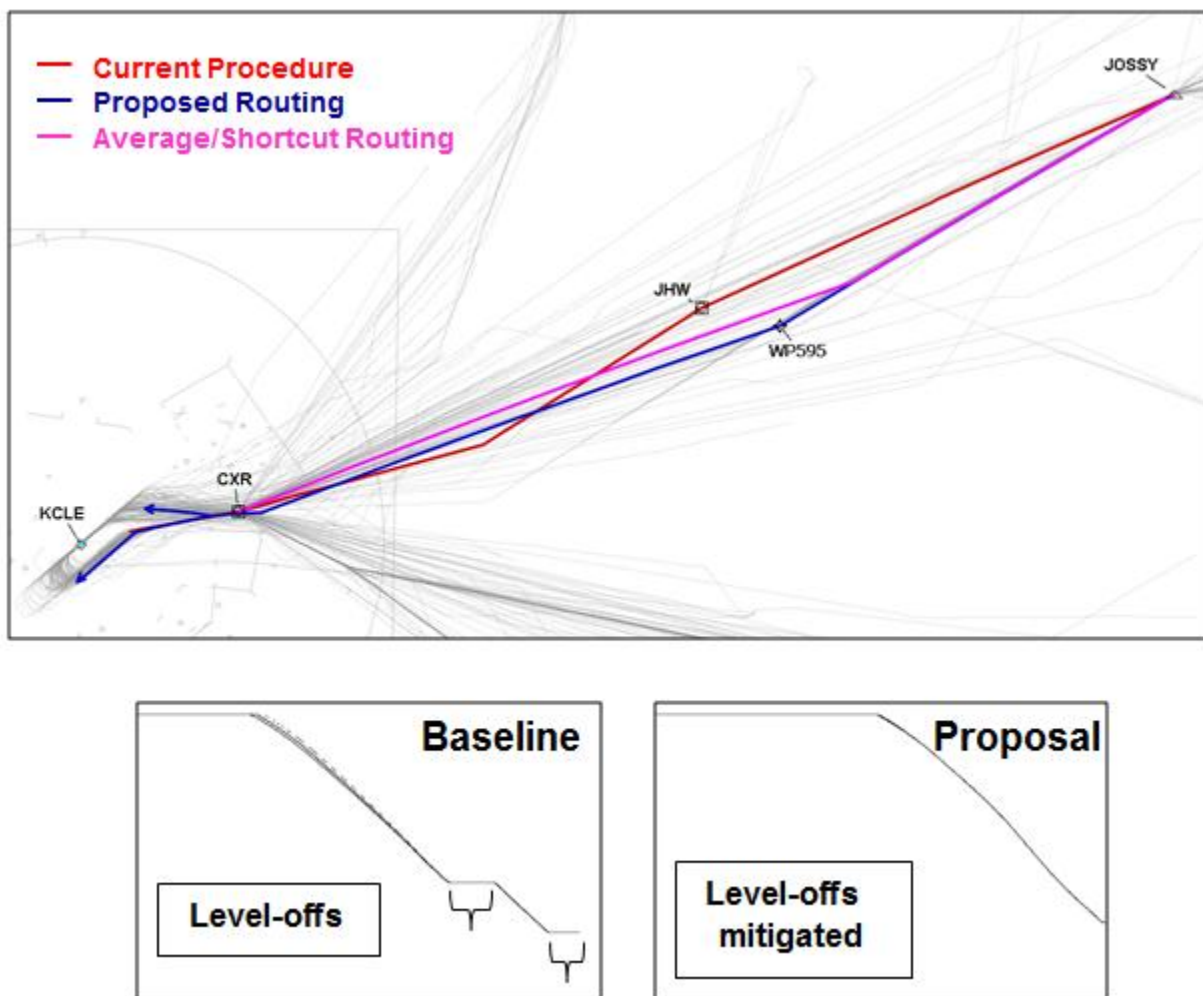
1. The radar track data from the days mentioned previously were parsed by flows into and out of Cleveland and Detroit. These flows were then analyzed to determine geographic location, altitude, and length of level-offs in the airspace. The average overall track flow length was also estimated.
2. Baseline routes were developed that mimic the average vertical and lateral path of the tracks in the flows.
3. Proposed conceptual routes were designed by the MST.
4. The impacts of the proposed conceptual routes were estimated as compared to the current published procedure for the flow, if any, and the baseline route.

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<sup>6</sup> These figures were chosen based on the fact that most of the aircraft flown in the study area are narrow-body; for heavy aircraft or international or long-haul flights, the numbers could be significantly greater.

- a) Vertical savings: Compare the baseline vertical path with its associated level-offs with the proposed vertical path, which ideally has fewer and/or shorter level-offs.
  - b) Lateral distance savings: Compare the length of the baseline procedure or route to the length of the proposed procedure or route.
5. The fuel and cost savings were then estimated based on the above impacts. Both lateral and vertical savings are based on both fuel savings and CTC savings.

Figure 1 shows published, baseline, and proposed routes for a flow, with the comparisons for lateral savings highlighted, and sample vertical profiles as well.



**Figure 1. Sample Analysis: Lateral and Vertical Baselines**

### **3.5 Key Considerations for Evaluation of Impacts and Risks**

In addition to the quantitative and qualitative benefits assessments described in Section 3.4, the Cleveland/Detroit MST was tasked with identifying the impacts and risks from the FAA operational and safety perspective, as well as from the airspace user perspective. For each individual issue and proposed solution throughout Section 4 of this report, specific impacts and risks are identified. However, there are a number of impacts and risks that generally apply to many proposed solutions, as described below:

- **Controller and pilot training:** With the increased focus on PBN and the proposed changes in airspace and procedures, controller and pilot training will be a key consideration for nearly all proposals.
- **“Descend via” procedure issues:** The proposed use of “descend via” clearances will similarly require controller and pilot training, and agreement must be reached during D&I on exactly how procedures will be requested, assigned, and utilized from both the FAA and user perspectives.
- **Aircraft equipage:** There are challenges with working in a mixed equipage environment, and these risks must be considered during D&I. While procedures have been designed to take advantage of PBN efficiencies, procedures and processes must be developed for conventional operations as well.
- **Safety Risk Management (SRM):** Safety is always the primary concern, and all of the proposed solutions will require an SRM assessment, which will occur during the Operational and Environmental Review phase.
- **Environmental issues:** All proposed solutions are subject to environmental review, and the Metroplex schedule limits that review to a CATEX or EA rather than an EIS. The MST worked with environmental specialists to determine whether any of the proposed solutions has the potential for significant environmental impacts, and developed mitigation alternatives if necessary.

## 4 Identified Issues and Proposed Solutions

This section presents the findings and results of the Cleveland/Detroit MST analysis. It reviews identified issues, proposed solutions, benefits/impacts/risks, and analysis results.

Originally 69 issues were submitted to the MST. Similar issues raised by all involved parties were consolidated and categorized by the MST to determine potential solutions. Some issues required additional coordination and input and could not be addressed within the time constraints of the MST process and were deferred to D&I for further consideration. The remaining issues were deemed out of scope.

**Table 6. Issues Disposition Summary**

<b>ATC Facility</b>	<b>Submitted Issues</b>	<b>Out of Scope</b>	<b>Deferred to D&amp;I</b>	<b>Issues Worked</b>
<b>DTW ATCT</b>	10	7	1	2
<b>D21 TRACON</b>	28	4	5	19
<b>CLE ATCT</b>	7	0	1	6
<b>ZOB</b>	9	0	1	8
<b>Industry</b>	15	2	4	9

### 4.1 Design Concepts

The primary goals of the Cleveland/Detroit MST were to use RNAV everywhere and RNP where beneficial. The use of PBN procedures will allow efficiency gains through optimized profile climbs/descents and enhanced lateral paths not reliant on ground based navigation, while allowing predictability and repeatability and reducing ATC task complexity and frequency congestion. The MST removed unused transitions to reduce chart clutter and the potential for improper flight planning. Runway transitions were used where practical, while limiting potential environmental risks. The MST recommends the use of transitional separation (3 NM increasing to 5 NM) that may increase airspace efficiencies for departures.

Currently, controllers rely on an assortment of conventional and RNAV departure procedures. The facilities use both vectors and route structure where necessary to maintain separation and expedite aircraft climbs into en route airspace.

The proposed departure procedures attempt to maintain unrestricted climbs as much as possible, while providing procedural segregation where practical from other Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). It is fully expected that ATC will continue to tactically enable shorter routings and remove climb restrictions. Additionally, the use of transitional separation between terminal and en route facilities may increase airspace efficiency. Transitional separation will allow terminal facilities to provide 3 NM separation increasing to 5 NM in the en route environment. Airspace modifications that enable procedural efficiencies may need to be considered during D&I.

RNAV SIDs with flow dependent transitions were designed for repeatable, predictable paths. The MST recognizes that RNAV off-the-ground procedures may create a disbenefit in track miles flown in certain circumstances. The D&I Team may elect to further evaluate the combination of radar vectors and RNAV off-the-ground SIDs to determine the most beneficial method of departing from Cleveland/Detroit airports.

With respect to the conceptual departure proposals, Figure 2 depicts benefits, impacts, and risks for the FAA and airspace users, as well as environmental considerations.

FAA Operational/Safety	
Benefits	Impacts/Risks
<ul style="list-style-type: none"> <li>• Reduced communications</li> <li>• Multiple runway transitions</li> <li>• Reduced vectoring</li> <li>• Ability to procedurally segregate from STARs</li> <li>• Increased procedure conformance</li> </ul>	<ul style="list-style-type: none"> <li>• Runway transitions</li> <li>• LOA/SOP revisions</li> <li>• Training</li> <li>• Sectorization</li> <li>• Frequency Licensing</li> </ul>

Airspace User	
Benefits	Impacts/Risks
<ul style="list-style-type: none"> <li>• Reduced track miles</li> <li>• Reduced level segments</li> <li>• Reduced cost to carry</li> <li>• Reduced fuel burn and carbon emissions</li> </ul>	<ul style="list-style-type: none"> <li>• Runway assignment</li> <li>• Training</li> </ul>

Environmental Considerations
<ul style="list-style-type: none"> <li>• Noise screening/analysis</li> <li>• Emissions analysis</li> </ul>

**Figure 2. Benefits, Impacts, and Risks of the Departure Proposals**

In general, the issues associated with the current arrival procedures to Cleveland/Detroit were related to inefficient lateral and vertical paths, conflicts with departure traffic, and underutilized en route transitions.

In addition to optimizing vertical profiles, lateral paths were shortened; routes were segregated; unused en route transitions were removed; and flow dependent transitions were proposed. The D&I Team will need to assess the location of waypoints to add additional en route transitions to the STARs. STARs at all major and several satellite airports in Cleveland/Detroit were created. These new STARs are procedurally segregated from SIDs and other STARs where possible.

Procedures associated with the Windsor/Toronto/Montreal (WTM) airspace project, with NAV CANADA, will be implemented in the near term. The MST included WTM proposed changes in the baseline proposal during notional procedure development.

ZOB has been involved with the New York/New Jersey/Philadelphia (NY/NJ/PHL) Airspace Redesign project, which is currently inactive. Based on this status, the MST notional designs used current flows as baseline. If the NY/NJ/PHL project is re-activated, alternative solutions will be required.

Airspace modifications that enable procedural efficiencies will need to be considered during D&I. Current conventional (non-RNAV) STARs may need modification during D&I. Holding



patterns were not designed and need to be addressed in D&I. MST recommends all holding patterns to be designed above or outside the lateral boundary of terminal airspace.

Required Navigational Performance (RNP) Instrument Approach Procedures are recommended to be developed at CLE and DTW during the D&I phase.

With respect to the conceptual arrival proposals, Figure 3 depicts benefits, impacts, and risks for the FAA and airspace users, as well as environmental considerations.

FAA Operational/Safety	
Benefits	Impacts/Risks
<ul style="list-style-type: none"> <li>• Reduced communications</li> <li>• Multiple runway transitions</li> <li>• Reduced vectoring</li> <li>• Increased procedure conformance</li> </ul>	<ul style="list-style-type: none"> <li>• Runway transitions</li> <li>• LOA/SOP revisions</li> <li>• Training</li> <li>• Sectorization</li> <li>• Frequency Licensing</li> </ul>

Airspace User	
Benefits	Impacts/Risks
<ul style="list-style-type: none"> <li>• Reduced track miles</li> <li>• Reduced level segments</li> <li>• Reduced cost to carry</li> <li>• Reduced fuel burn and carbon emissions</li> </ul>	<ul style="list-style-type: none"> <li>• Preferred runway assignment</li> <li>• Training</li> </ul>

Environmental Considerations
<ul style="list-style-type: none"> <li>• Noise screening/analysis</li> <li>• Emissions analysis</li> </ul>

**Figure 3. Benefits, Impacts, and Risks of the Arrival Proposals**

## 4.2 CLE Procedures

CLE is the busiest airport within CLE TRACON terminal area with 494 daily operations on average in 2012, with 95% being either air carrier or air taxi flights. BKL and CGF are the primary satellite airports within CLE TRACON terminal area. CLE TRACON airspace extends from the surface to 12,000 feet mean sea level (MSL) with some shelves. Airspace adjacent to CLE TRACON includes: TOL to the west, D21 to the northwest, ZOB to the north, ERI to the northeast, YNG to the east, CAK to the southeast and MFD to the southwest. ZOB airspace

overlies CLE airspace. CLE has an east/west runway configuration, with the west flow being the predominant flow at 62%.

## **4.2.1 CLE Arrivals**

This section describes the operational issues, solutions, and expected benefits the MST has identified for arrivals to CLE.

Arrival issues for CLE include lack of RNAV STARs, inefficient lateral paths, no vertical profiles (level segments) and excessive vectoring. Short side operations hamper controllers with limited time and/or distance to sequence arrivals. Efficiency can also be degraded where arrivals to satellite airports are mixed with arrivals to CLE.

In en route airspace, the CLE HIMEZ TWO STAR is in close proximity to D21 terminal airspace. This issue is complicated with limited airspace available between D21 and CLE TRACON.

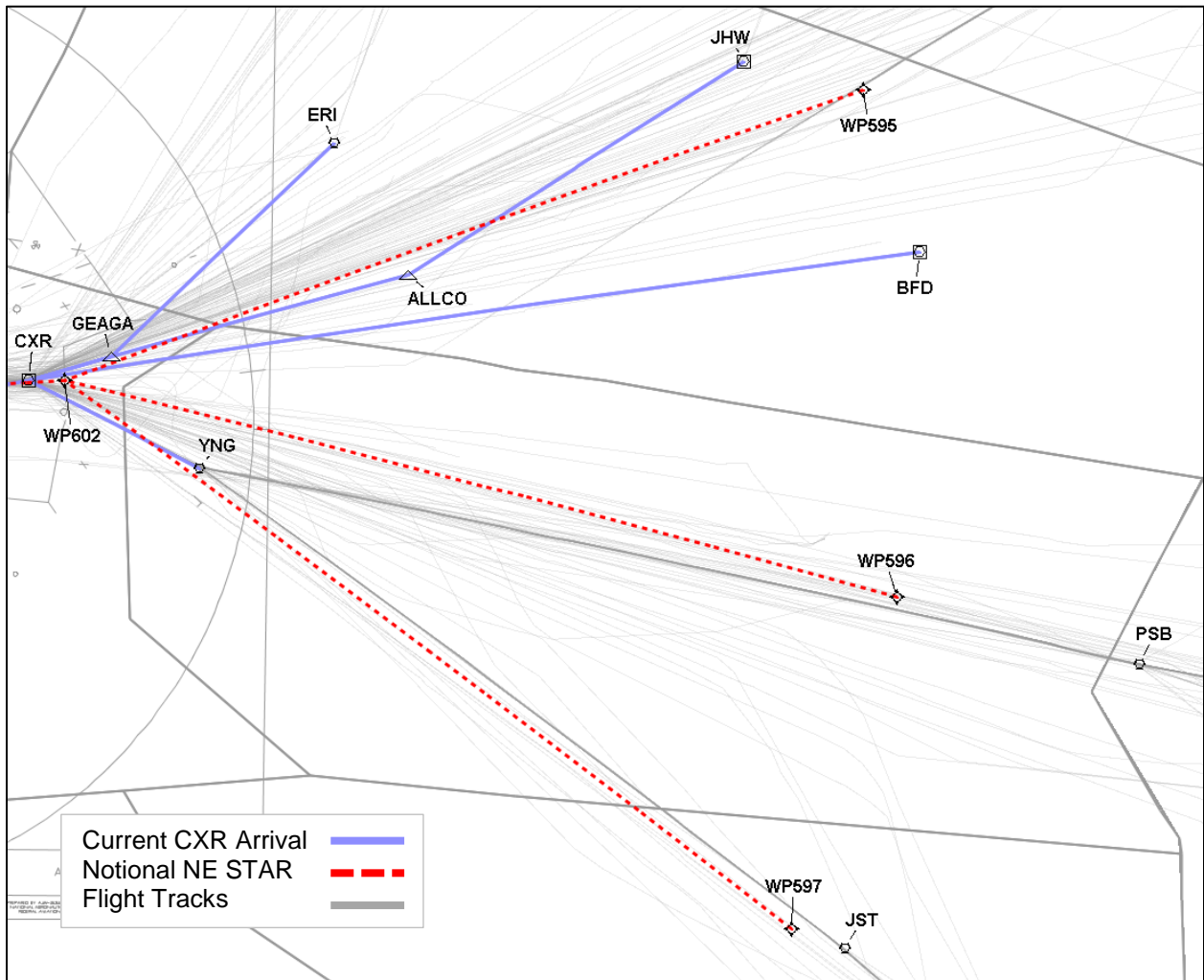
FAAO 7110.65 paragraph 4-7-1 b requires controllers to provide course guidance to multiple runways on initial contact or as soon as practical. If the runway assignment, or any subsequent runway change, is not issued prior to 10 NM from the runway transition waypoint, radar vectors to final must be provided.

### **4.2.1.1 CLE NE STAR**

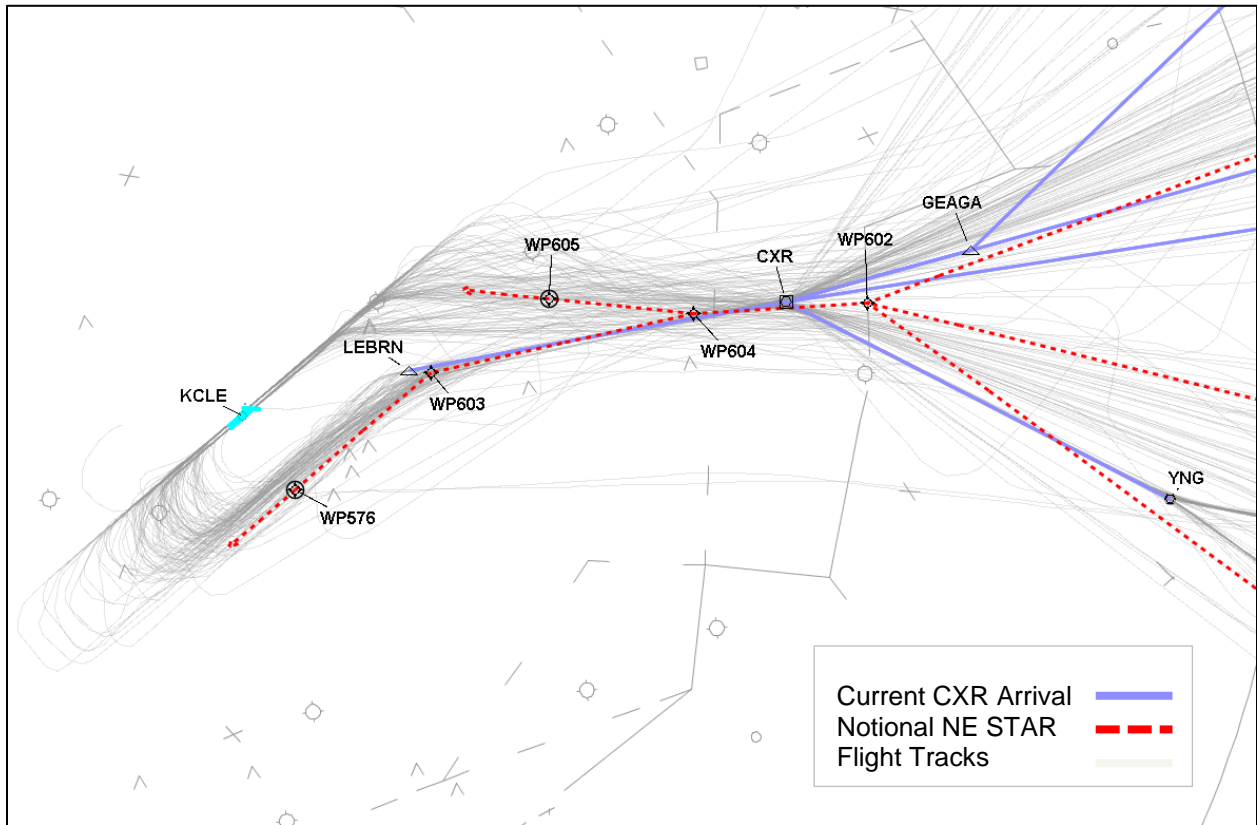
The CLE NE STAR accounts for approximately 39% of all CLE jet arrivals.

- Issues
  - There are excessive level-offs and inefficient lateral paths
  - Lack of RNAV STAR
  - Lack of vertical profile (OPD)
  - Actual flight tracks do not follow current arrival (procedure conformance)
- Solutions
  - Removed unused en route transitions
  - Created en route transitions that mirror current tracks
  - Created runway transitions for east and west flows that terminate in FM legs at 6,000 feet MSL
  - Added terminal speed constraints to manage compression

- Created an RNAV STAR with an OPD



**Figure 4. Current CLE CHARDON STAR and Proposed CLE NE STAR en route view**



**Figure 5. Current CLE CHARDON STAR and Proposed CLE NE STAR terminal view**

- Benefits: Projected annual savings for the proposed CLE NE STAR are estimated in Table 7.

**Table 7. Proposed CLE NE STAR Annual Benefits**

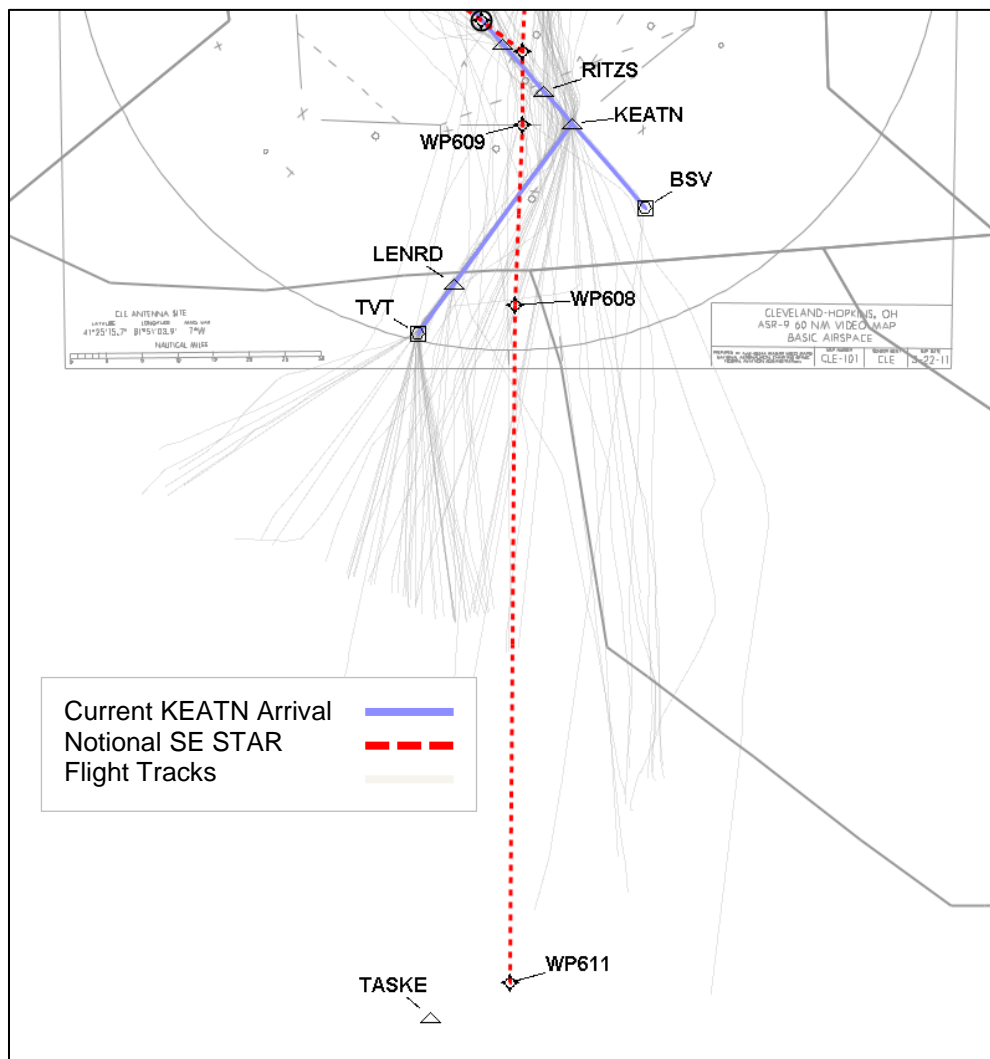
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$327K</b>
	<b>Cost to Carry</b>	<b>\$26K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$353K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>116K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>1,094</b>

#### **4.2.1.2 CLE SE STAR**

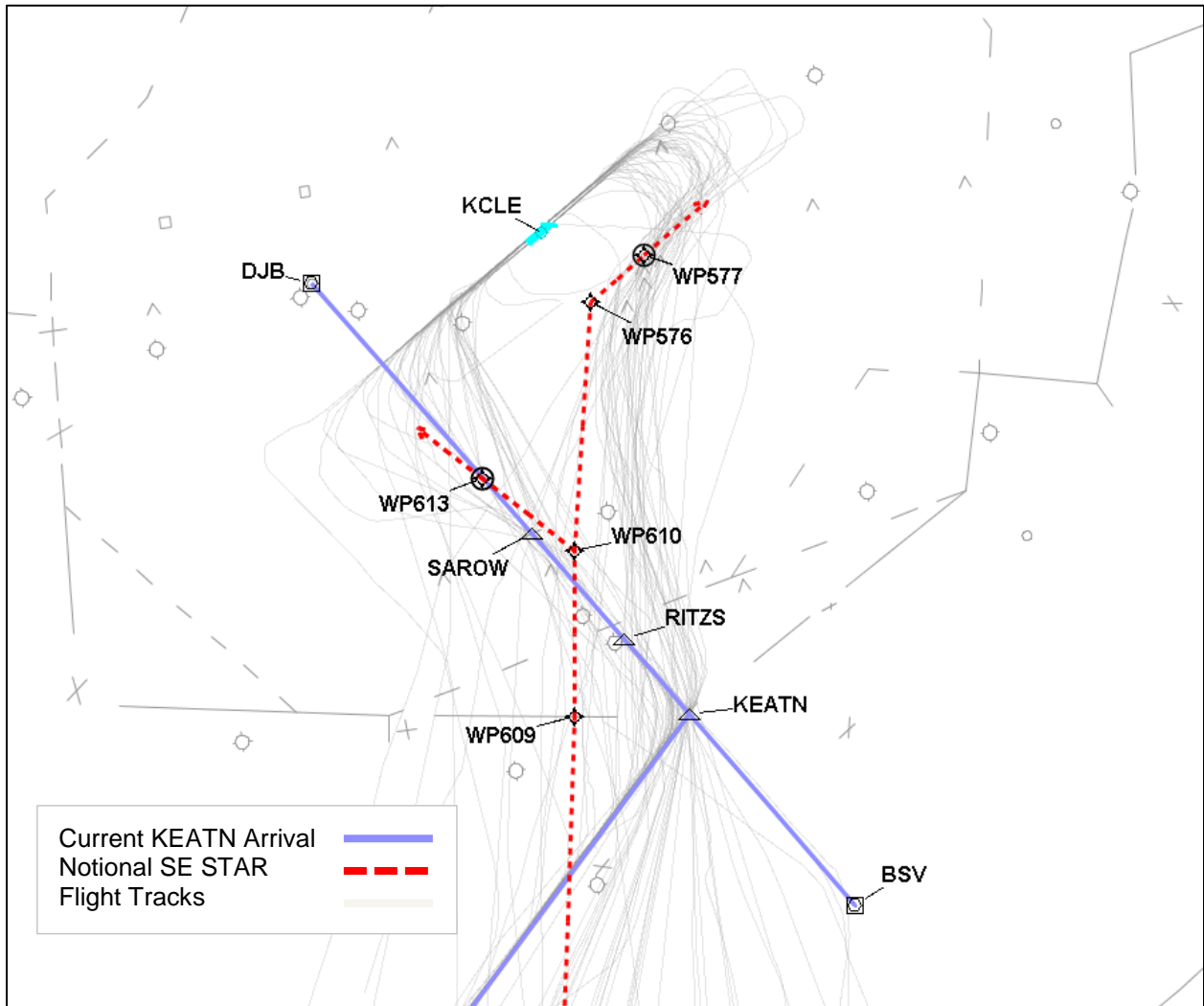
The CLE SE STAR accounts for approximately 18% of all CLE jet arrivals.

- Issues
  - There are excessive level-offs and inefficient lateral paths
  - Lack of RNAV STAR
  - Lack of vertical profile (OPD)
  - Actual flight tracks do not follow current arrival (procedure conformance)

- Solutions
  - Removed unused en route transitions
  - Created en route transitions that mirror current tracks
  - Created runway transitions for east and west flows that terminate in FM legs at 6,000 feet MSL
  - Added terminal speed constraints to manage compression
  - Created an RNAV STAR with an OPD



**Figure 6. Current KEATN STAR and Proposed CLE SE STAR en route view**



**Figure 7. Current KEATN STAR and Proposed CLE SE STAR terminal view**

- Benefits: Projected annual savings for the CLE SE STAR are estimated in Table 8.

**Table 8. Proposed CLE SE STAR Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$1.07M</b>
	<b>Cost to Carry</b>	<b>\$85K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$1.16M</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>381K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>3,583</b>

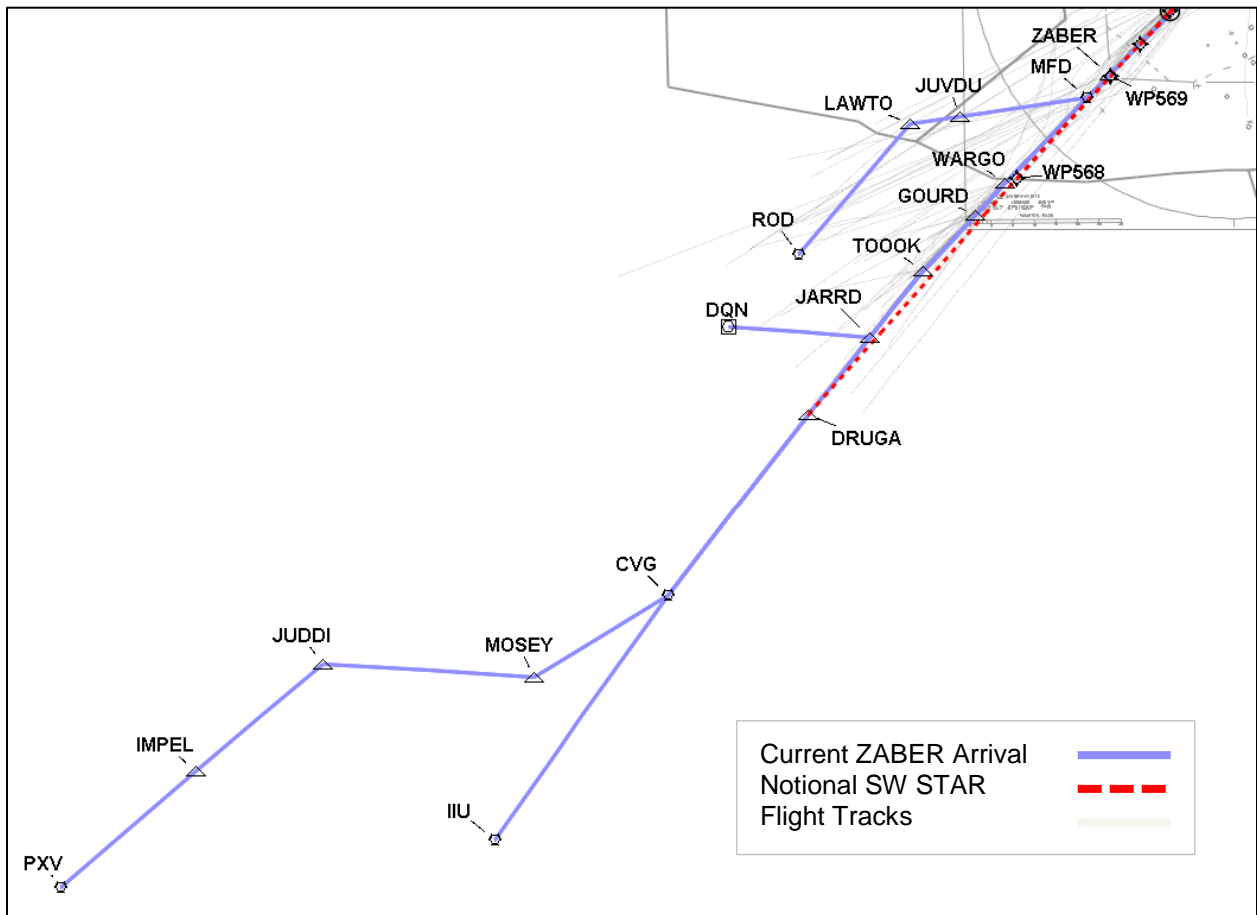
**4.2.1.3 CLE SW STAR**

The CLE SW STAR accounts for approximately 16% of all CLE jet arrivals.

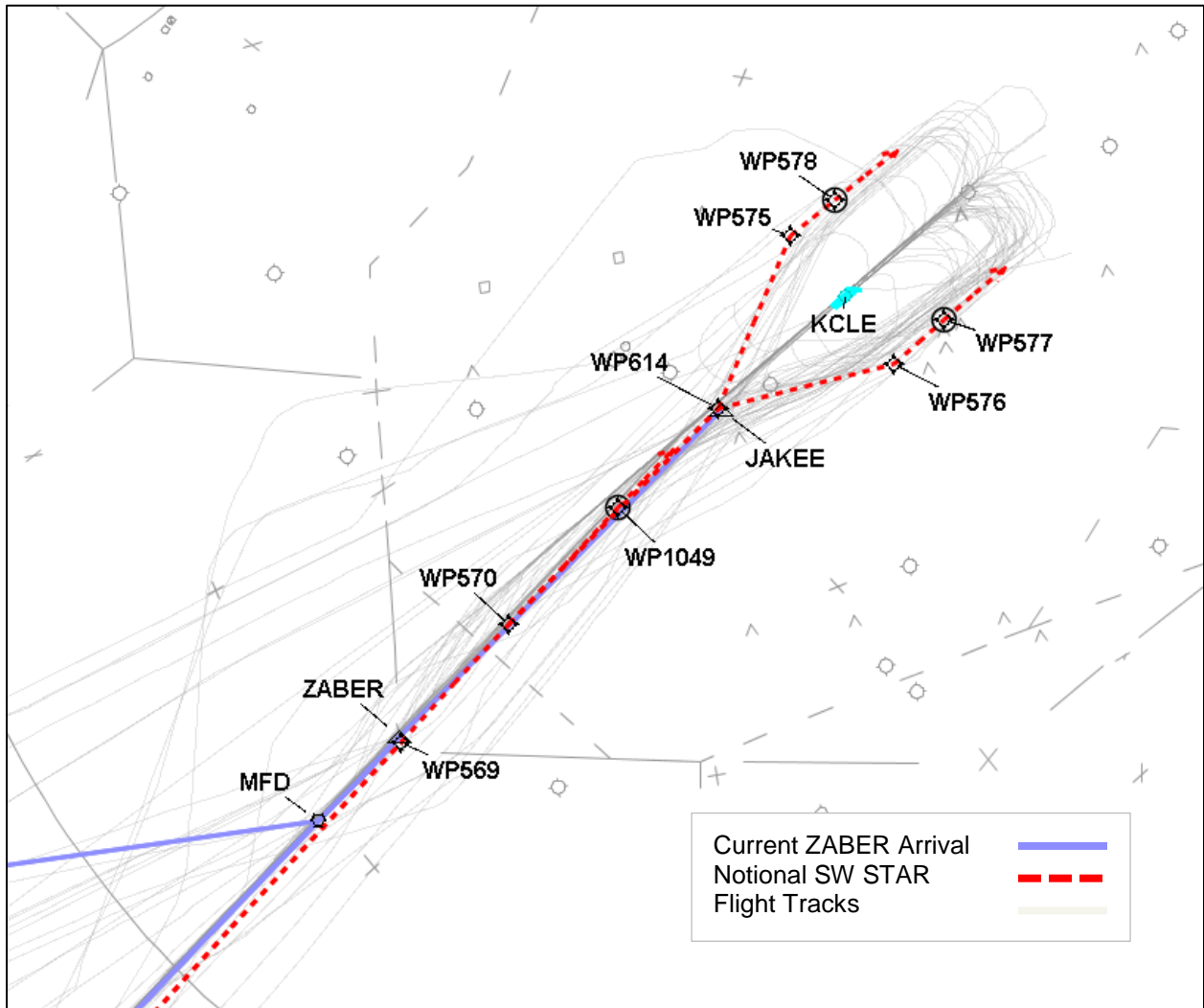
- Issues
  - There are excessive level-offs and inefficient lateral paths
  - Lack of RNAV STAR
  - Lack of vertical profile (OPD)
  - Actual flight tracks do not follow current arrival (procedure conformance)
  - ZABER arrival fix is aligned with the RWY06 final approach course



- Solutions
  - Removed unused en route transitions
  - Created en route transitions that mirror current tracks
  - Created runway transitions for east and west flows that terminate in FM legs at 6,000 feet MSL
  - Added terminal speed constraints to manage compression
  - Created an RNAV STAR with an OPD



**Figure 8. Current ZABER and Proposed CLE SW STAR en route view**



**Figure 9. Current ZABER and Proposed CLE SW STAR terminal view**

- Benefits: Projected annual savings for the CLE SW STAR are estimated in Table 9.

**Table 9. Proposed CLE SW STAR Annual Benefits**

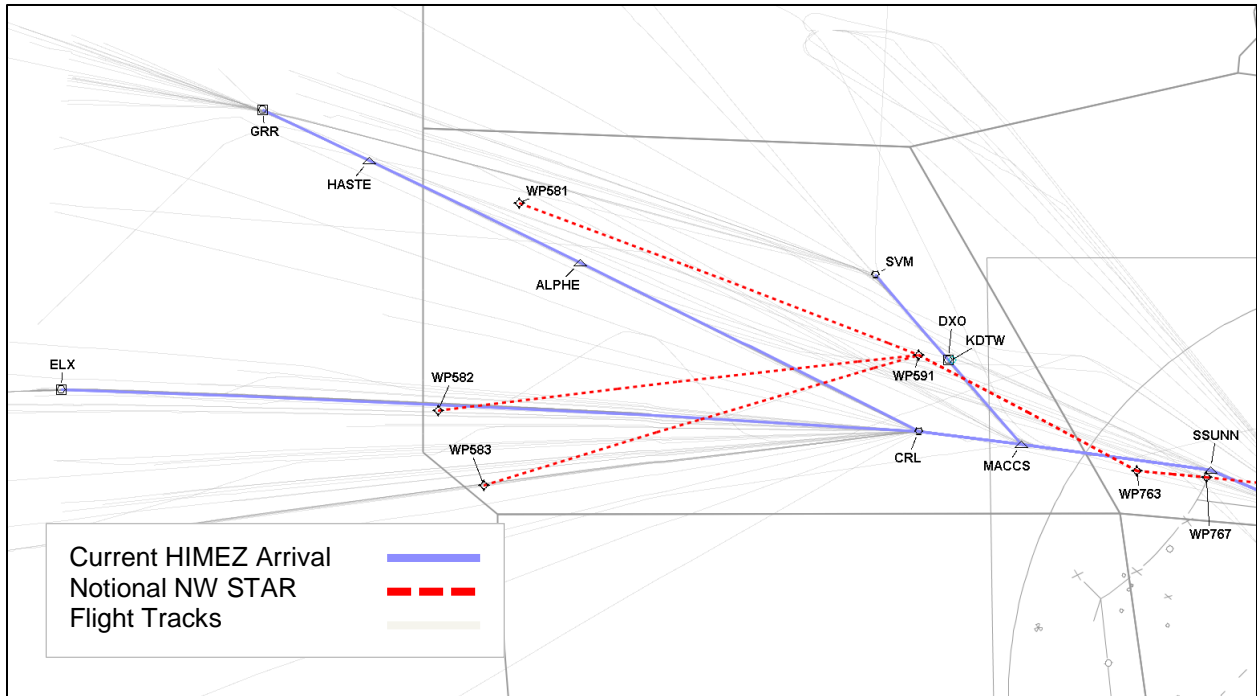
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$588K</b>
	<b>Cost to Carry</b>	<b>\$47K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$635K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>210K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>1,970</b>

**4.2.1.4 CLE NW STAR**

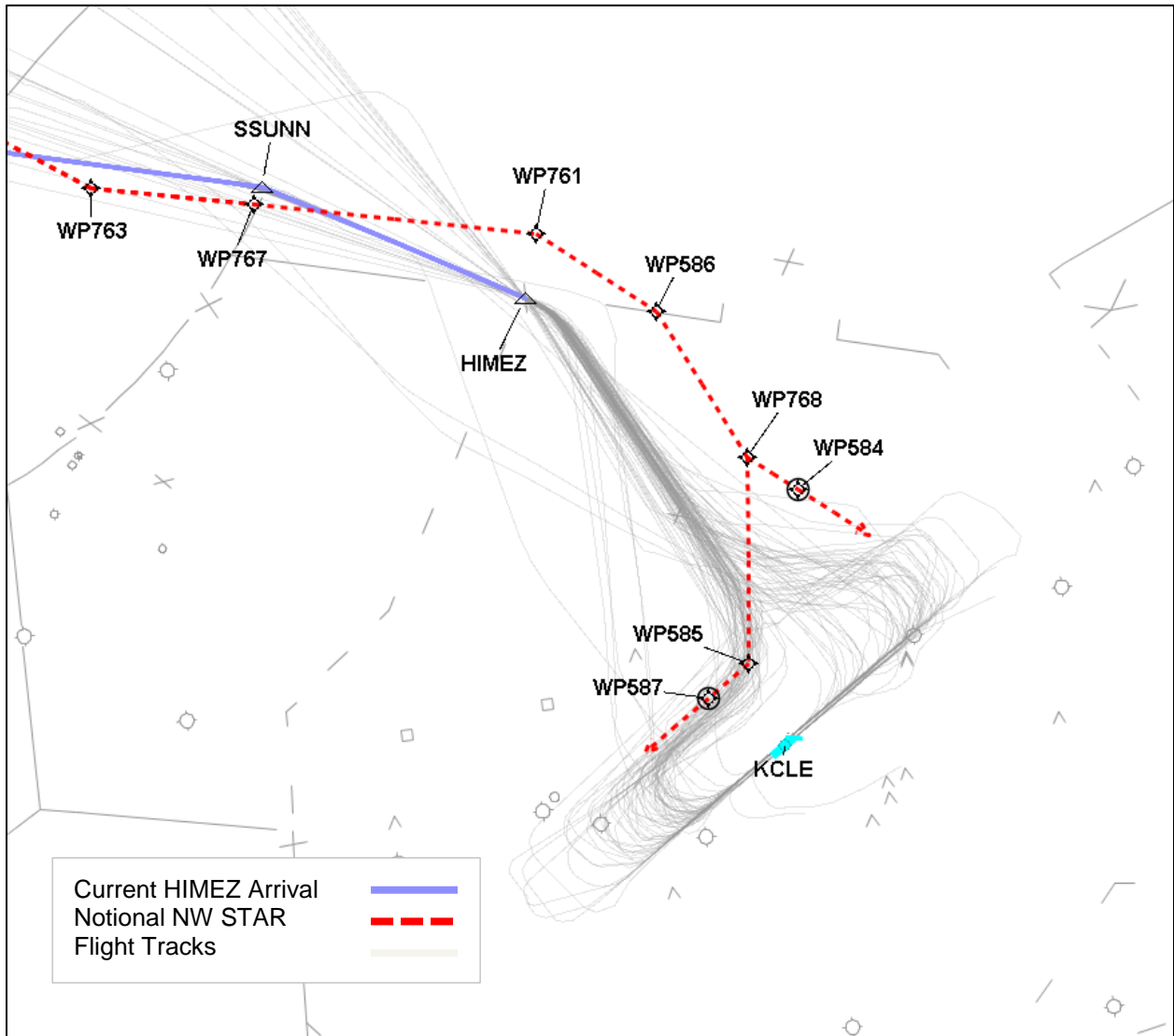
The CLE NW STAR accounts for approximately 24% of all CLE jet arrivals.

- Issues
  - There are excessive level-offs and inefficient lateral paths
  - Lack of RNAV STAR
  - Lack of vertical profile (OPD)
  - Actual flight tracks do not follow current arrival (procedure conformance)
- Solutions
  - Removed unused en route transitions
  - Created en route transitions that mirror current tracks

- Created runway transitions for east and west flows that terminate in FM legs at 6,000 feet MSL
- Added terminal speed constraints to manage compression
- Created an RNAV STAR with an OPD



**Figure 10. Current HIMEZ and Proposed CLE NW STAR en route view**



**Figure 11. Current HIMEZ and Proposed CLE NW STAR terminal view**

- Benefits: Projected annual savings for the CLE NW STAR are estimated in Table 10.

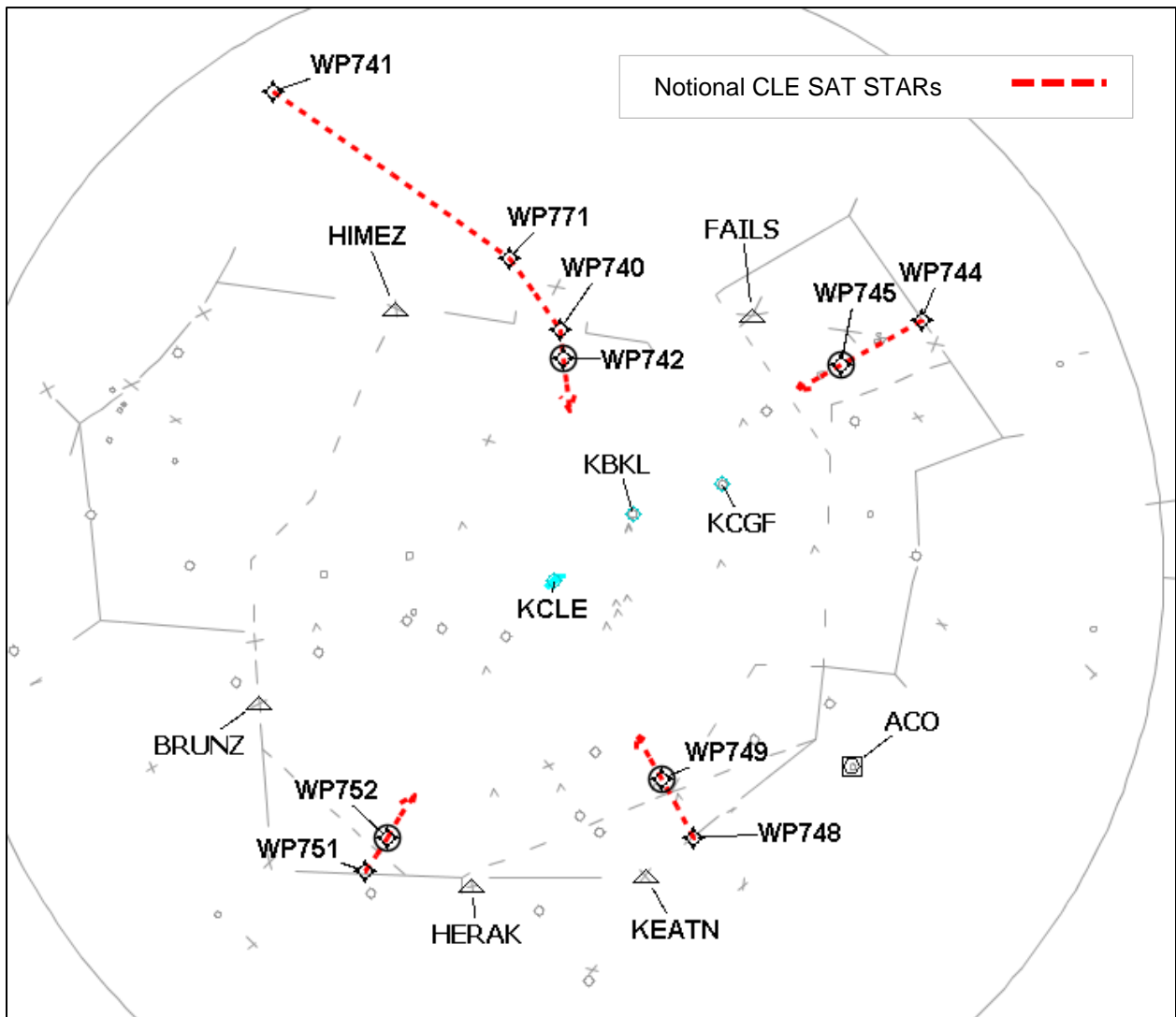
**Table 10. Proposed CLE NW STAR Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$141K</b>
	<b>Cost to Carry</b>	<b>\$11K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$152K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>50K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>471</b>

**4.2.1.5 CLE Satellite (SAT) Arrival Issues**

- Issues
  - No existing RNAV STARs for satellite airports
  - SAT traffic shares routes with CLE arrival traffic
  - FAILS1 arrival conflicts with CLE arrival and departure traffic

- Solutions
  - Developed RNAV STARs for satellite airports at each of the four corner post
  - Developed multiple common routes in terminal airspace that terminated in FM legs
  - Segregated SAT arrivals from the CLE arrivals and departures



**Figure 12. Current FAILS ONE STAR and Proposed CLE SAT STARs**

## **4.2.2 CLE Departures**

This section describes the operational issues, solutions, and expected benefits the MST has identified for CLE departures.

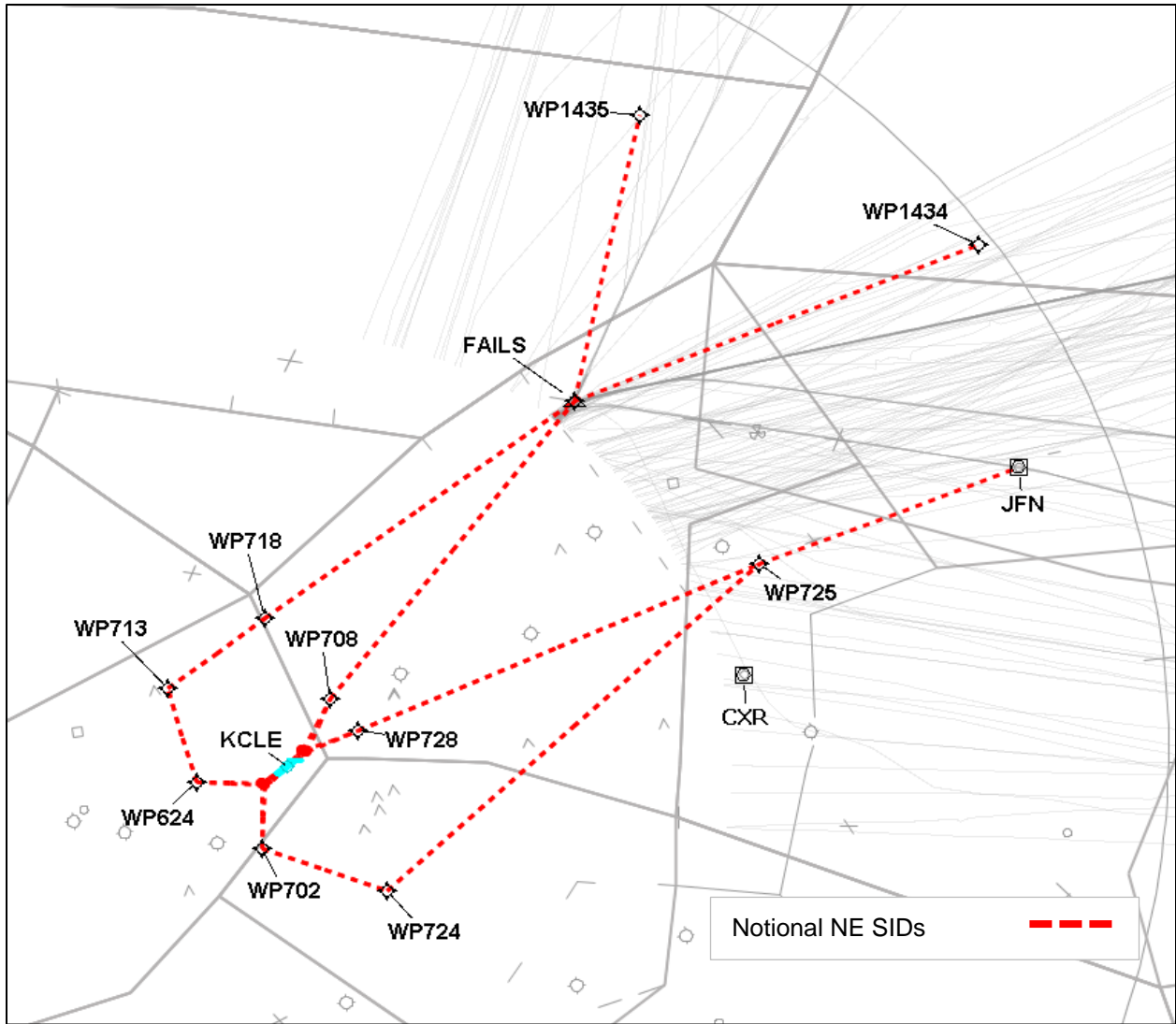
Currently, there are four SIDs: one RNAV SID and three conventional SIDs serving CLE. The MST used the existing SIDs as the starting point for procedure development. The issues with the current CLE departures are the lack of RNAV SIDs and the close proximity of the HUDDZ and BRUNZ departure gates.

### **4.2.2.1 CLE NE 1 and 2 SIDs**

The current northeast departures are on PDRs and account for approximately 27% of all CLE jet departures.

- Issues
  - Lack of repeatable predictable paths for departures
  - CAK arrivals interfere with the FAILS departures
- Solutions
  - RNAV departure procedure for traffic filed northeast bound via FAILS (NE 1)
  - RNAV departure procedure for traffic filed to the east (NE 2)
- Benefits: Projected annual savings for the DTW CLE NE 1 and 2 SIDs are estimated in Table 11.





**Figure 13. Current PDR flight tracks and Proposed CLE NE 1 and 2 SIDs**

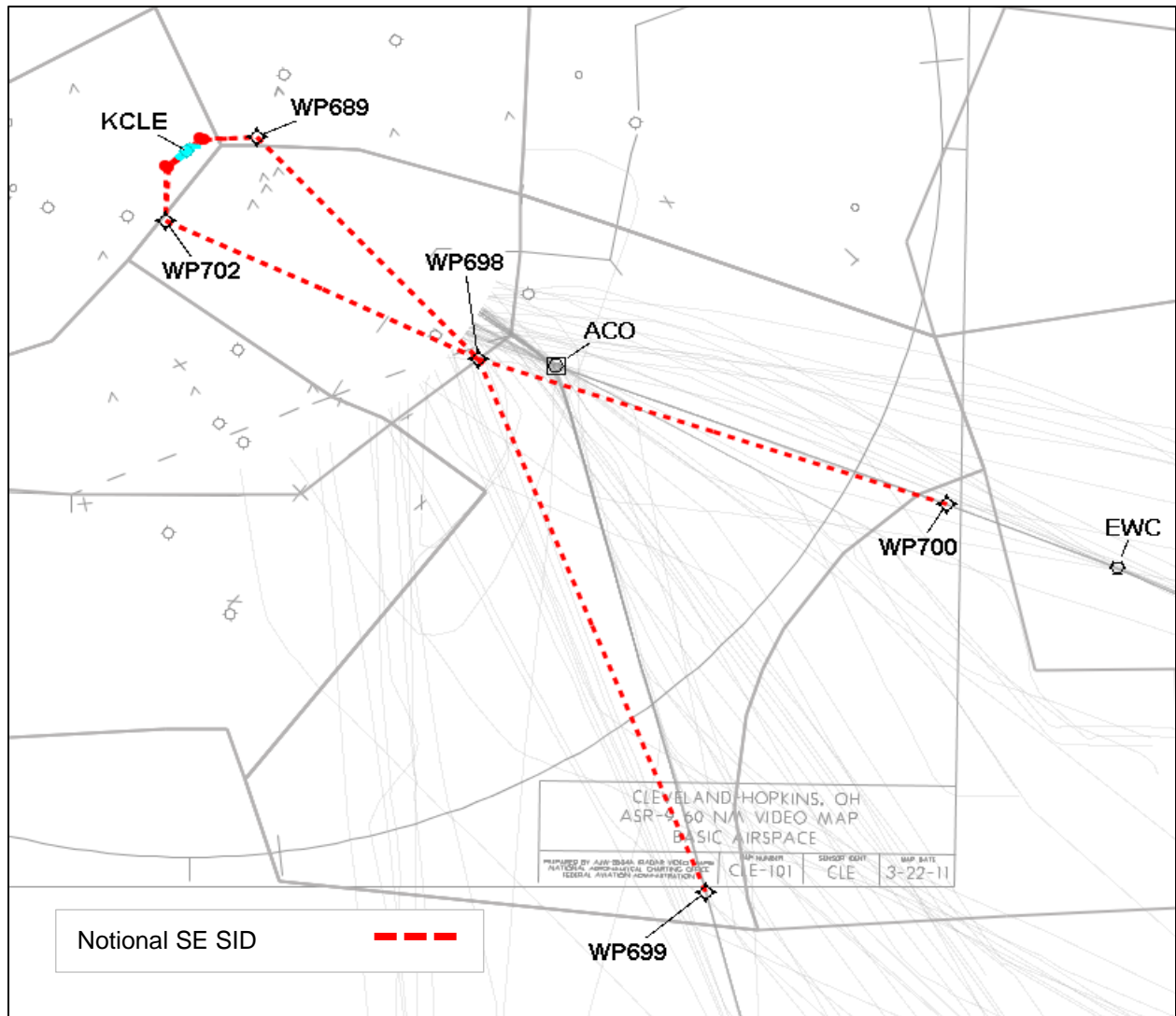
**Table 11. Proposed CLE NE 1 and 2 SID Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$137K</b>
	<b>Cost to Carry</b>	<b>\$11K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$148K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>49K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>460</b>

**4.2.2.2 CLE SE SID**

The current southeast departures are on PDRs and accounts for approximately 16% of all CLE jet departures.

- Issue
  - Lack of repeatable predictable paths for departures
- Solution
  - RNAV departure procedure for traffic filed southeast bound via ACO
- Benefits: Projected annual savings for the CLE SE SID are estimated in Table 12.



**Figure 14. Current PDR flight tracks and Proposed CLE SE SID**

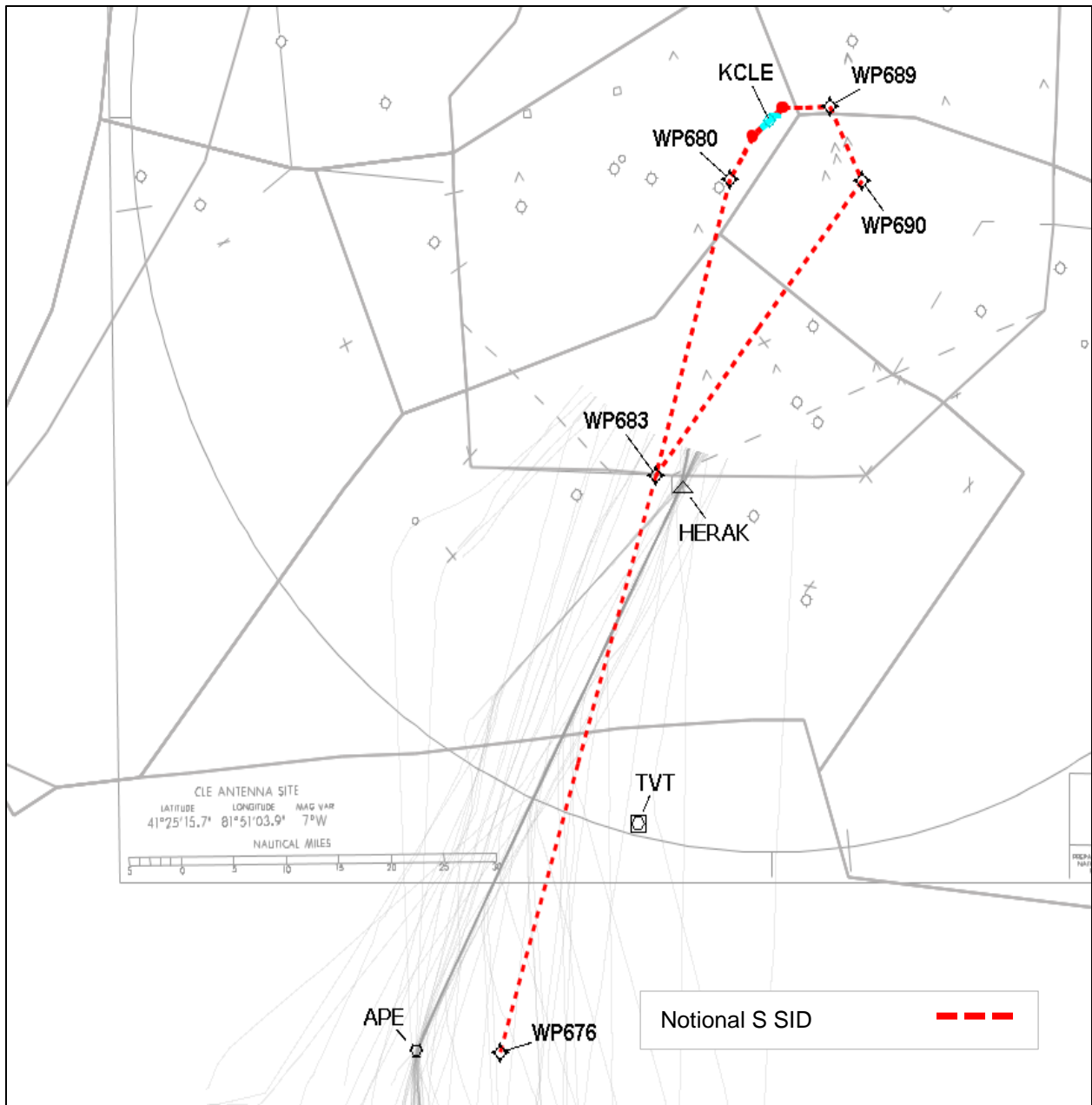
**Table 12. Proposed CLE SE SID Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$53K</b>
	<b>Cost to Carry</b>	<b>\$4K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$57K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>19K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>178</b>

**4.2.2.3 CLE S SID**

The current south departures are on PDRs and accounts for approximately 16% of all CLE jet departures.

- Issue
  - Lack of repeatable predictable paths for departures
- Solution
  - RNAV departure procedure for traffic filed south bound via HERAK



**Figure 15. Current PDR flight tracks and Proposed CLE S SID Benefits**

- Benefits: Projected annual savings for CLE S SID are estimated in Table 13.

**Table 13. Proposed CLE S SID Annual Benefits**

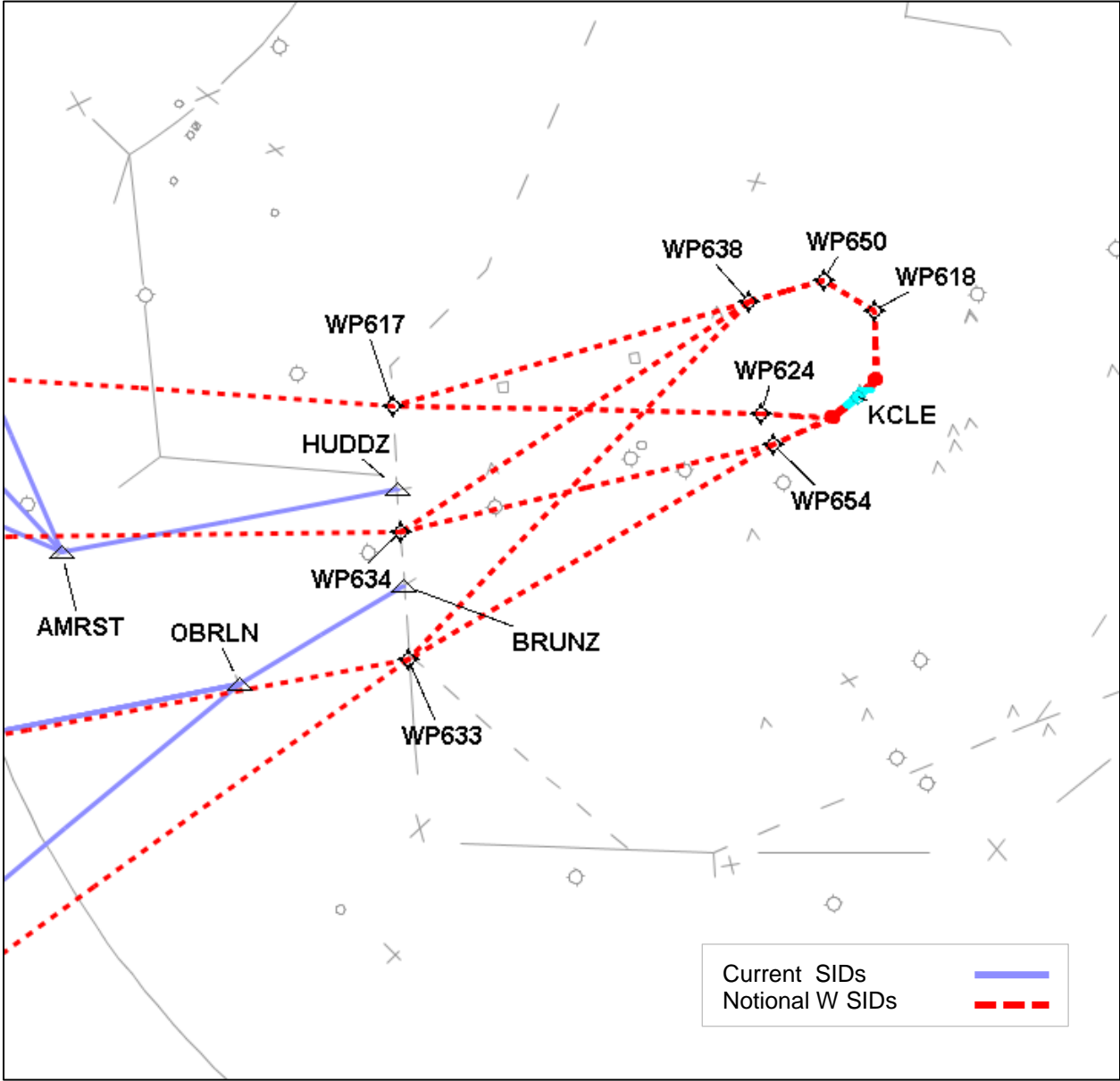
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$130K</b>
	<b>Cost to Carry</b>	<b>\$10K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$140K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>46K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>436</b>

**4.2.2.4 CLE W1, W2 and W3 SIDs**

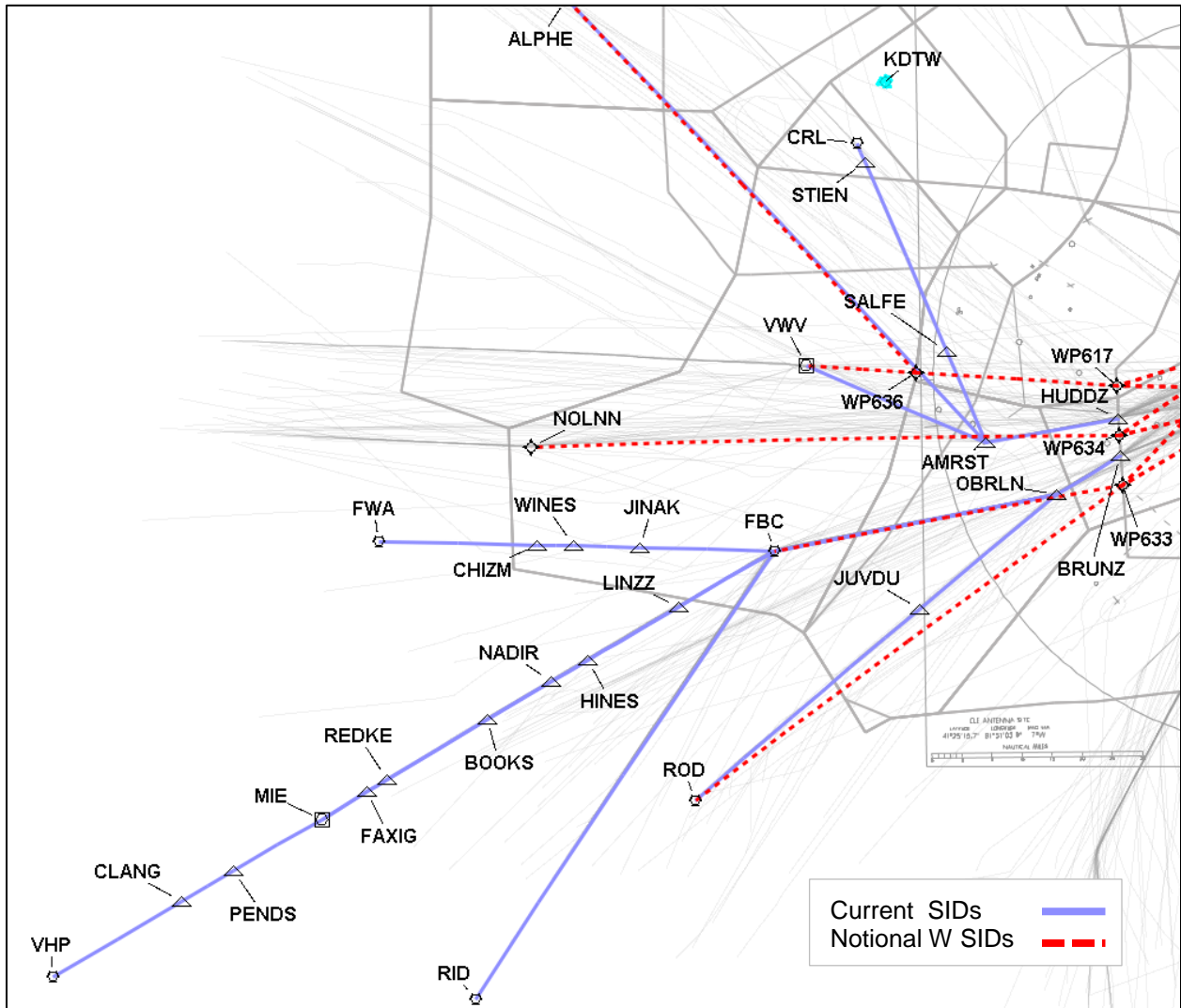
The current west departures are on the ALPHE, AMRST and OBRLN SIDs and accounts for approximately 41% of all CLE jet departures

- Issues
  - Lack of repeatable predictable path for departures
  - Lack of RNAV SIDs (AMRST, OBRLN)
  - Close proximity of HUDDZ and BRUNZ

- Solutions
  - RNAV departures procedures for traffic filed via: ALPHE (W1), AMRST (W2) and OBRLN (W3)
  - Increase lateral separation between HUDDZ and BRUNZ



**Figure 16. Current ALPHE THREE, AMRST THREE and OBRLN THREE and Proposed CLE W1, W2 and W3 SIDs terminal view**



**Figure 17. Current ALPHE THREE, AMRST THREE and OBRLN THREE and Proposed CLE W1, W2 and W3 SIDs en route view**

- Benefits: Projected annual savings for the new CLE W1, W2 and W3 SIDs are estimated in Table 14.



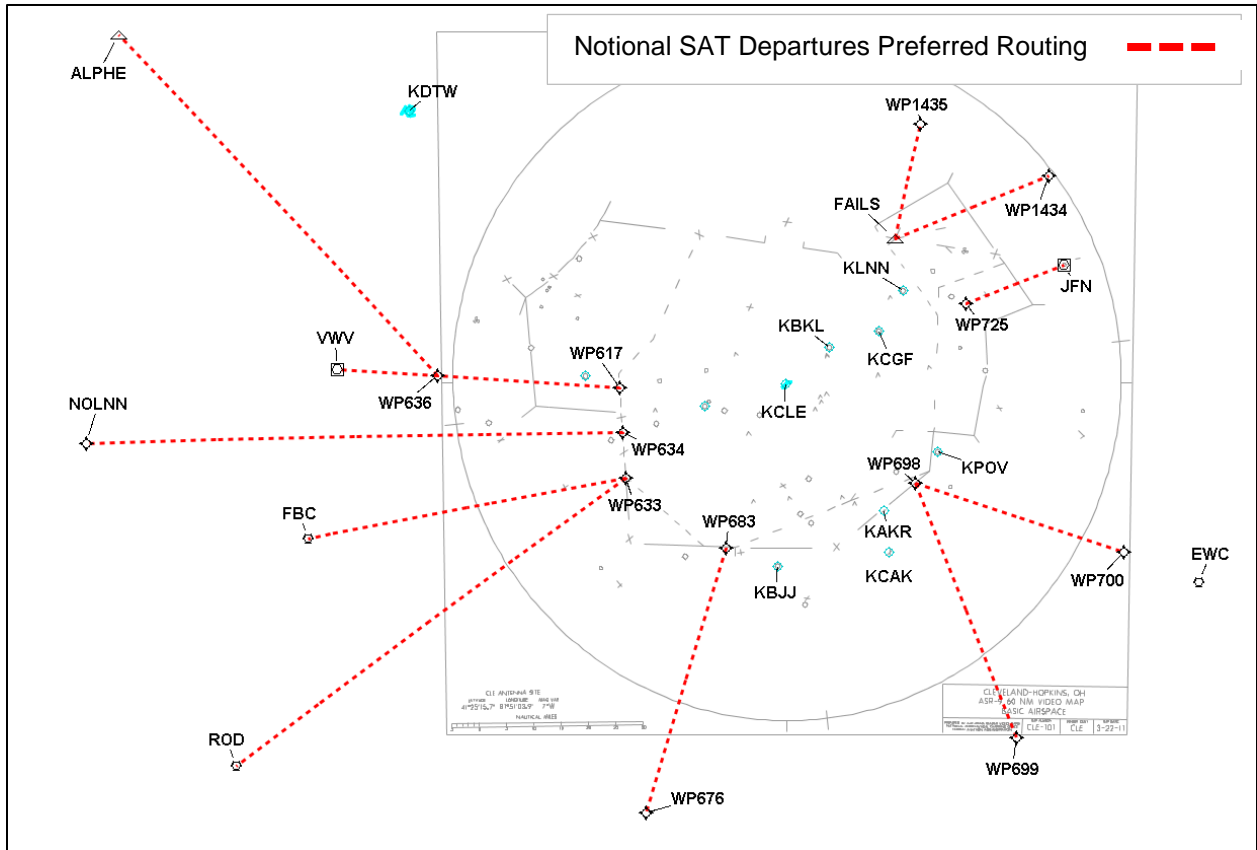
**Table 14. Proposed CLE W1, W2 and W3 SIDs Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$75K</b>
	<b>Cost to Carry</b>	<b>\$10K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$85K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>28K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>264</b>

### **4.2.3 CLE SAT Departures Issues**

The APLHE THREE (RNAV), AMRST THREE, OBRLN THREE and SKY THREE SIDs service the following satellite airports: Elyria Airport (1G1); Medina Municipal Airport (1G5); Painesville/Concord Airpark (2G1); Geauga County Airport (7G8); Burke Lakefront Airport (BKL); Cuyahoga County Airport (CGF); Willoughby Lost Nation Municipal Airport (LNN) and Lorain County Regional Airport (LPR). CLE SAT airports accounts for approximately 23% of all CLE TRACON departures.

- Issue: No existing RNAV procedures for satellite airports, except for the ALPHE THREE (RNAV)
- Solution: Use PDRs utilizing CLE RNAV SID waypoints located at the terminal boundary and on en route transitions
- Benefits: This procedure was not modeled



**Figure 18. Proposed SAT PDRs**

#### 4.2.4 Summary of Potential Benefits for CLE

As shown in Table 15 below, the proposed CLE STARs and SIDs are estimated to provide \$2.73 million annually in fuel savings.

**Table 15. Total Annual Fuel Burn Benefits for CLE**

	<b>Fuel Burn Benefit (\$)</b>	<b>Cost to Carry (\$)</b>	<b>Overall Fuel Benefit (\$)</b>	<b>Estimated Carbon Savings (Metric Tons)</b>
<b>Arrivals</b>	<b>\$2.13M</b>	<b>\$170K</b>	<b>\$2.30M</b>	<b>7,118</b>
<b>Departures</b>	<b>\$395K</b>	<b>\$35K</b>	<b>\$430K</b>	<b>1,338</b>
<b>Total Annual Savings</b>	<b>\$2.52M</b>	<b>\$205K</b>	<b>\$2.73M</b>	<b>8,456</b>

### **4.3 DTW Procedures**

DTW is the busiest airport within D21 terminal area with 1,172 daily operations on average in 2012, with 98% being either air carrier or air taxi flights. YIP and PTK are the primary satellite airports within D21 terminal area. D21 airspace extends from the surface to 13,000 feet mean sea level (MSL) with some shelves. Airspace adjacent to D21 includes: LAN to the west, FNT to the northwest, MTC to the northeast, ZOB to the east, CLE to the southeast and TOL to the south. ZOB airspace overlies D21. DTW has a north/south runway configuration, with the south flow being the predominant flow at 74%. DTW infrequently departs runways 27L/R.

#### **4.3.1 DTW Arrivals**

This section describes the operational issues, solutions, and expected benefits the MST has identified for DTW arrivals.

Arrival issues for DTW include lack of RNAV STARs, inefficient lateral paths, no vertical profiles (level segments) and excessive vectoring.

FAAO 7110.65 paragraph 4-7-1 b requires controllers to provide course guidance to multiple runways on initial contact or as soon as practical. If the runway assignment, or any subsequent runway change, is not issued prior to 10 NM from the runway transition waypoint, radar vectors to final must be provided.

MST developed dual RNAV STARs with OPDs that are flow specific to optimize the vertical paths and to comply with FAAO 7110.65 paragraph 4-7-1 b and FAAO 7100.9E.

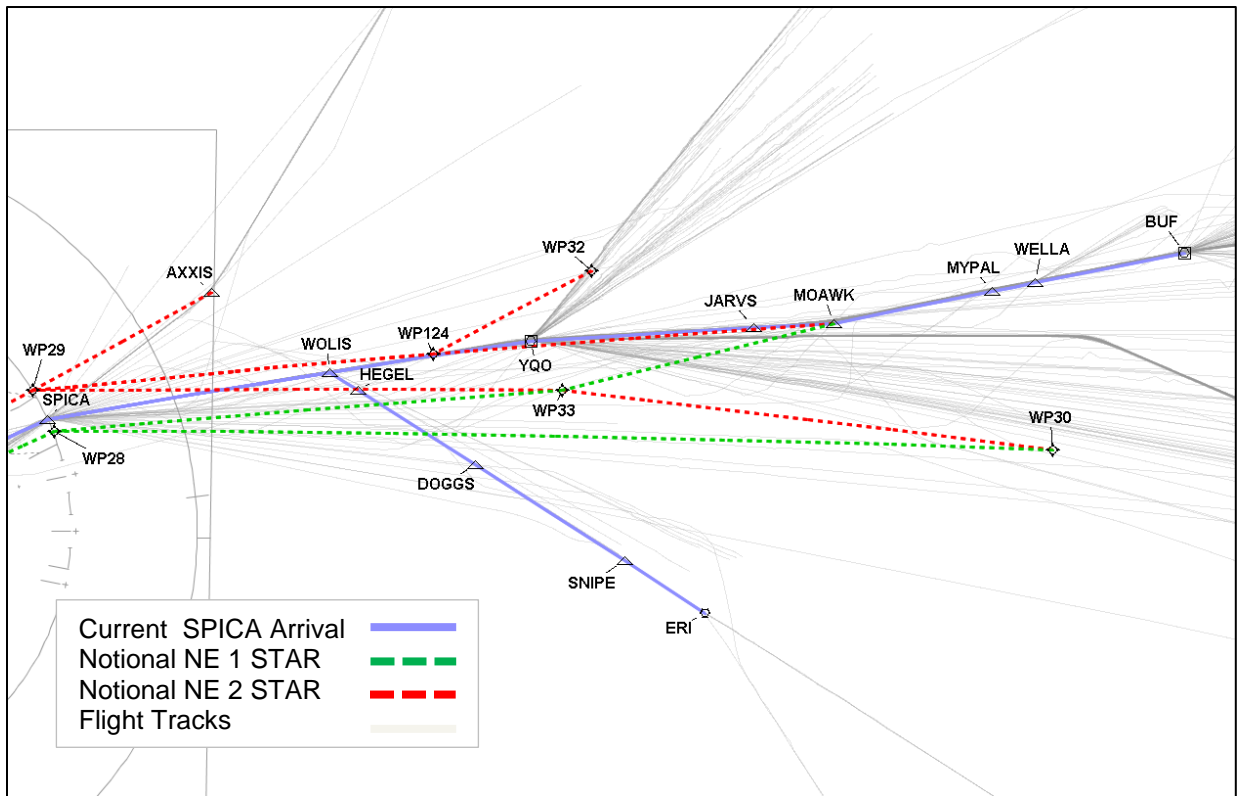
The MST developed 16 uni-directional RNAV OPD STARs, 4 at each corner post:

- DTW NE 1 NORTH STAR
- DTW NE 1 SOUTH/WEST STAR
- DTW NE 2 NORTH STAR
- DTW NE 2 SOUTH/WEST STAR
- DTW SE 1 NORTH/WEST STAR
- DTW SE 1 SOUTH STAR
- DTW SE 2 NORTH/WEST STAR
- DTW SE 2 SOUTH STAR
- DTW SW 1 NORTH STAR
- DTW SW 1 SOUTH/WEST STAR
- DTW SW 2 NORTH STAR
- DTW SW 2 SOUTH/WEST STAR
- DTW NW 1 NORTH/WEST STAR
- DTW NW 1 SOUTH STAR
- DTW NW 2 NORTH/WEST STAR
- DTW NW 2 SOUTH STAR

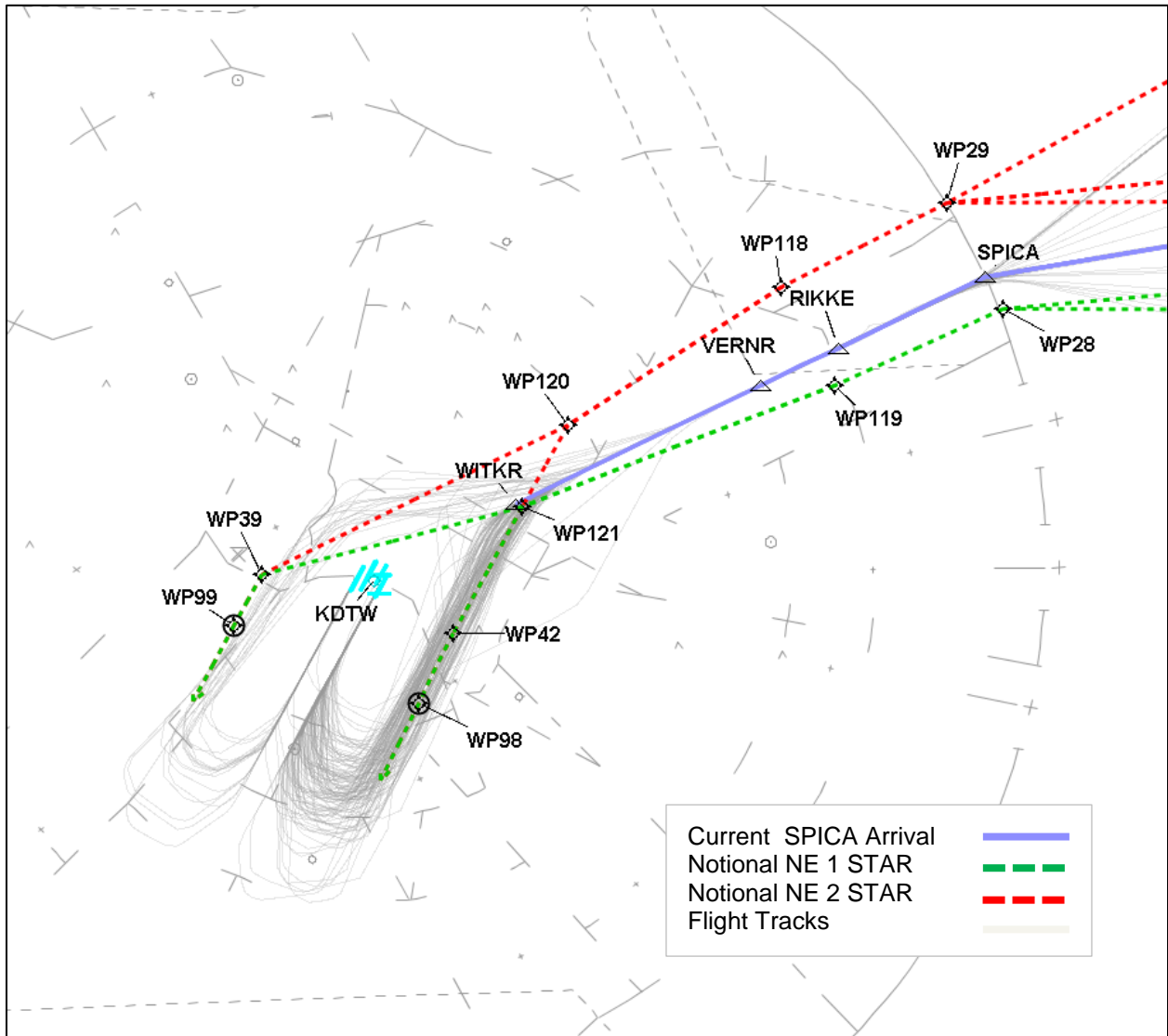
#### **4.3.1.1 DTW NE 1 and NE 2 NORTH STARs**

The DTW SPICA TWO STAR accounts for 23% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures
  - Level segments and inefficient lateral paths
  - Lack of dual arrivals for triple ILS operation
  - Lack of OPDs
- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS



**Figure 19. Current SPICA TWO and Proposed DTW NE 1 and NE 2 NORTH STARS en route view**



**Figure 20. Current SPICA TWO and Proposed DTW NE 1 and NE 2 NORTH STARS terminal view**

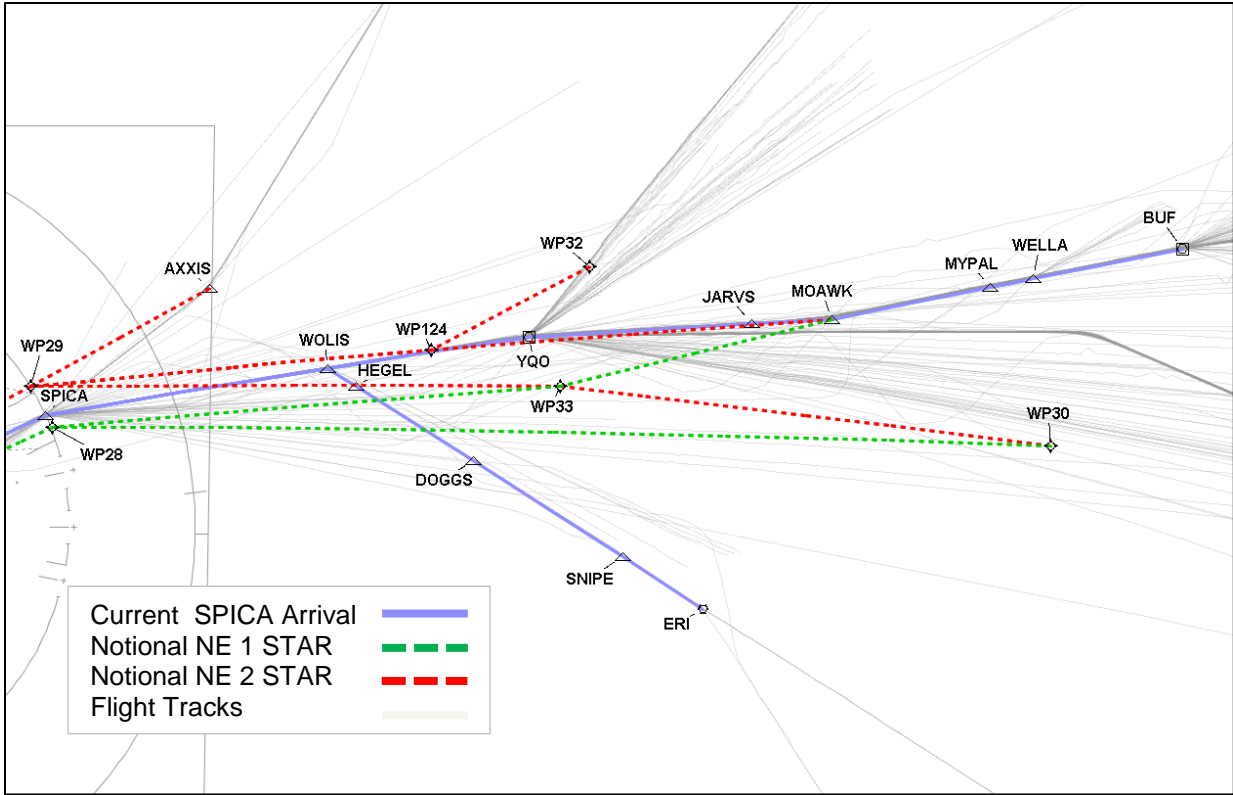
- Benefits: Projected annual savings for the DTW NE 1 STAR are estimated in Table 16.

#### **4.3.1.2 DTW NE 1 and NE 2 SOUTH/WEST STARs**

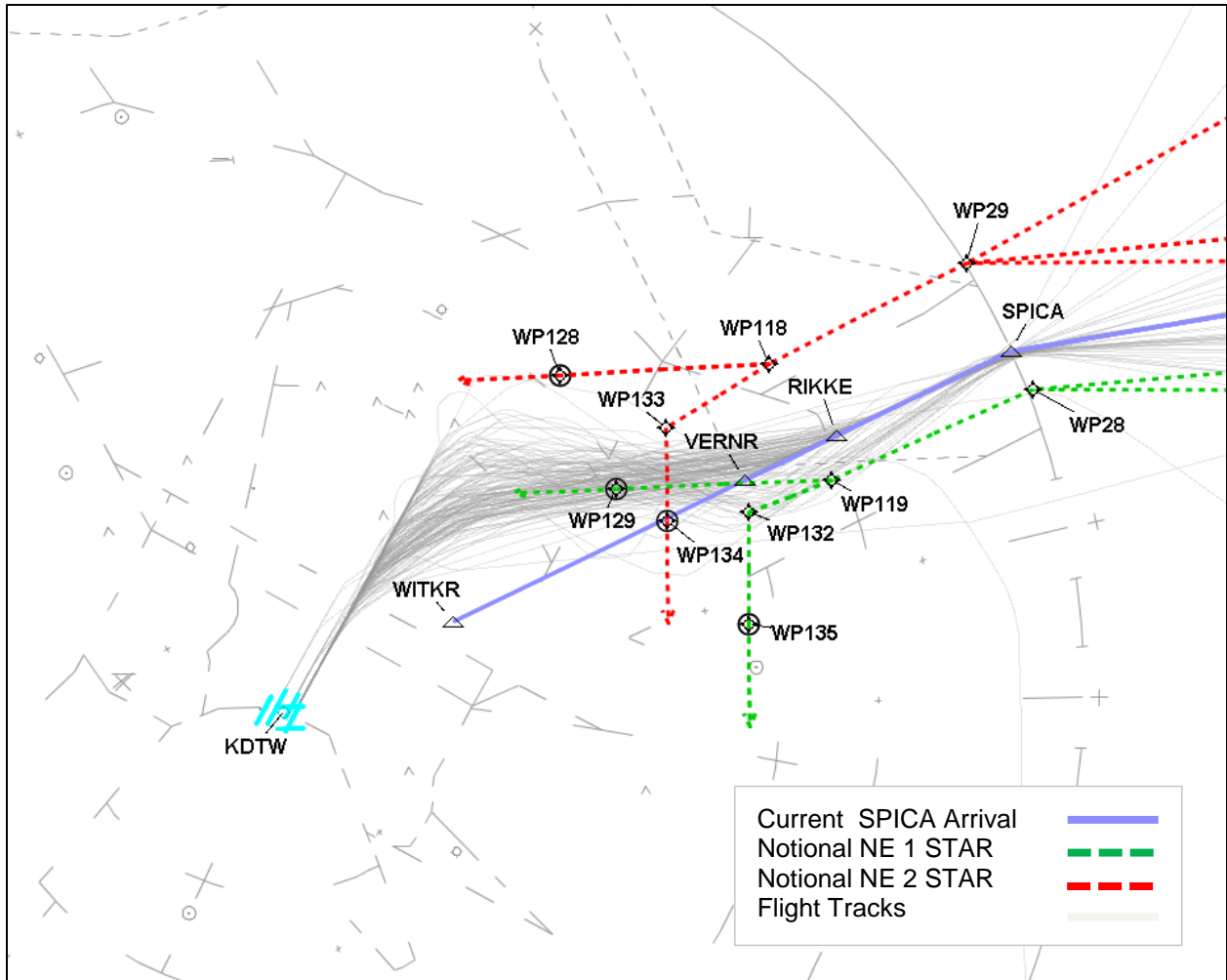
The DTW SPICA TWO STAR accounts for 23% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures
  - Level segments and inefficient lateral paths
  - Lack of dual arrivals for triple ILS operation
  - Lack of OPDs
- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS
- Benefits: Projected annual savings for the proposed DTW NE 1 NORTH , NE 1SOUTH/WEST, NE 2 NORTH and NE 2 SOUTH/WEST STARs are estimated in Table 16.





**Figure 21. Current SPICA TWO and Proposed DTW NE 1 and NE 2 SOUTH/WEST STARS en route view**



**Figure 22. Current SPICA TWO and Proposed DTW NE 1 and NE 2 SOUTH/WEST STARs terminal view**

**Table 16. Proposed DTW NE 1 NORTH, NE 1SOUTH/WEST, NE 2 NORTH and NE 2 SOUTH/WEST STARs Annual Benefits**

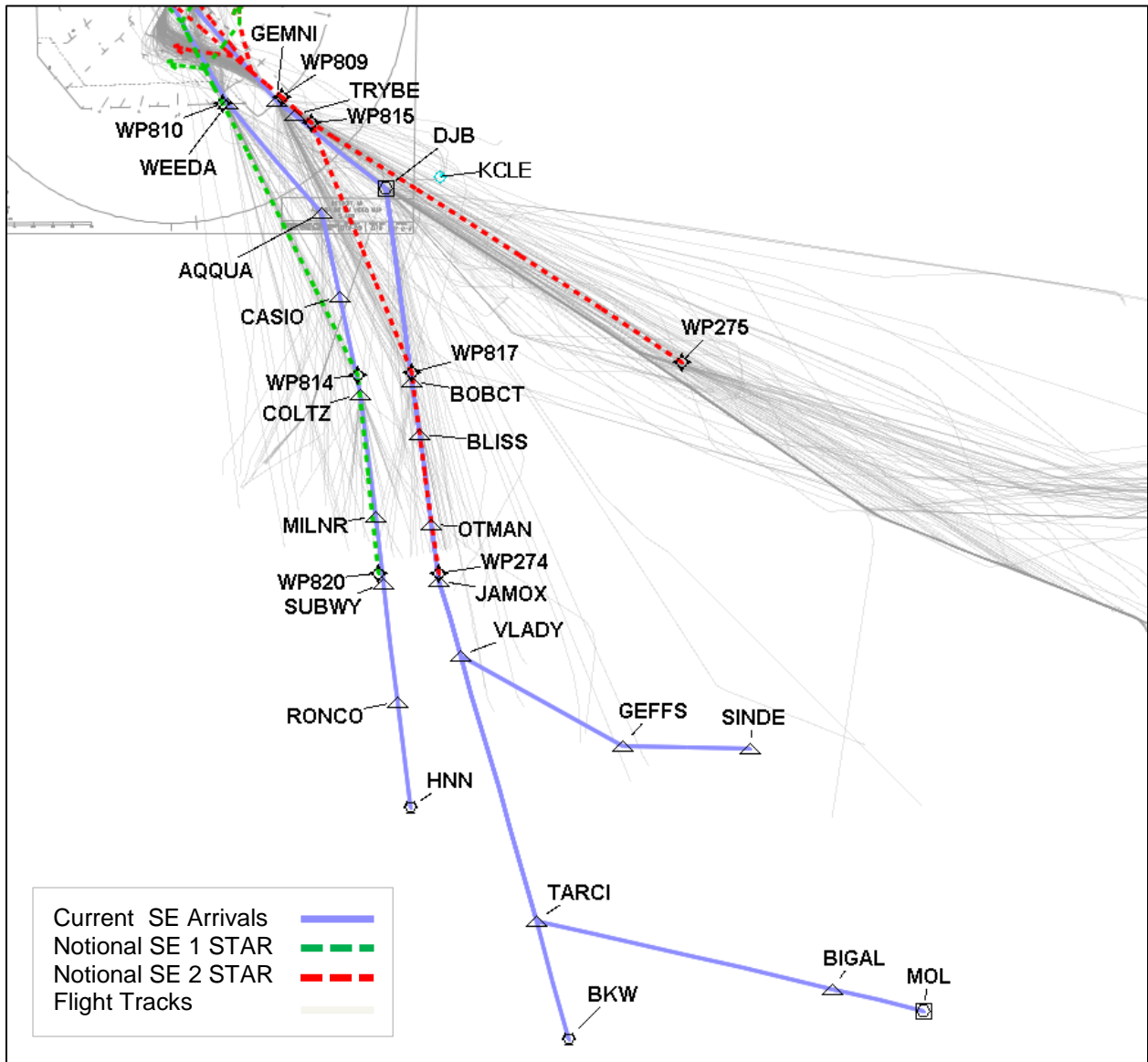
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$1.23M</b>
	<b>Cost to Carry</b>	<b>\$123K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$1.35M</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>445K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>4,183</b>

**4.3.1.3 DTW SE 1 and SE 2 SOUTH STARs**

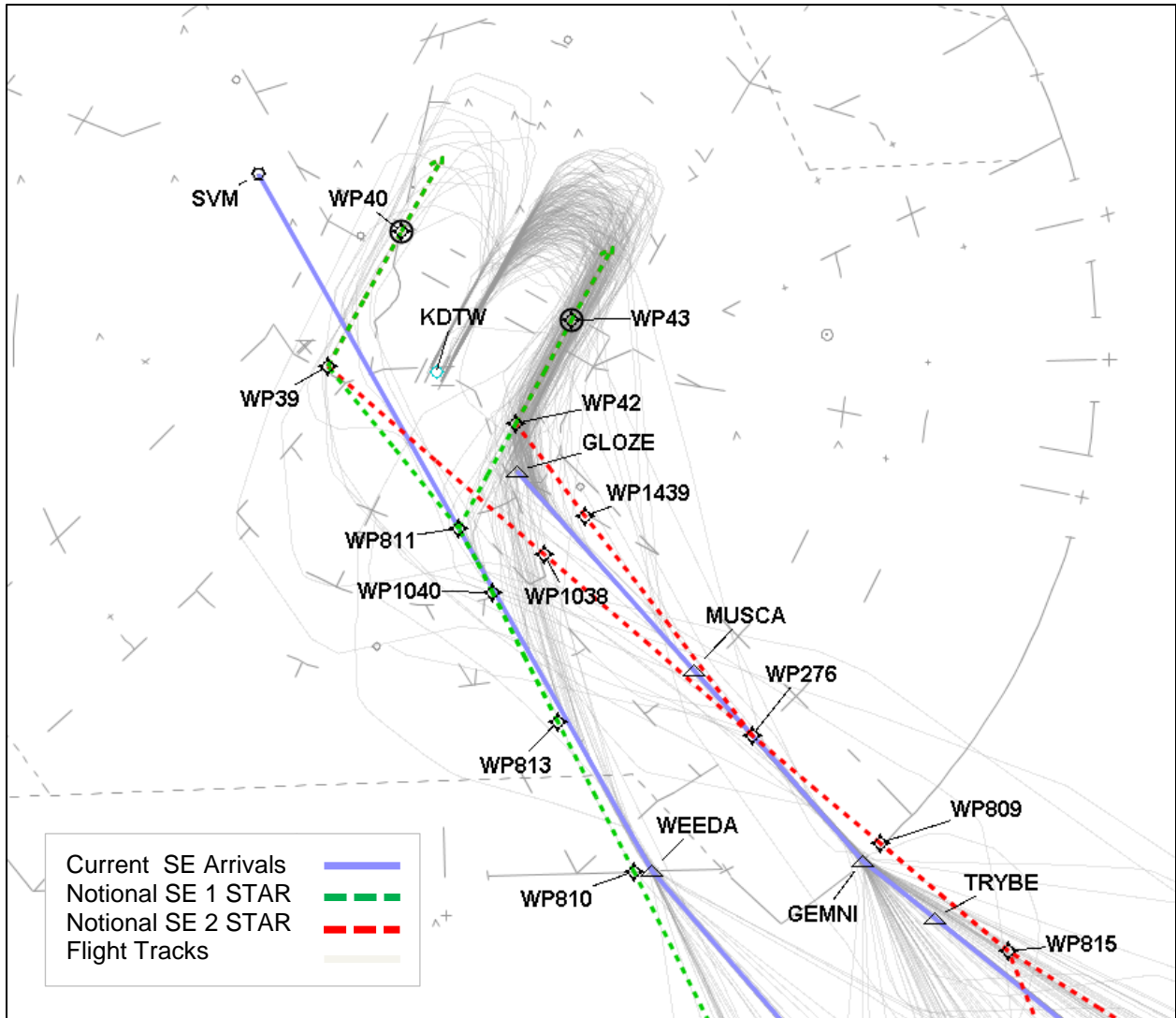
The DTW GEMNI THREE and WEEDA ONE STAR accounts for 29% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures
  - Level segments and inefficient lateral paths
  - Lack of dual arrivals for triple ILS operation
  - Lack of OPDs

- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS



**Figure 23. Current GEMNI THREE and WEEDA ONE Proposed DTW SE 1 and SE 2 SOUTH STARs en route view**



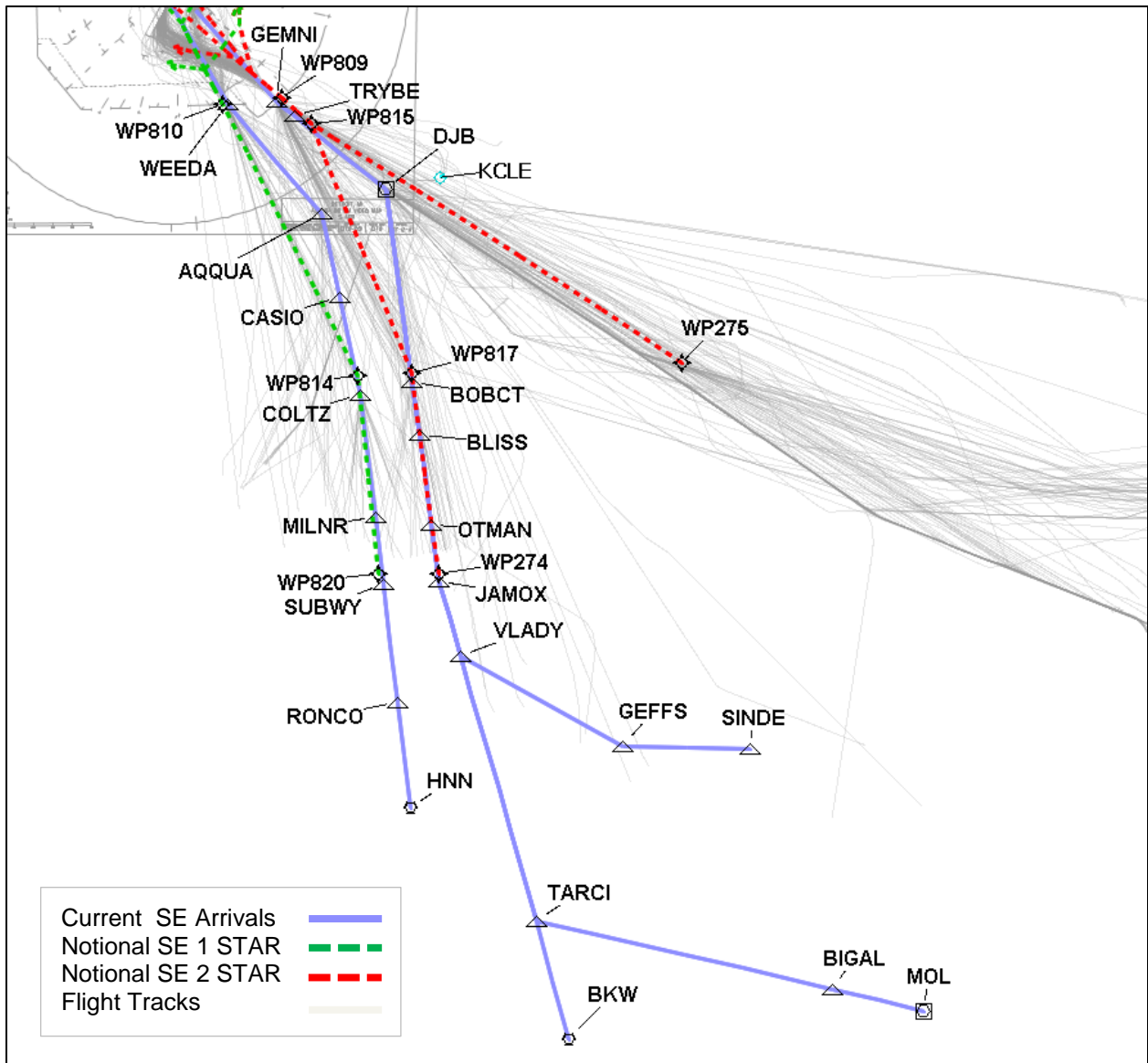
**Figure 24. Current GEMNI THREE and WEEDA ONE and Proposed DTW SE 1 and SE 2 SOUTH STARs terminal view**

#### 4.3.1.4 DTW SE 1 and SE 2 NORTH/WEST STARs

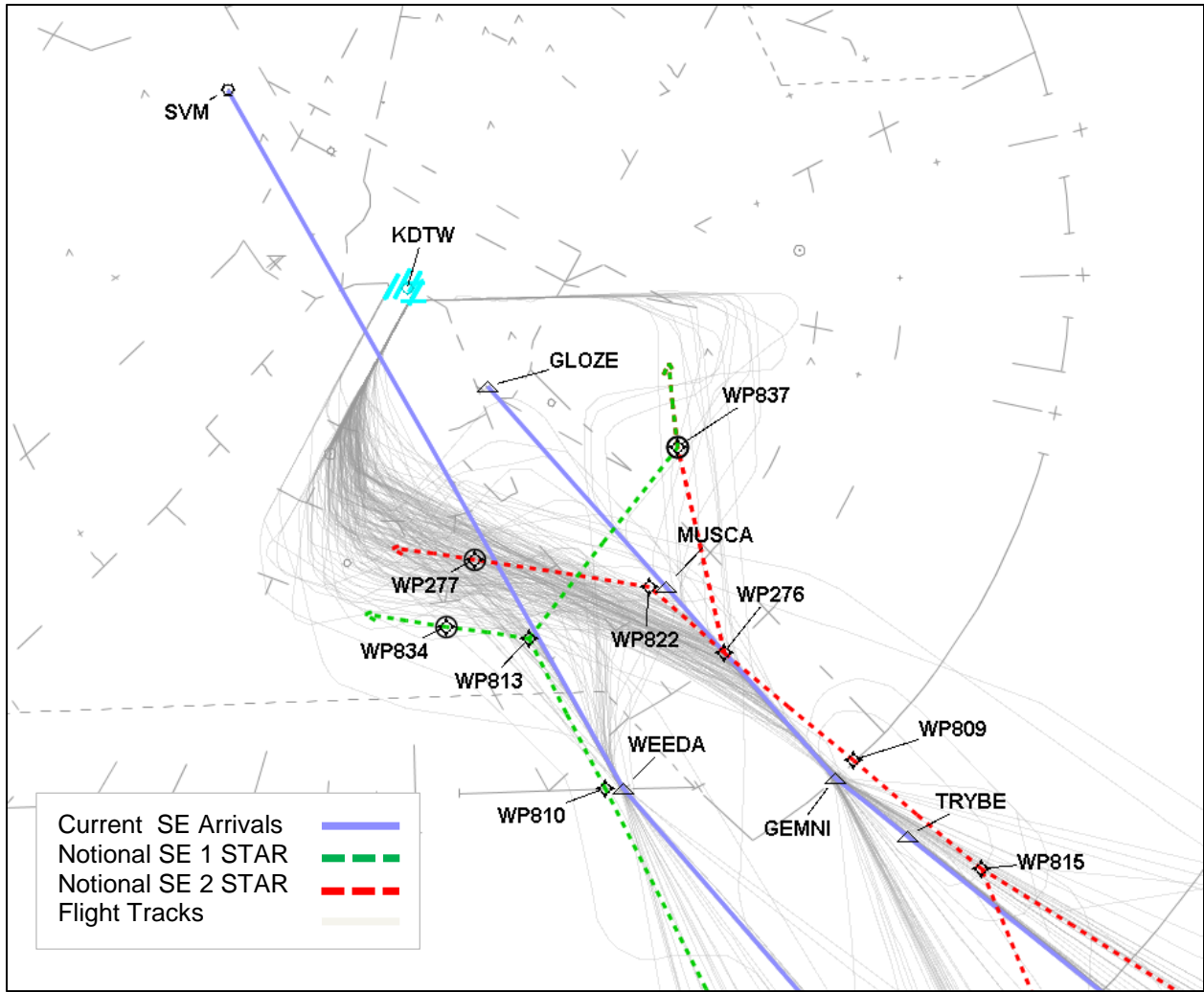
The DTW GEMNI THREE and WEEDA ONE STAR accounts for 29% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures

- Level segments and inefficient lateral paths
- Lack of dual arrivals for triple ILS operation
- Lack of OPDs
- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS
- Benefits: Projected annual savings for the proposed DTW SE 1, SOUTH, SE 1 NORTH/WEST, SE 2 SOUTH and SE 2 NORTH/WEST STARs are estimated in Table 17.



**Figure 25. Current GEMNI THREE and WEEDA ONE Proposed DTW SE 1 and SE 2 NORTH/WEST STARS en route view**



**Figure 26. Current GEMNI THREE and WEEDA ONE and Proposed DTW SE 1 and SE 2 NORTH/WEST STARS terminal view**



**Table 17. Proposed DTW SE 1 SOUTH, SE 1 NORTH/WEST, SE 2 SOUTH and SE 2 NORTH/WEST STARs Annual Benefits**

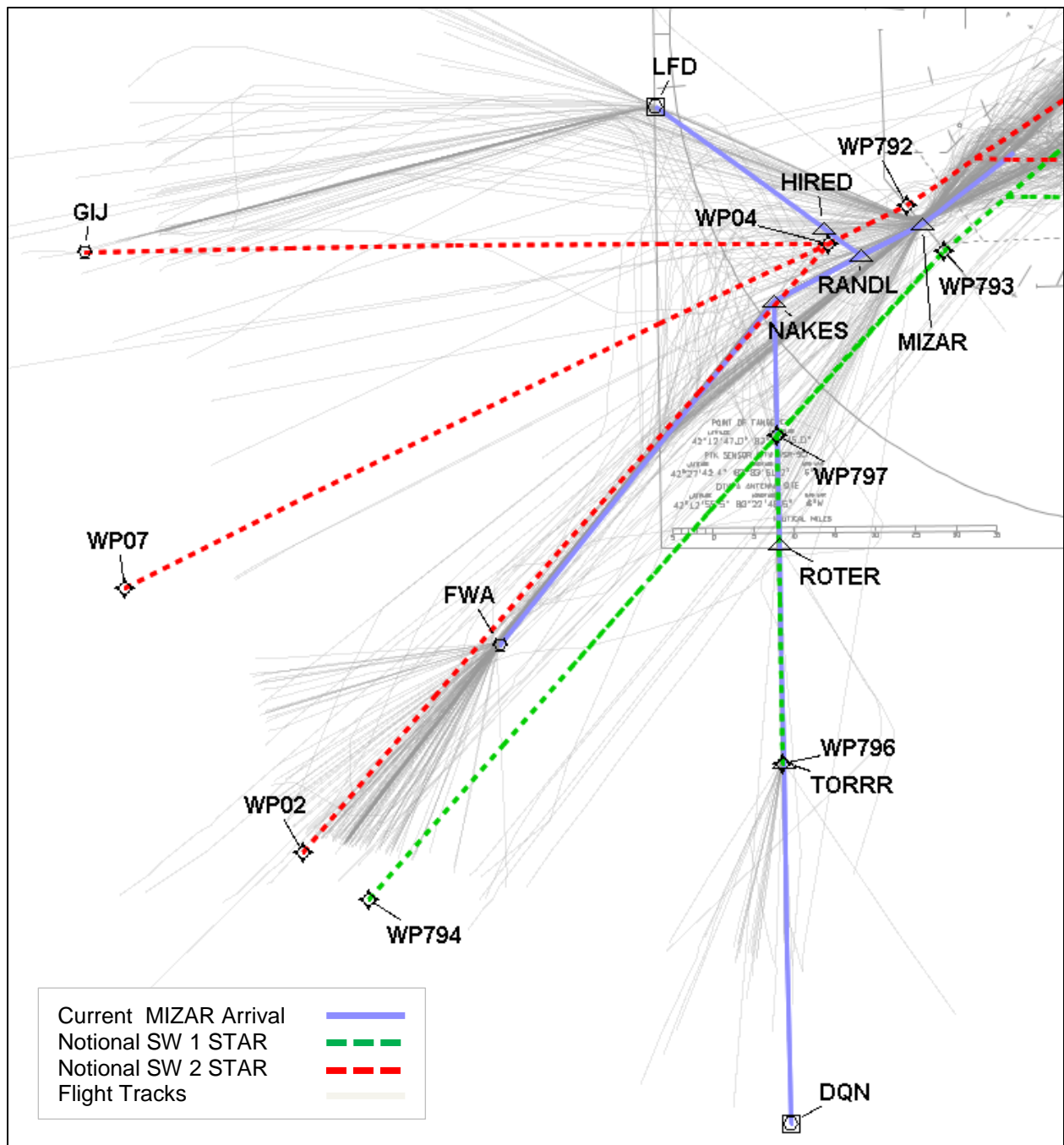
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$2.12M</b>
	<b>Cost to Carry</b>	<b>\$278K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$2.40M</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>793K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>7,451</b>

**4.3.1.5 DTW SW 1 and SW 2 NORTH STARs**

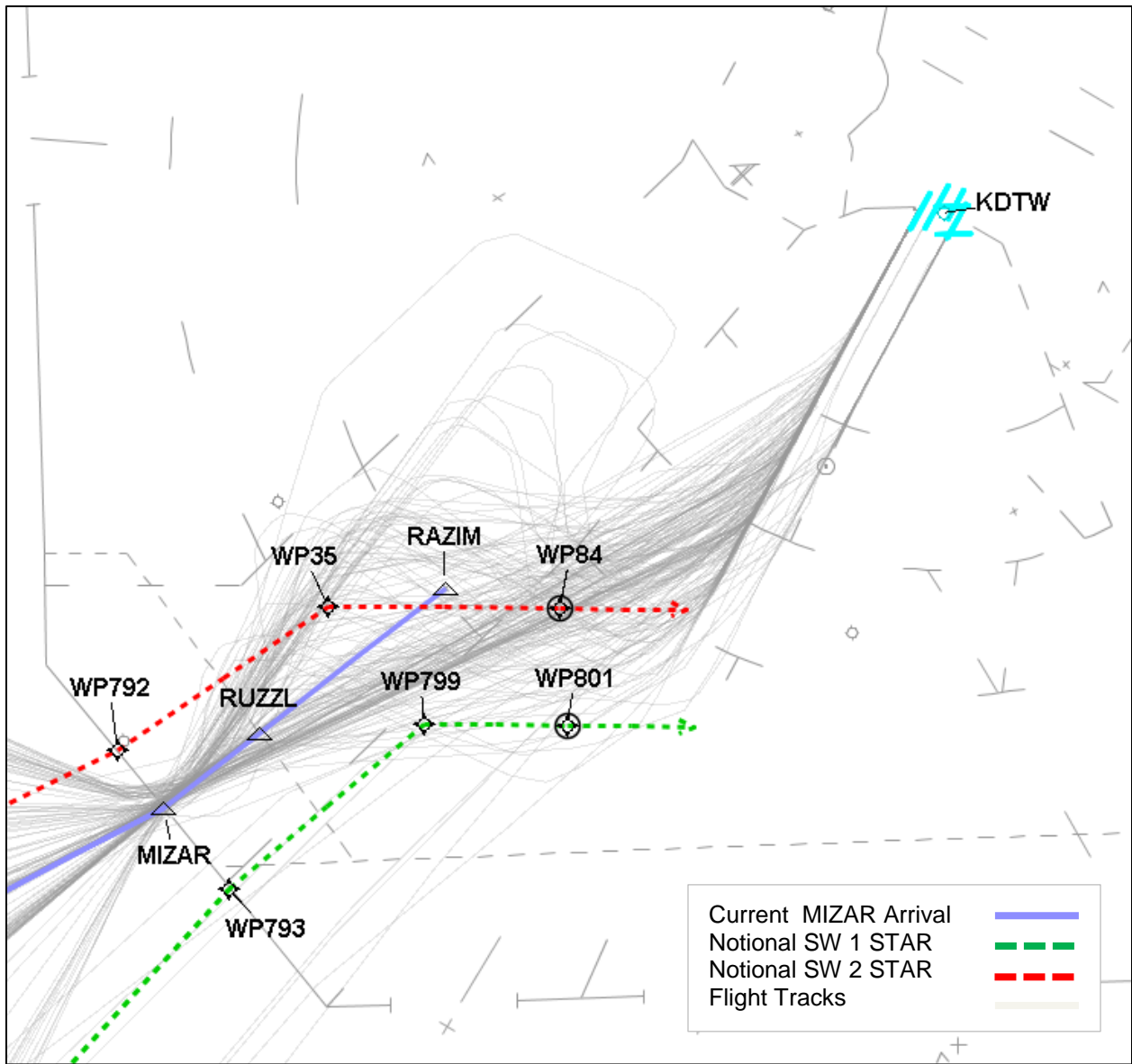
The DTW MIZAR THREE STAR accounts for 26% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures
  - Level segments and inefficient lateral paths
  - Lack of dual arrivals for triple ILS operation
  - Lack of OPDs

- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS



**Figure 27. Current MIZAR THREE Proposed DTW SW 1 and SW 2 NORTH STARS en route view**



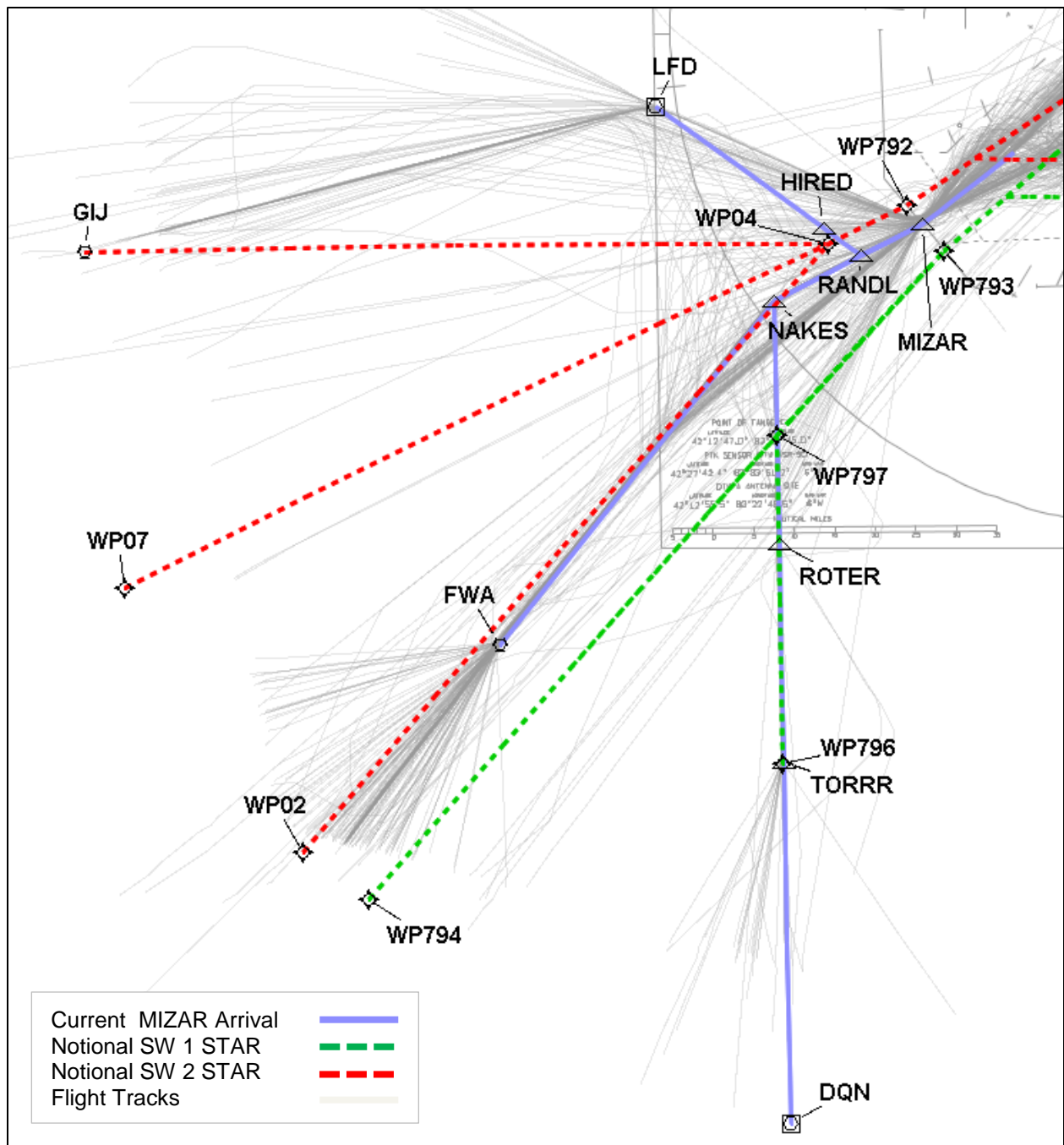
**Figure 28. Current MIZAR THREE Proposed DTW SW 1 and SW 2 NORTH STARs terminal view**

**4.3.1.6 DTW SW 1 and SW 2 SOUTH/WEST STARs**

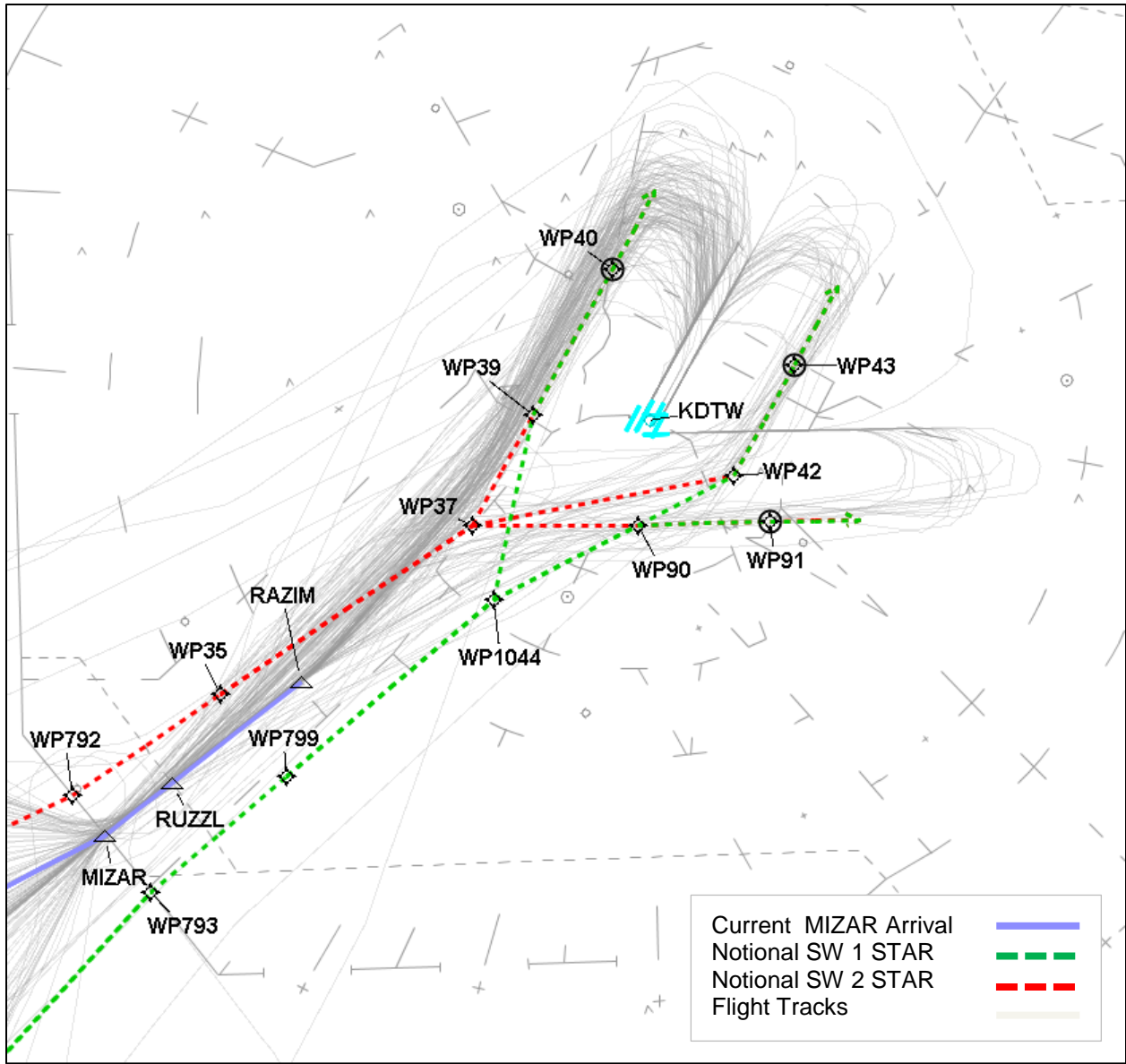
The DTW MIZAR THREE STAR accounts for 26% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary

- Actual flight tracks do not follow current arrival procedures
- Level segments and inefficient lateral paths
- Lack of dual arrivals for triple ILS operation
- Lack of OPDs
- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS
- Benefits: Projected annual savings for the proposed DTW SW 1 NORTH, SW 1 SOUTH/WEST, SW 2 NORTH and SW 2 SOUTH/WEST STARs are estimated in Table 18.



**Figure 29. Current MIZAR THREE Proposed DTW SW 1 and SW 2 SOUTH/WEST STARs en route view**



**Figure 30. Current MIZAR THREE Proposed DTW SW 1 and SW 2 SOUTH/WEST STARs terminal view**

**Table 18. Proposed DTW SW 1 NORTH, SW 1 SOUTH/WEST, SW 2 NORTH and SW 2 SOUTH/WEST STARs Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$1.70M</b>
	<b>Cost to Carry</b>	<b>\$198K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$1.90M</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>627K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>5,888</b>

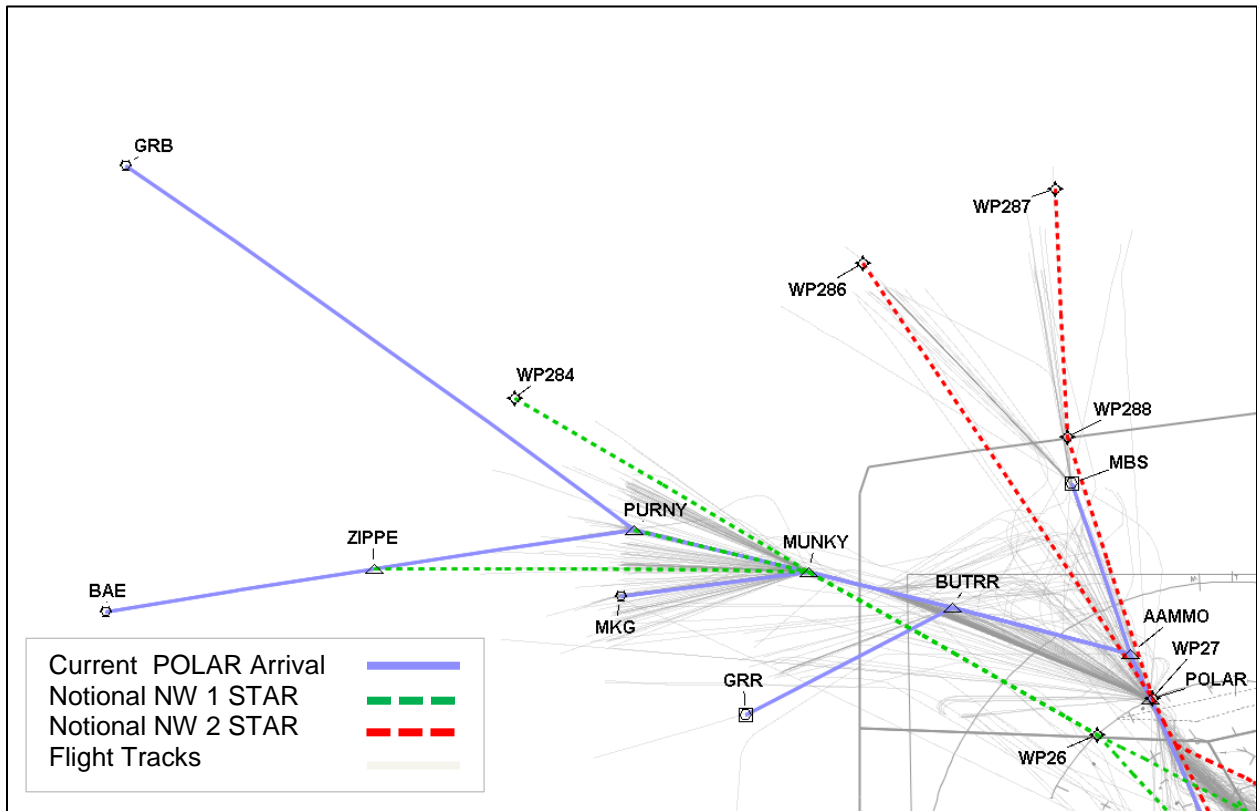
**4.3.1.7 DTW NW 1 and NW 2 SOUTH STARs**

The DTW POLAR THREE STAR accounts for 22% of all DTW jet arrivals.

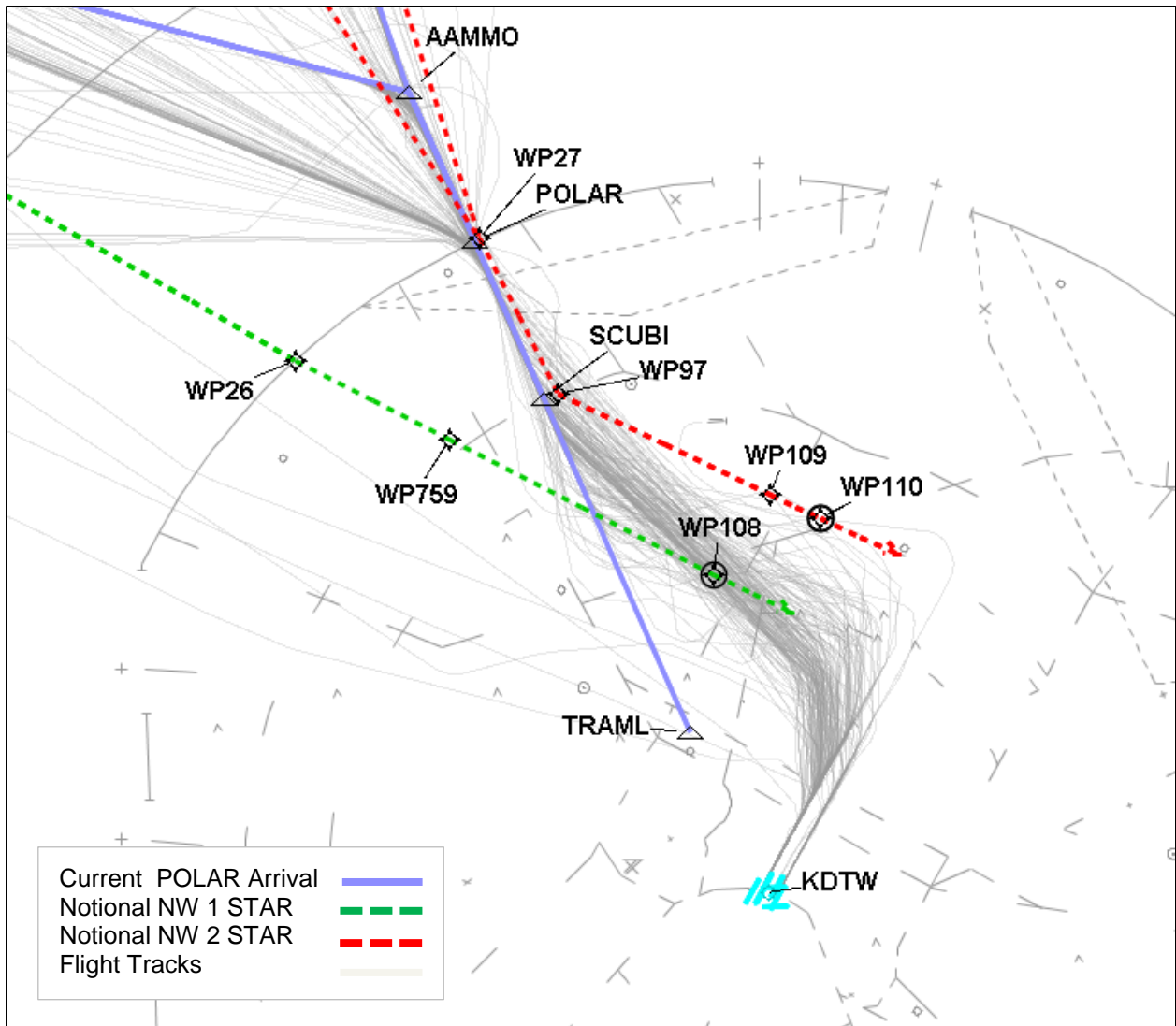
- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures
  - Level segments and inefficient lateral paths
  - Lack of dual arrivals for triple ILS operation
  - Lack of OPDs



- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS



**Figure 31. Current POLAR THREE Proposed DTW NW 1 and NW 2 SOUTH STARs en route view**



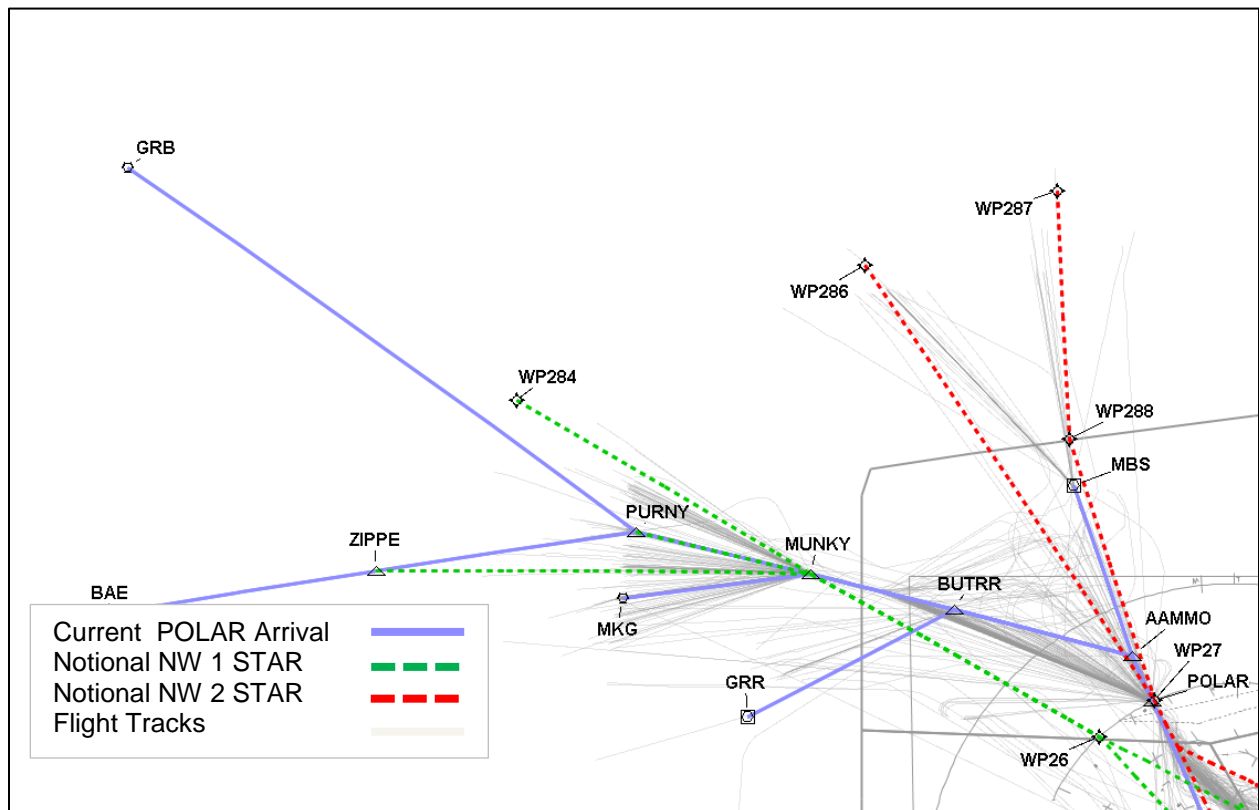
**Figure 32. Current POLAR THREE Proposed DTW NW 1 and NW 2 SOUTH STARs terminal view**

#### 4.3.1.8 DTW SW 1 and SW 2 NORTH/WEST STARs

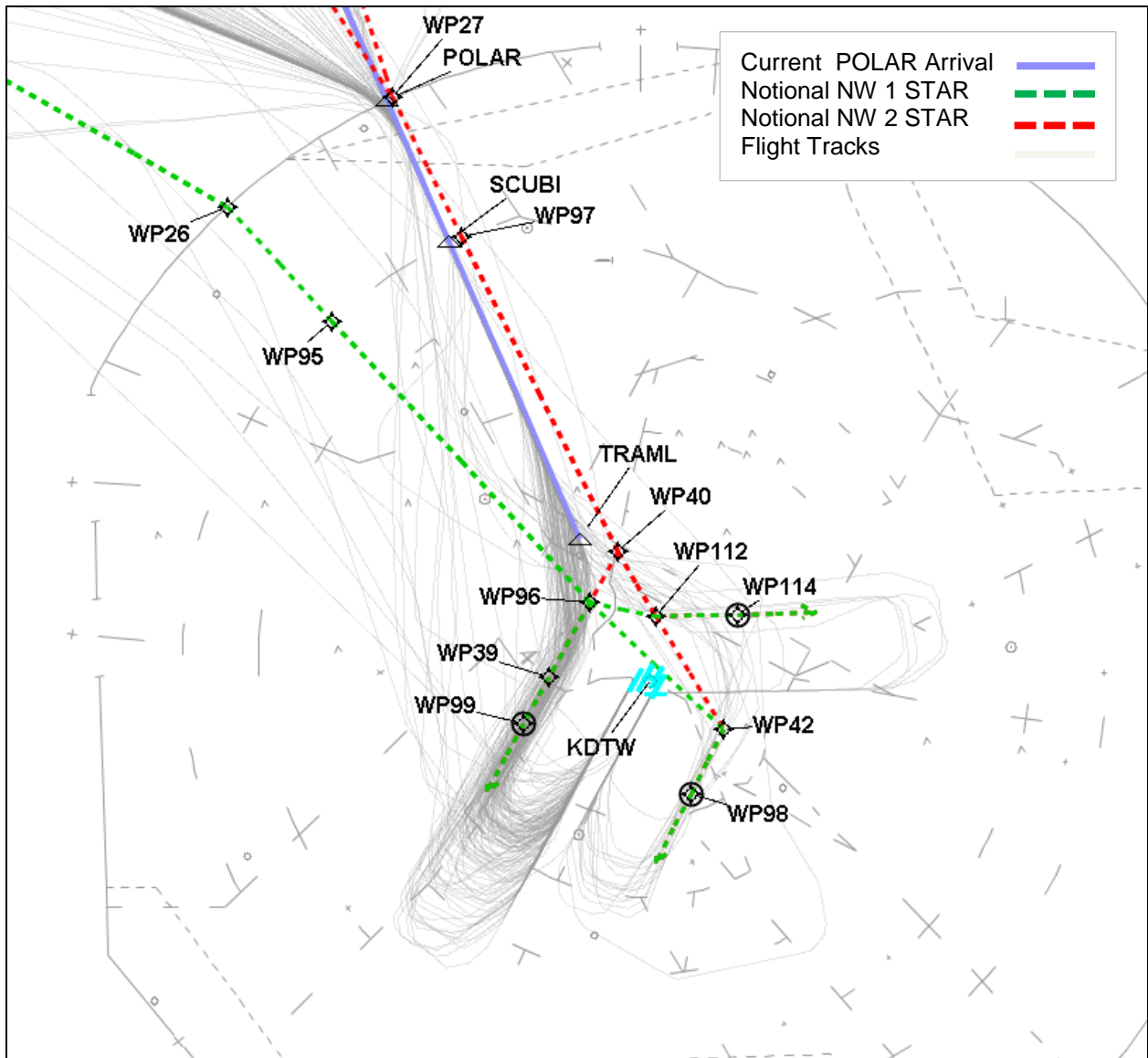
The DTW POLAR THREE STAR accounts for 22% of all DTW jet arrivals.

- Issues
  - Lack of RNAV STAR from the northeast
  - En route traffic sequenced near terminal boundary
  - Actual flight tracks do not follow current arrival procedures

- Level segments and inefficient lateral paths
- Lack of dual arrivals for triple ILS operation
- Lack of OPDs
- Solutions
  - Dual RNAV STARs with OPDs that are flow specific
  - Dual RNAV STARs allow independent operations when appropriate conditions exist, including Triple ILS
- Benefits: Projected annual savings for the proposed DTW NW 1 SOUTH, NW 1 NORTH/WEST, NW 2 SOUTH and NW 2 NORTH/WEST STARs are estimated in Table 19.



**Figure 33. Current POLAR THREE Proposed DTW NW 1 and NW 2 NORTH/WEST STARs en route view**



**Figure 34. Current POLAR THREE Proposed DTW NW 1 and NW 2 NORTH/WEST STARS terminal view**

**Table 19. Proposed DTW NW 1 SOUTH, NW 1 NORTH/WEST, NW 2 SOUTH and NW 2 NORTH/WEST STARs Annual Benefits**

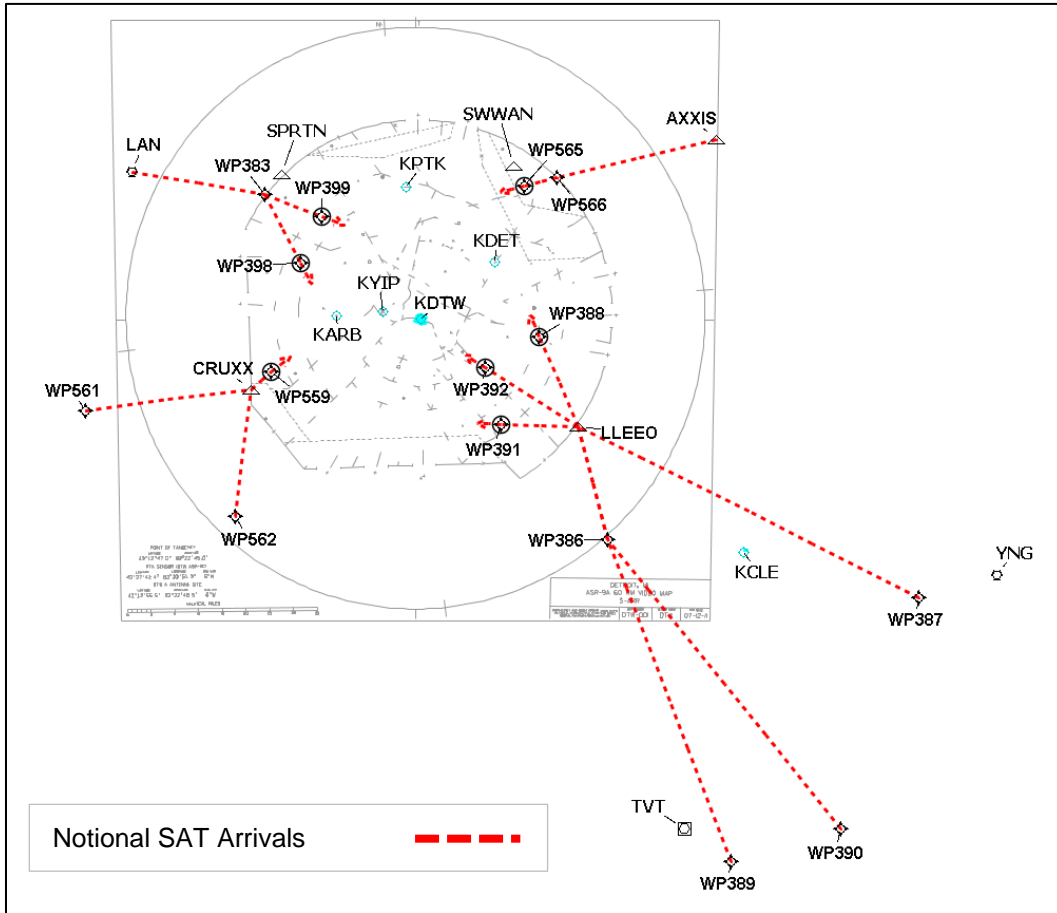
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$2.48M</b>
	<b>Cost to Carry</b>	<b>\$290K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$2.77M</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>915K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>8,595</b>

**4.3.1.9 DTW SAT Arrival Issues**

The CRUXX FOUR, LLEEO TWO, PALCE SEVEN, SPRTN THREE and GOHMA TWO STARs serves the following satellite airports: Ann Arbor Municipal Airport (ARB), Coleman A. Young Municipal Airport (DET), Oakland County International Airport (PTK), Willow Run Airport (YIP), Custer Airport (TTF), Livingston County Spencer J. Hardy Airport (OZW), Meyers-Diver’s Airport (3TE), Canton-Plymouth-Mettetal Airport (1D2), Oakland Southwest Airport (Y47), Grosse Ice Municipal Airport (ONZ), Oakland/Troy Airport (VLL), Selfridge Air National Guard Base (MTC), Romeo State Airport (D98) and Windsor Airport (CYQG). Satellite Airports account for approximately 23% of all D21 TRACON arrival traffic.

- Issues
  - Lack of RNAV STAR for SAT airports
  - PTK arrivals over LLEEO descended over 40 miles from airport
  - CRUXX STAR contains a large turn at CRUXX

- Solution
  - RNAV STAR for satellite airports at each of the four corner posts



**Figure 35. DTW SAT STARs**

### 4.3.2 DTW Departures

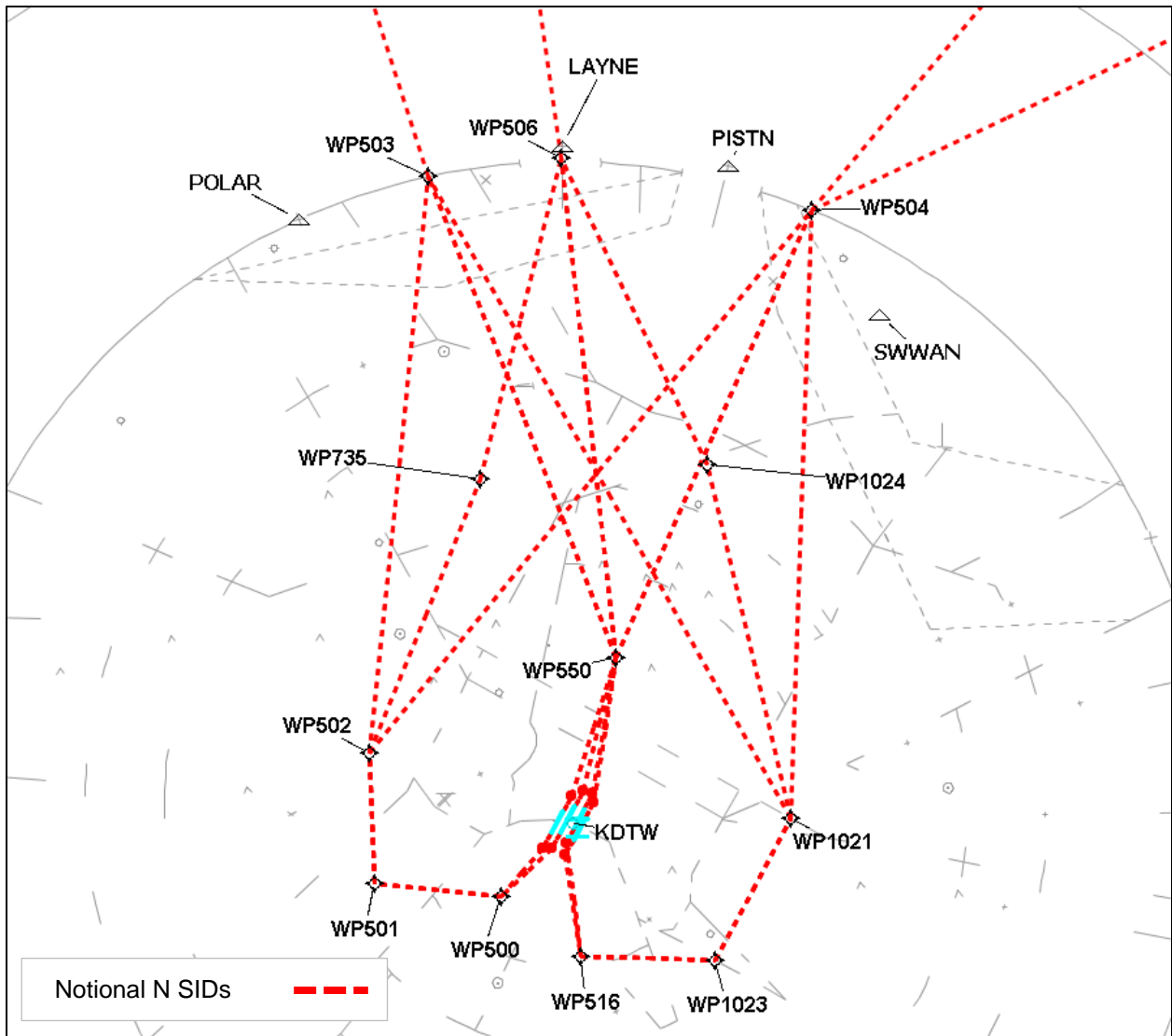
This section describes the operational issues, recommendations, and derived benefits the MST has identified for DTW departures.

The MST used the existing SIDs as the starting point for procedure development. Current departure dispersal headings were used in the development of the notional SIDs. The issues with the current DTW departures are the absence of RNAV SIDs, currently there are eight radar vector SIDs. Problematic to radar vector SIDs is the sharing of intersections which create situations where controllers have to use off course vectors to ensure lateral separation.

#### **4.3.2.1 DTW N 1, N 2 and N 3 SIDs**

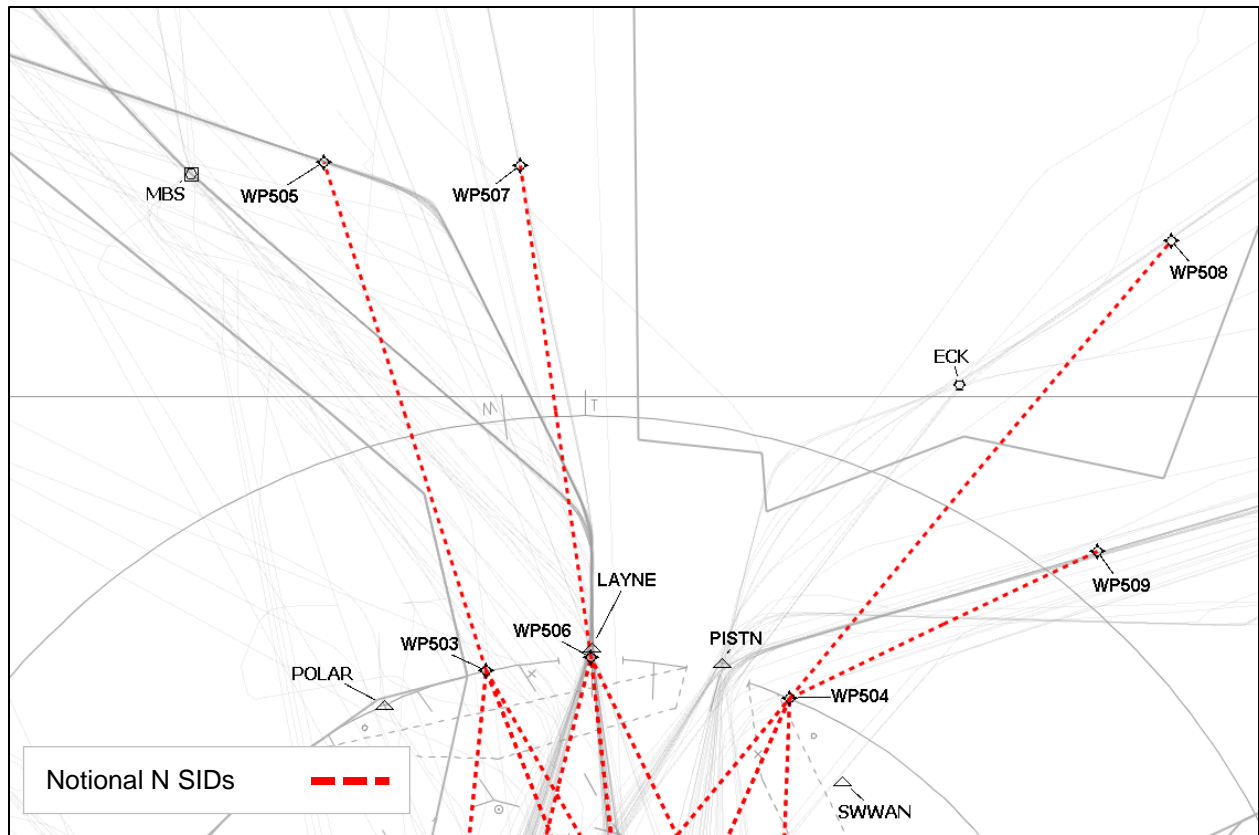
The current STCLR SIX and PALCE SEVEN SIDs account for approximately 12% of all DTW jet departures.

- Issues
  - Lack of RNAV SIDs
  - Departures not contained within appropriate ZOB sector (south flow)
- Solutions
  - RNAV departure procedure for traffic filed via PISTN (N 1)
  - RNAV departure procedure for traffic filed via LAYNE (N 2)
  - New RNAV departure procedure west of LAYNE (N 3)
- Benefits: Projected annual savings for the proposed DTW N 1, N 2 and N 3 are estimated in Table 20.



**Figure 36. Current STCLR SIX and PALCE SEVEN SIDs and Proposed DTW N 1, N 2 and N 3 SIDs terminal view**





**Figure 37. STCLR and PALCE SEVEN and Proposed DTW N 1, N 2 and N 3 SIDs en route view**

**Table 20. Proposed DTW N 1, N 2 and N 3 SIDs Annual Benefits**

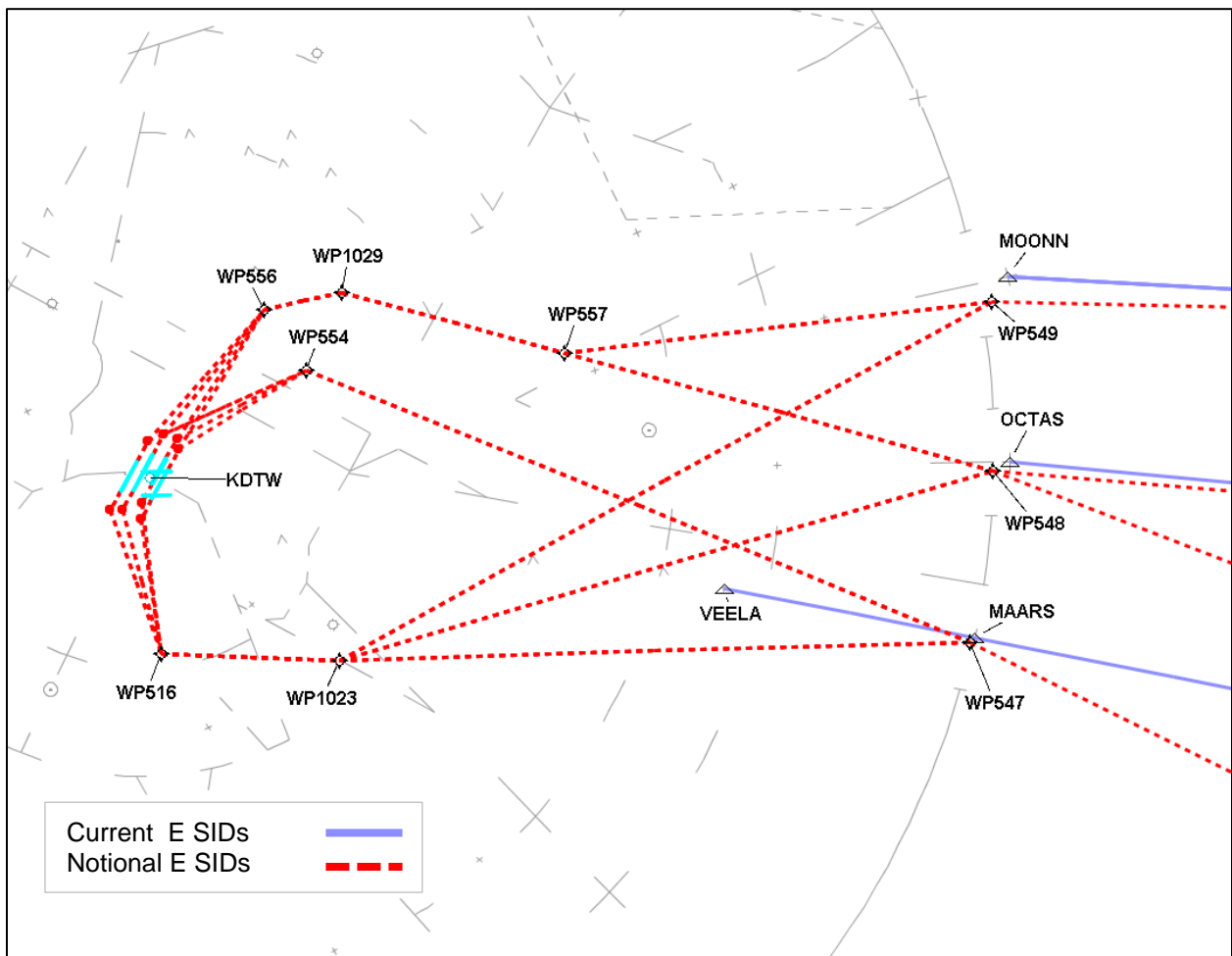
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$177K</b>
	<b>Cost to Carry</b>	<b>\$18K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$195K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>64K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>605</b>

**4.3.2.2 DTW E 1, E 2 and E 3 SIDs**

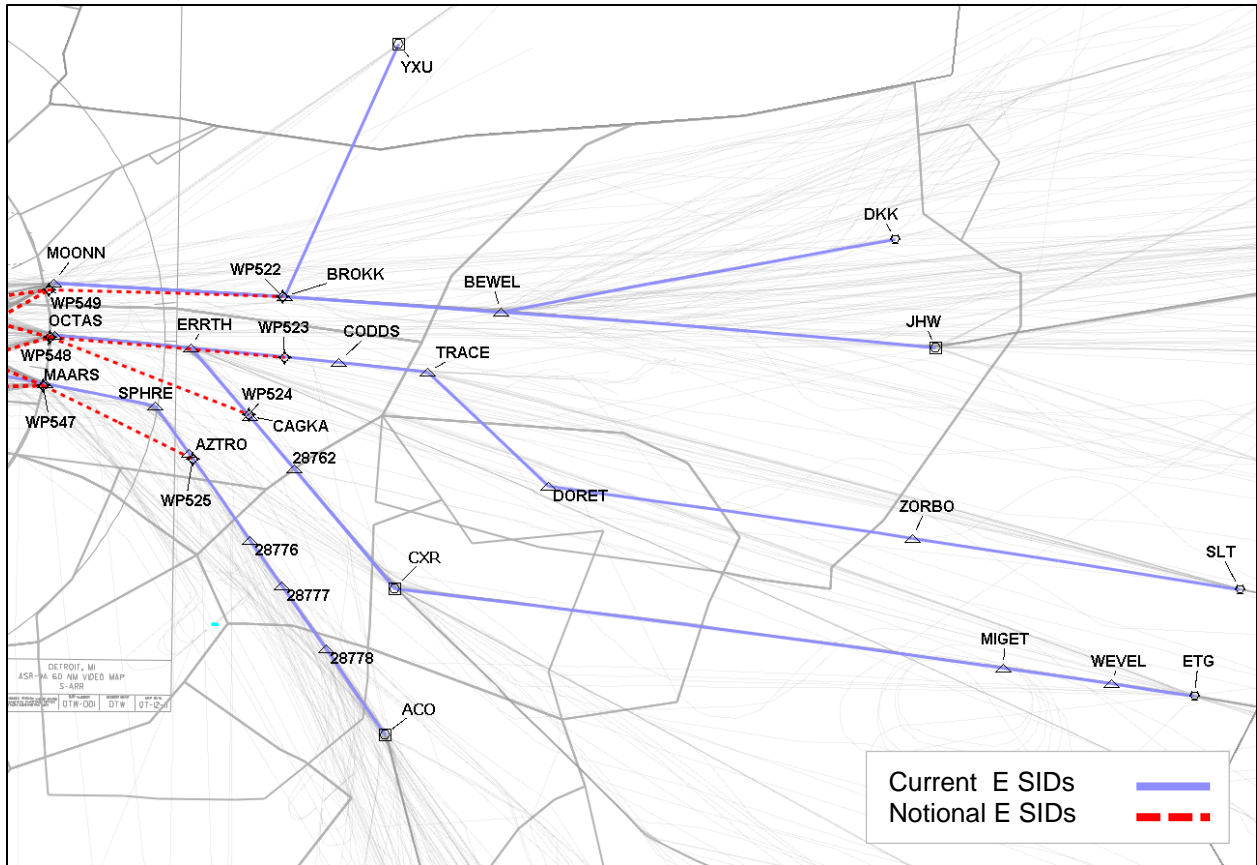
The current ERRTH THREE, MOONN FOUR, STCLR SIX and AKRON THREE SIDs account for approximately 33% of all DTW jet departures.

- Issues
  - Lack of RNAV SIDs
  - Too many departure fixes
  - Vectors required around HIMEZ shelf (south flow)
  - Departures not contained within appropriate ZOB sector (south flow)
  - Departures level off or vectored off course to climb
  - Conflicts with SPICA arrival traffic (north flow)
  - Aircraft incorrectly file via DKK

- Solutions
  - RNAV departure procedure for traffic filed via MAARS (E 1)
  - RNAV departure procedure for traffic filed via ERRTH (E 2)
  - RNAV departure procedure for traffic filed via MOONN (E 3) to segregate traffic from SPICA arrivals and removes DKK transition
- Benefits: Projected annual savings for the proposed DTW N 1, N 2 and N 3 are estimated in Table 21.



**Figure 38. Current ERRTH THREE, MOONN FOUR, STCLR SIX and AKRON THREE SIDs and Proposed DTW E 1, E 2 and E 3 SIDs terminal view**



**Figure 39. ERRTH THREE, MOONN FOUR, STCLR SIX and AKRON THREE SIDs and Proposed DTW E 1, E 2 and E 3 SIDs en route view**

**Table 21. Proposed DTW E 1, E 2 and E 3 SIDs en route view Annual Benefits**

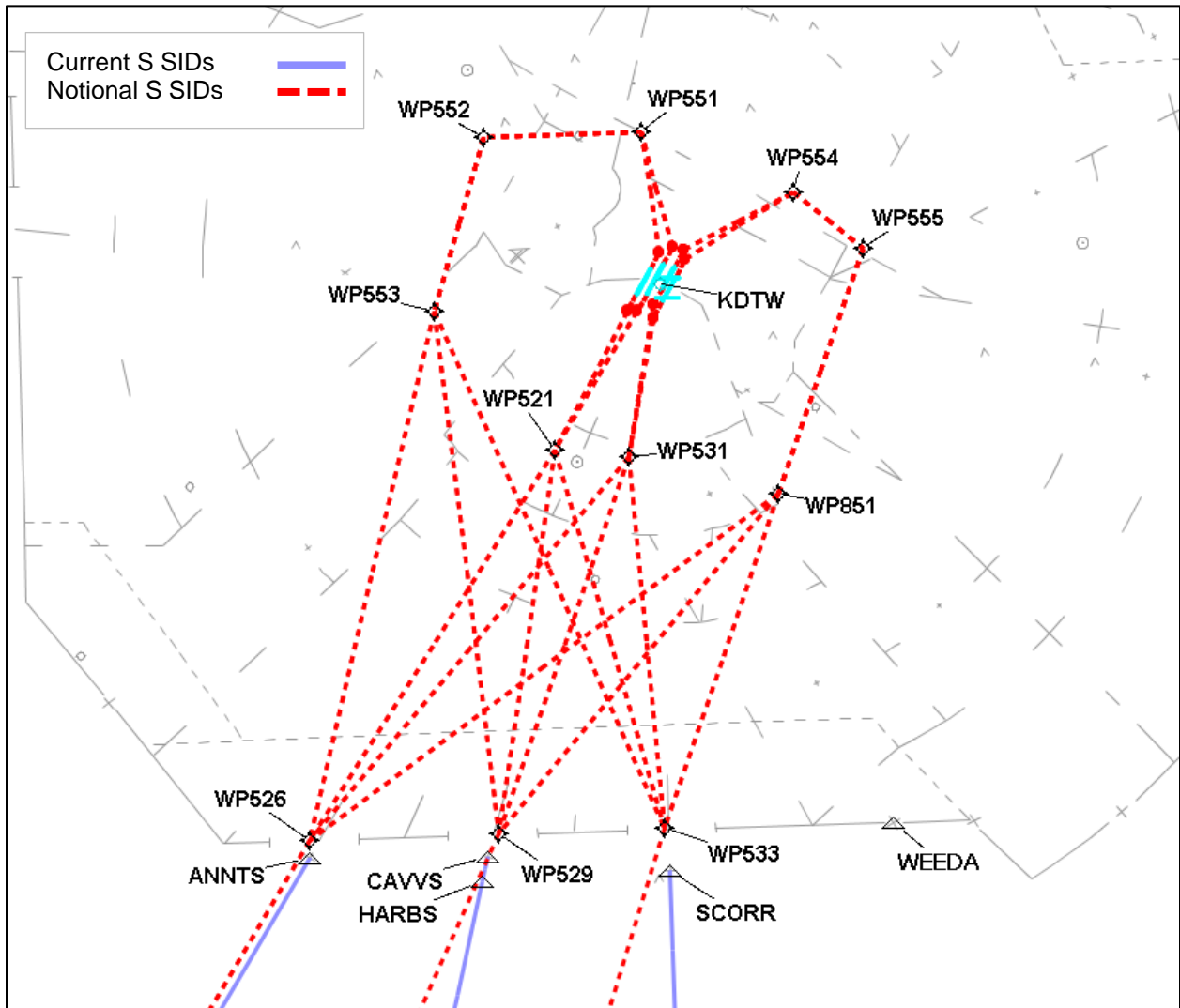
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$473K</b>
	<b>Cost to Carry</b>	<b>\$56K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$529K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>175K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>1,639</b>

**4.3.2.3 DTW S 1, S 2 and S 3 SIDs**

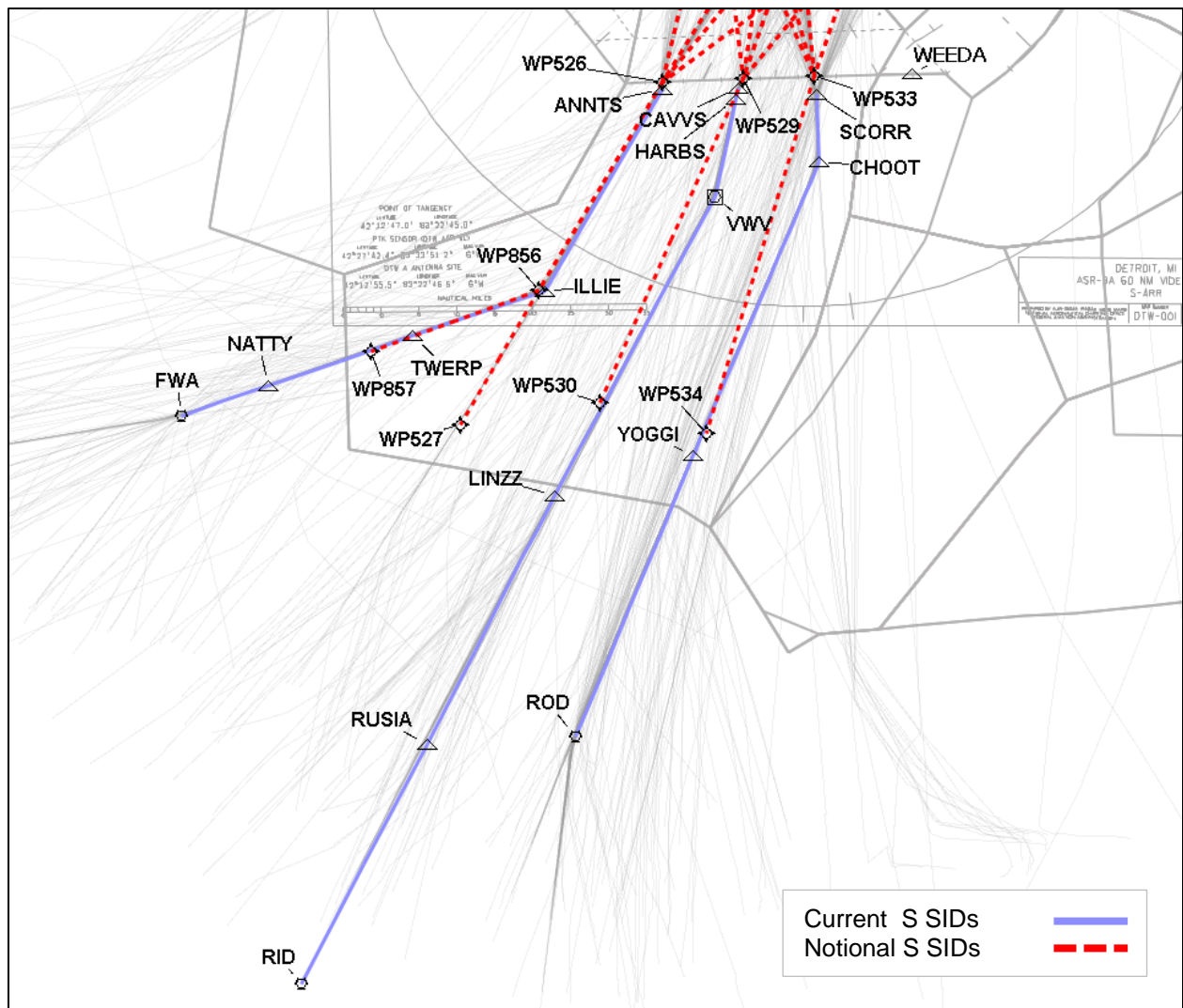
The current STCLR SIX, ROD THREE, RID FIVE, FWA FOUR and PALCE SEVEN SIDs account for approximately 32% of all DTW jet departures.

- Issues
  - Lack of RNAV SIDs
  - Too many departure fixes
  - Departures not contained within appropriate ZOB sector (south flow)

- Solutions
  - RNAV departure procedure for traffic filed via ANNTS (S 1)
  - RNAV departure procedure for traffic filed via CAVVS (S 2)
  - RNAV departure procedure for traffic filed via SCORR (S 3)
- Benefits: Projected annual savings for the proposed DTW S 1, S 2 and S 3 are estimated in Table 22.



**Figure 40. Current STCLR SIX, ROD THREE, RID FIVE, FWA FOUR and PALCE SEVEN SIDs and Proposed DTW S 1, S 2 and S 3 SIDs terminal view**



**Figure 41. STCLR SIX, ROD THREE, RID FIVE, FWA FOUR and PALCE SEVEN SIDs and Proposed DTW S 1, S 2 and S 3 SIDs en route view**

**Table 22. Proposed DTW S 1, S 2 and S 3 SIDs Annual Benefits**

<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$359K</b>
	<b>Cost to Carry</b>	<b>\$36K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$395K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>130K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>1,225</b>

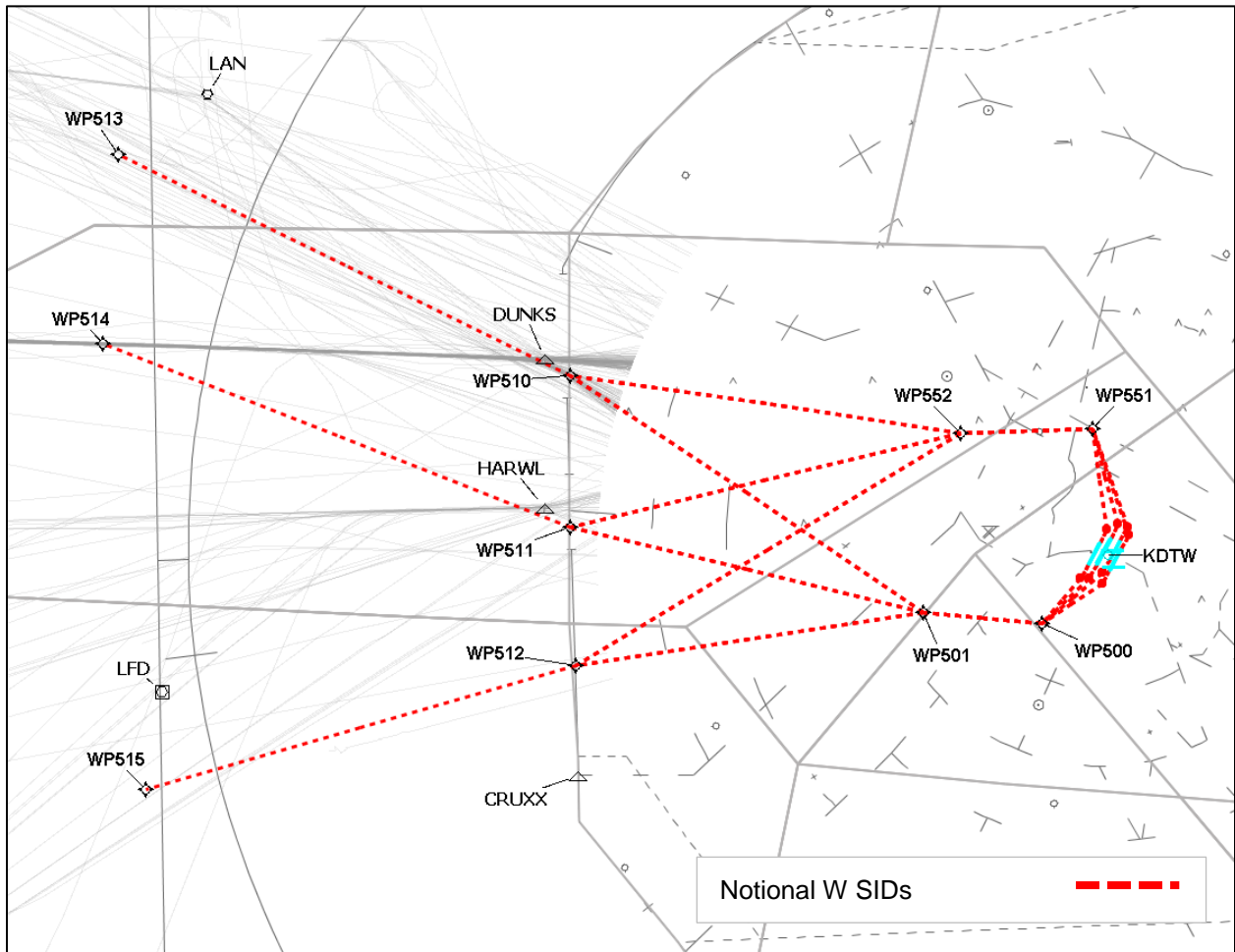
**4.3.2.4 DTW W 1, W 2 and W 3 SIDs**

The current PALCE SEVEN SID accounts for approximately 23% of all DTW jet departures.

- Issues
  - Lack of RNAV SIDs
  - Departures not contained within appropriate ZOB sector (south flow)



- Solutions
  - RNAV departure procedure for traffic filed via DUNKS (W 1)
  - RNAV departure procedure for traffic filed via HARWL (W 2)
  - RNAV departure procedure for southwest bound traffic (W 3)
- Benefits: Projected annual savings for the proposed DTW W 1, W 2 and W 3 are estimated in Table 23.



**Figure 42. Current PALCE SEVEN SID and Proposed DTW W 1, W 2 and W 3 SIDs**

**Table 23. Proposed DTW W 1, W 2 and W 3 SIDs Annual Benefits**

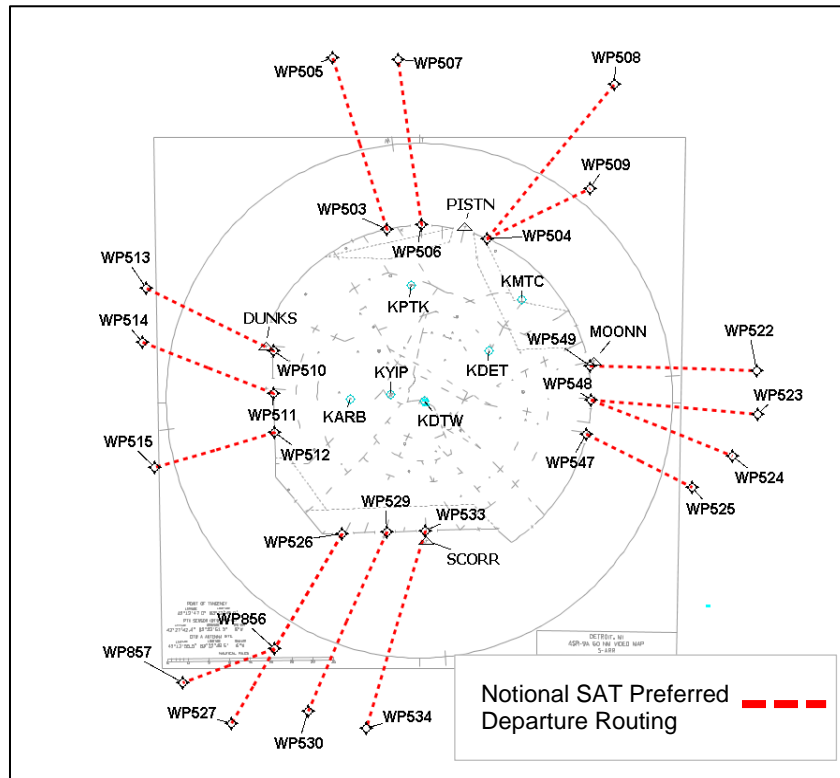
<b>Estimated Annual Fuel Savings (Dollars)</b>	<b>Fuel Burn (Distance and Profile)</b>	<b>\$247K</b>
	<b>Cost to Carry</b>	<b>\$25K</b>
<b>Total Estimated Annual Fuel Savings (Dollars)</b>		<b>\$272K</b>
<b>Total Estimated Annual Fuel Savings (Gallons)</b>		<b>90K</b>
<b>Total Estimated Annual Carbon Savings (Metric Tons)</b>		<b>842</b>

**4.3.2.5 DTW SAT Departure Issues**

The ACO THREE, ERRTH THREE, FWA FOUR, MOONN FOUR, PALCE SEVEN, RID FIVE, ROD THREE AND STCLR SIX SIDs service the following airports: Ann Arbor Municipal Airport (ARB), Coleman A. Young Municipal Airport (DET), Oakland County International Airport (PTK), and Willow Run Airport (YIP). Satellite Airports account for approximately 25% of all D21 TRACON traffic.

- Issues
  - No existing RNAV SIDs for satellite airports
  - Satellite departures are sequenced with DTW departures
  - PTK turboprop departures may be assigned low altitudes for extended periods

- Solutions
  - Use preferred routings utilizing DTW RNAV SID waypoints located at the terminal boundary
  - Incorporate in the LOA the ability to “stack” satellite departures in lieu of sequencing with DTW departures



**Figure 43. DTW SAT Departures Preferred Routing**

### 4.3.3 Summary of Potential Benefits for DTW

As shown in Table 24 below, the proposed DTW STARs and SIDs are estimated to provide \$9.81 million annually in fuel savings.

**Table 24. Total Annual Fuel Burn Benefits for DTW**

	<b>Fuel Burn Benefit (\$)</b>	<b>Cost to Carry (\$)</b>	<b>Overall Fuel Benefit (\$)</b>	<b>Estimated Carbon Savings (Metric Tons)</b>
<b>Arrivals</b>	<b>\$7.53M</b>	<b>\$889K</b>	<b>\$8.42M</b>	<b>26,117</b>
<b>Departures</b>	<b>\$1.26M</b>	<b>\$135K</b>	<b>\$1.39M</b>	<b>4,311</b>
<b>Total Annual Savings</b>	<b>\$8.79M</b>	<b>\$1.02M</b>	<b>\$9.81M</b>	<b>30,428</b>

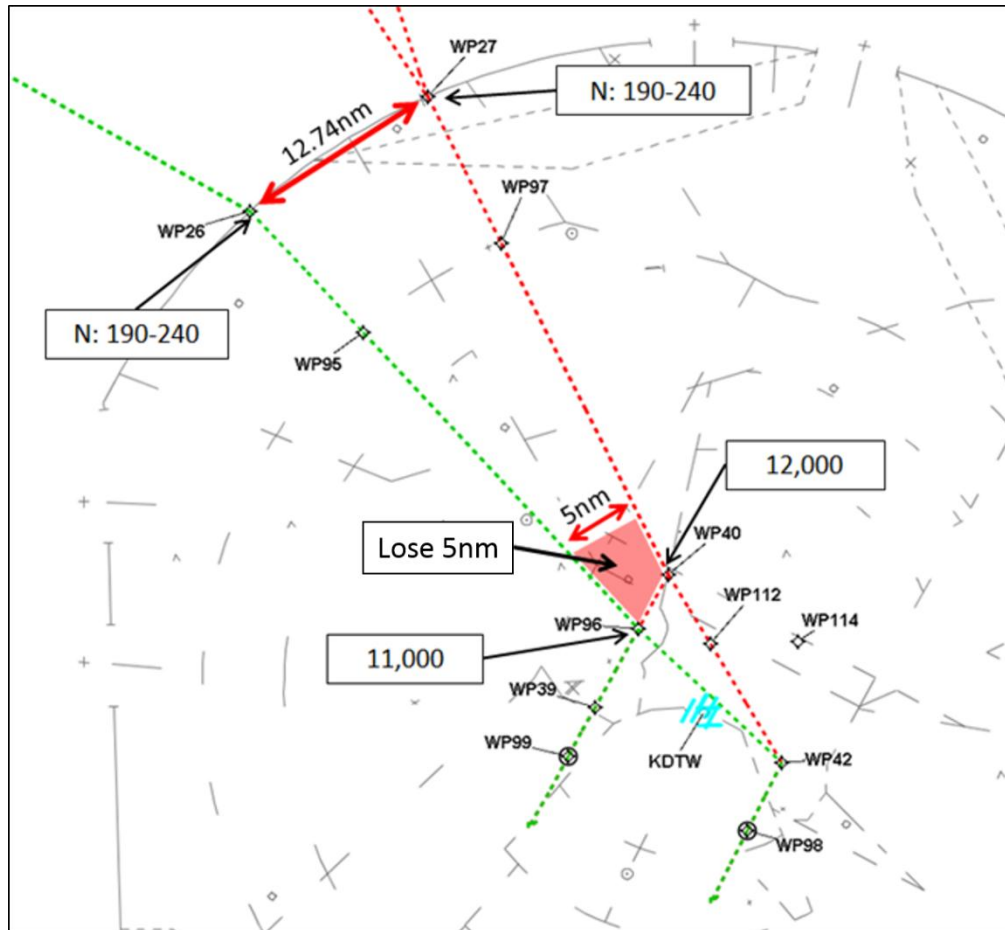
#### **4.4 D21 Airspace Issues**

The MST notionally designed dual arrivals on each corner post. When aircraft are transitioning to the downwind (long side operation) waypoints were created with anchor altitudes of 11,000 feet and 12,000 feet to ensure vertical separation prior to the loss of lateral separation. These waypoints are approximately 10 NM from DTW.

Aircraft will need to be established within terminal airspace prior to loss of en route separation criteria. (See Figure 44 below) The point where en route separation is lost the D&I Team will need to choose one of three options: 1) Force aircraft into terminal airspace prior to losing en route lateral separation (this will create level segments); 2) Raise terminal airspace to an altitude that supports terminal separation prior to losing en route lateral separation or 3) Combination of raising the vertical limits of D21 airspace and forcing aircraft into the new airspace.

- Issues
  - Study Team notional designs to support dual OPDs at the corner posts require higher TRACON altitude
  - Holding pattern protected airspace infringes on approach airspace

- Solutions
  - Raise the D21 vertical limit to retain terminal separation minima to support creation of dual OPDs
  - Establish holding pattern airspace above and/or outside of D21 airspace

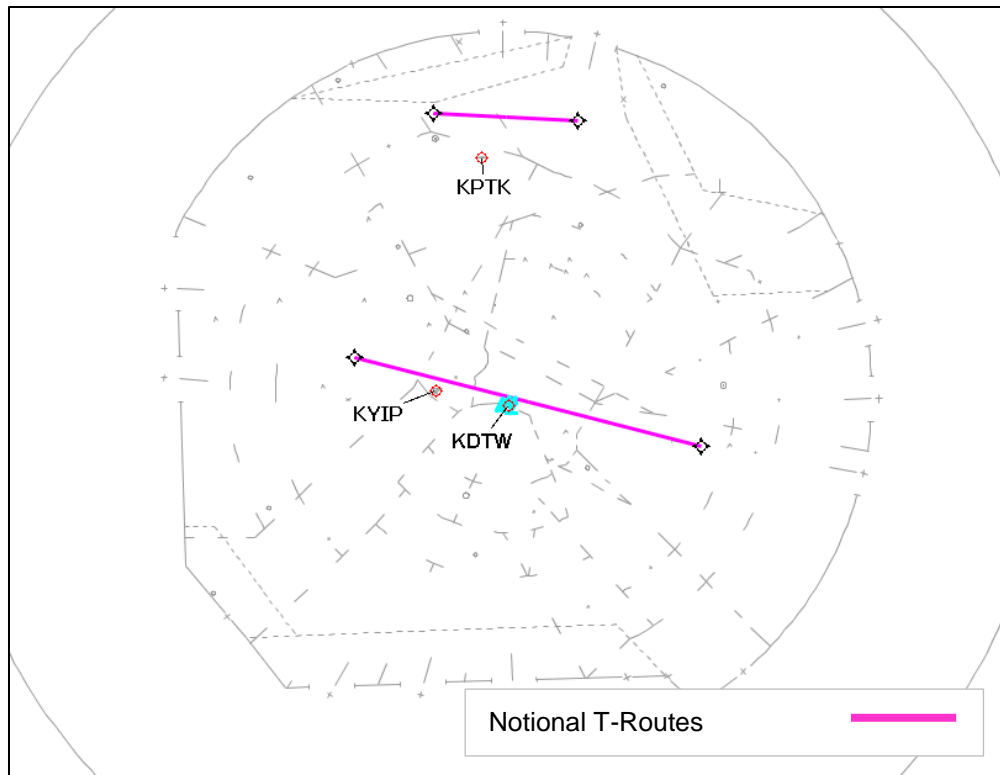


**Figure 44. Notional Separation within D21**

## 4.5 T-Route Notional Designs

Currently there are no designated overflight routes transitioning D21 airspace.

- Issues
  - ZOB and approach controls must APREQ overflights
- Solution
  - T-Routes to provide a predictable, assignable path through D21 airspace

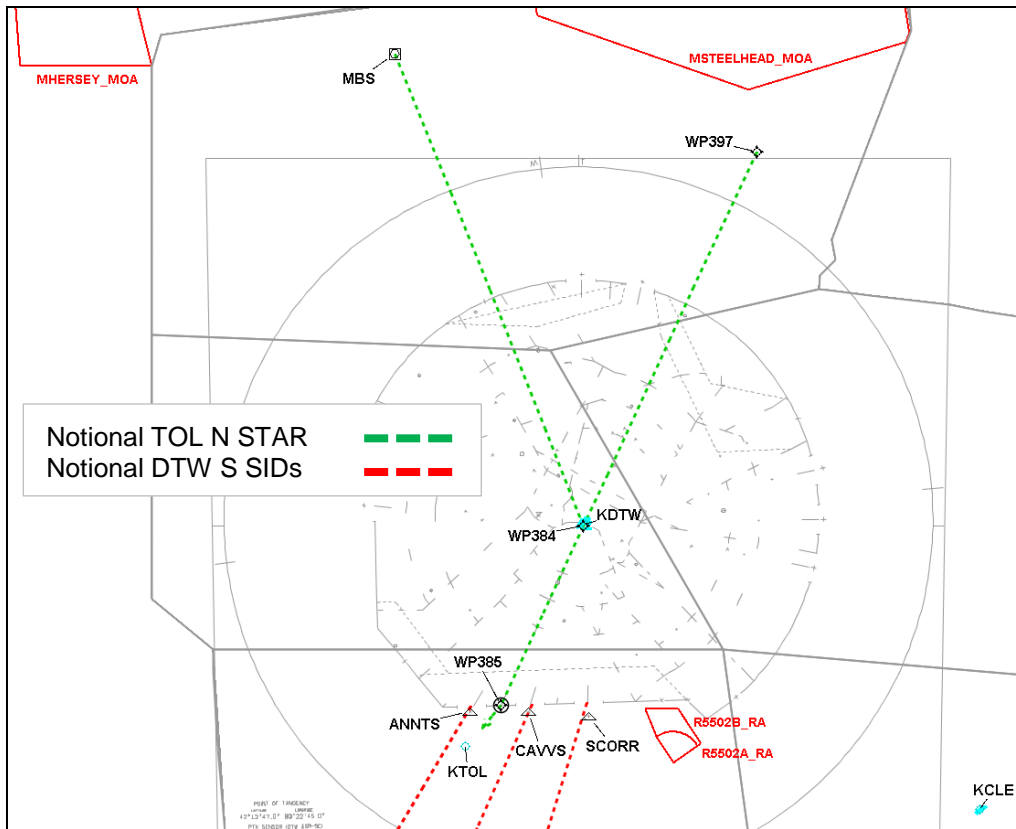


**Figure 45. Notional T-Route Designs**

## 4.6 Military Issues

### 4.6.1 180<sup>th</sup> FW Issues

- Issues
  - Inefficient arrival procedure from the north into TOL
  - Inefficient northbound departure procedure from TOL
  - Nonstandard formation departures require excessive coordination
- Solutions
  - Develop TOL RNAV STAR for arrivals from the north
  - Northbound departure procedure from TOL to be addressed during D&I
  - Departure coordination procedure to be reviewed between TOL, ZOB and the Air National Guard 180<sup>th</sup> Fighter Wing



**Figure 46. Notional TOL N STAR**

#### 4.6.2 KMTC Issues

- Issues
  - Arrivals into KMTC from the east are often descended early and held at 12,000
  - Arrivals into KMTC via LLEEO2.DJB descends early and are often held at 4,000 or 6,000
  - Large, nonstandard formation departures require excessive coordination
- Solutions
  - East arrivals to mirror the DTW NE 2 STAR
  - Southeast arrivals to mirror the DTW SE 2 STAR
  - Close collaboration between DOD, KMTC, ZOB and D21
  - Establish an LOA between KMTC and D21 to resolve departure issues
  - KMTC departure procedures to be further refined within the LOA between D21 and ZOB

## 4.7 Industry Issues

- Issues
  - Requesting RNAV Arrival/Departures (OPDs included)
  - Requesting higher altitudes on STARs
  - Requesting fuel efficient speeds on arrivals
  - Surface efficiency in regards to ATC departure gates and taxi times
  - Explore Time Based Flow Management (TBFM) and additional systemic impacts of PBN implementation
  - Requesting 2,000 foot altitude buffer in terminal environment to avoid TCAS alerts
- Solutions
  - Develop RNAV SIDs and STARs with OPDs
  - Procedural altitudes and speed restrictions will be finalized during D&I
  - Develop additional departure transitions to allow more efficient dispersal of aircraft at the runway. Ground staging to be reviewed.
  - TBFM support during D&I to minimize systemic inefficiency
  - TCAS altitude buffer to be reviewed during D&I

## 4.8 Out of Scope Issues

The MST determined the following issues were out of scope.

- D21
  - Limited final airspace due to confines of Bravo
  - SOP procedures restrict triple approach flexibility
  - Arrival strips printed at central location
  - Southwest flow, arriving RWY22R and 27L, departing RWY22L and 21R



- DTW
  - Limited ASDE-X displays
  - Lack of tower simulator
  - Insufficient Aerobahn bandwidth
  - Limited Traffic Management of ground traffic
  - Inefficient cab layout
  - Inaccurate wind instrumentation
  - RNAV RNP overlay to RWYs 4L/22R to solve the localizer critical area issue

## 4.9 Additional D&I Considerations

The MST identified and characterized a range of problems and developed a number of notional solutions; however, some issues require additional coordination and input and could not be addressed within the time constraints of the MST process. These issues may be explored further either during or outside the D&I process. The following issues were identified:

- En Route and Terminal Sectorization/Boundary Changes
- En Route connectivity
- Instrument Approach Procedure (IAP) connectivity
- Bidirectional vs. Unidirectional STARs at CLE
- Adjacent Center/Terminal facility design collaboration
- YIP ILS RWY 23L interaction with DTW
- Stacked arrivals at the TCP
- Northeast Flow; depart RWY9R/9L and land RWY 4R/4L
- RNAV arrival and departure procedures for RWY9R/9L
- Explore Time Based Flow Management (TBFM) and additional systemic impacts of PBN implementation
- DTW PDC automation configuration coordination with ZOB Facility Automation Support Team (FAST) Program Office Field Manager (POFM)
- Departure Divergence Alternative Design: Further analysis between ground delay vs. gate volume will need to be pursued.

## 5 Summary of Benefits

### 5.1 Qualitative Benefits

#### 5.1.1 Near-Term Impacts

The benefits of the PBN procedures proposed by the MST include the following:

- Reduced phraseology, frequency congestion, and pilot workload:

Reduced phraseology due to PBN will reduce the number of transmissions needed to accomplish required restrictions by combining multiple clearances into a single transmission. Prior studies have demonstrated transmission reductions on the order of 18% to 34% with 85% RNAV equipage,<sup>7</sup> and the MST believes it is reasonable to expect a similar level of savings. Reduced transmissions will translate into less frequency congestion which could potentially reduce “hear back/read back” errors. In addition, the consolidation of clearances associated with an RNAV procedure reduces pilot workload, which allows for more “heads-up” time and allows the crew to focus on high-workload situations.

- Repeatable, predictable flight paths and accurate fuel planning:

The introduction of PBN ensures lateral flight path accuracy. The predictable flight paths help assure procedurally segregated traffic flows and allow airlines to more accurately plan for a consistent flight path. It also allows users to more accurately predict the amount of fuel required for a procedure.

- Enhanced lateral and vertical flight paths:

Optimized climbs and descents and shorter lateral paths reduce the number and length of level-offs and total distance flown, thereby reducing fuel burn and carbon emissions. Altitude windows can vertically separate traffic flows and allow for industry-standard glide paths.

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<sup>7</sup> Sprong, K., et al., June 2006, “Benefits Estimation of RNAV SIDs and STARs at Atlanta,” F083-B06-020, (briefing), The MITRE Corporation, McLean, VA.

### 5.1.2 Long-Term Impacts to Industry

Implementation of these proposed procedures will have long-term effects for industry.

- Flight planning

Metroplex proposed procedures will result in reduced mileage and fuel burn in the long-term, particularly as more metroplexes are optimized. In the near-term, more direct paths that are not dependent on ground-based navigational aids, plus optimized flight profiles, will lead to reduced fuel burn only within an optimized metroplex. Reduced fuel loading will also allow for a reduction in cost to carry.

- Timetable

Shortened, more efficient routes will necessitate timetable adjustments, particularly as more metroplexes are optimized. This will potentially benefit crew scheduling, connecting information, time on gates, ramp scheduling, etc.

## 5.2 Quantitative Benefits

The quantified benefits of the Cleveland/Detroit MST recommendations are broken down into annual fuel savings in dollars, annual fuel savings in gallons, and annual carbon emissions reductions in metric tons. The primary benefit drivers are improved vertical profiles and reduced miles flown.

Benefits from conceptual arrival procedures came from:

- RNAV STARs with OPDs
- More efficient lateral paths created by adjusting terminal entry points and removing doglegs
- Removal of unused en route transitions and development of runway transitions

Benefits from conceptual departure procedures came from:

- A combination of RNAV off-the-ground procedures and radar vector procedures to join RNAV routes
- Departure procedures designed to facilitate unrestricted climbs by removing or mitigating existing level-offs
- Procedural segregate, where practical, from other SIDs and STARs

Table 25 breaks down the total benefits for Cleveland/Detroit. The total potential annual fuel savings is estimated \$12.54 million. These numbers were derived by comparing currently flown track miles, published procedure miles, and vertical profiles to proposed PBN procedure track miles and vertical profiles. The benefits analysis assumes aircraft will fly the specific lateral and vertical RNAV procedures. It is fully expected that ATC will continue to offer shorter routings and remove climb restrictions, when feasible, further increasing operator benefits.

**Table 25. Total Annual Fuel Benefits Associated with Distance, Profile, and Filed Mile Changes**

	<b>Fuel Burn Benefit (\$)</b>	<b>Cost to Carry (\$)</b>	<b>Overall Fuel Benefit (\$)</b>	<b>Estimated Carbon Savings (Metric Tons)</b>
<b>Cleveland</b>	<b>\$2.52M</b>	<b>\$205K</b>	<b>\$2.73M</b>	<b>8,456</b>
<b>Detroit</b>	<b>\$8.79M</b>	<b>\$1.02M</b>	<b>\$9.81M</b>	<b>30,428</b>
<b>Total Annual Savings</b>	<b>\$11.31M</b>	<b>\$1.23M</b>	<b>\$12.54M</b>	<b>38,884</b>

## Appendix A Acronyms

Acronyms	
<b>AAR</b>	Airport Arrival Rate
<b>ARTCC</b>	Air Route Traffic Control Center
<b>ASPM</b>	Airport Specific Performance Metrics
<b>ATALAB</b>	Air Traffic Airspace Lab
<b>ATC</b>	Air Traffic Control
<b>ATCT</b>	Air Traffic Control Tower
<b>BADA</b>	Base of Aircraft Data
<b>CAASD</b>	Center for Advanced Aviation System Development
<b>CATEX</b>	Categorical Exclusion
<b>CTC</b>	Cost to Carry
<b>CY</b>	Calendar Year
<b>D&amp;I</b>	Design and Implementation
<b>DEP</b>	Depart
<b>EA</b>	Environmental Assessment

<b>Acronyms</b>	
<b>EIS</b>	Environmental Impact Statement
<b>ETMS</b>	Enhanced Traffic Management System
<b>EUROCONTROL</b>	European Organization for the Safety of Air Navigation
<b>FAA</b>	Federal Aviation Administration
<b>IAP</b>	Instrument Approach Procedure
<b>ICAO</b>	International Civil Aviation Organization
<b>IFR</b>	Instrument Flight Rules
<b>L/R</b>	Left/Right
<b>LOA</b>	Letter of Agreement
<b>Metroplex</b>	Optimization of Airspace and Procedures in the Metroplex
<b>MIT</b>	Miles-in-Trail
<b>MSL</b>	Mean Sea Level
<b>MST</b>	Metroplex Study Team
<b>NAS</b>	National Airspace System

<b>Acronyms</b>	
<b>NAT</b>	National Analysis Team
<b>NAVAID</b>	Navigational Aid
<b>NAV CANADA</b>	Canada's civil air navigation services provider
<b>NM</b>	Nautical Mile(s)
<b>NOP</b>	National Offload Program
<b>NTML</b>	National Traffic Management Log
<b>OPD</b>	Optimized Profile Descent
<b>PBN</b>	Performance Based Navigation
<b>PDARS</b>	Performance Data Analysis and Reporting System
<b>RITA</b>	Research and Innovative Technology Administration
<b>RNAV</b>	Area Navigation
<b>RNP</b>	Required Navigation Performance
<b>ROM</b>	Rough Order of Magnitude
<b>RTCA</b>	Radio Technical Commission for Aeronautics

<b>Acronyms</b>	
<b>SAT</b>	Satellite Airport
<b>SID</b>	Standard Instrument Departure
<b>SOP</b>	Standard Operating Procedure
<b>SRM</b>	Safety Risk Management
<b>STAR</b>	Standard Terminal Arrival Route
<b>TARGETS</b>	Terminal Area Route Generation Evaluation and Traffic Simulation
<b>TBFM</b>	Time Based Flow Management
<b>TCAS</b>	Traffic Collision and Avoidance System
<b>TCP</b>	Transfer of Control Point
<b>TFMS</b>	Traffic Flow Management System
<b>TMA</b>	Traffic Management Advisor
<b>TMI</b>	Traffic Management Initiatives
<b>TRACON</b>	Terminal Radar Approach Control
<b>WTM</b>	Windsor/Toronto/Montreal airspace project



## Appendix B PBN Toolbox

Sample PBN Toolbox Options
Adding an arrival route
Adding a departure route
Extend departure routes
Build in procedural separation between routes
Reduce route conflicts between airports
Changing airspace to accommodate a new runway
Adding a parallel arrival route (to a new runway)
Splitting a departure fix that serves more than one jet airway
Increased use of 3 NM separation
Increased use of terminal separation rules
Static realignment or reassignment of airspace
Adaptive realignment or reassignment of airspace
Improving sector boundaries (sector split, boundary move, new area of specialization)

### Sample PBN Toolbox Options

Shifting aircraft routing (Avoiding re-routes, shorter routes)

Eliminating altitude restrictions

More efficient holding (design, usage and management)

Adding surveillance coverage

Adding en route access points or other waypoint changes (NRS)

Adding en route routes

Reduce restrictions due to Special Use Airspace

TMA initiatives