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INTEGRATED CORRIDOR MANAGEMENT –
DES MOINES METRO AREA

PHASE 2 STRATEGY BUNDLE EVALUATION

5/17/2021
2.0

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Executive Summary

The Des Moines Integrated Corridor Management (ICM) project aims to deploy ICM strategies and selected capacity improvements to cost-effectively and proactively manage traffic in the Des Moines metropolitan area. A comprehensive analysis has been completed through the year 2050 toward the goal of identifying the benefits and costs of potential ICM improvement strategies. The analysis focuses on five ICM improvement bundles that range in their level of focus on roadway capacity, transportation system management and operations (TSMO) strategies, and transit capacity.

The five bundles considered were:

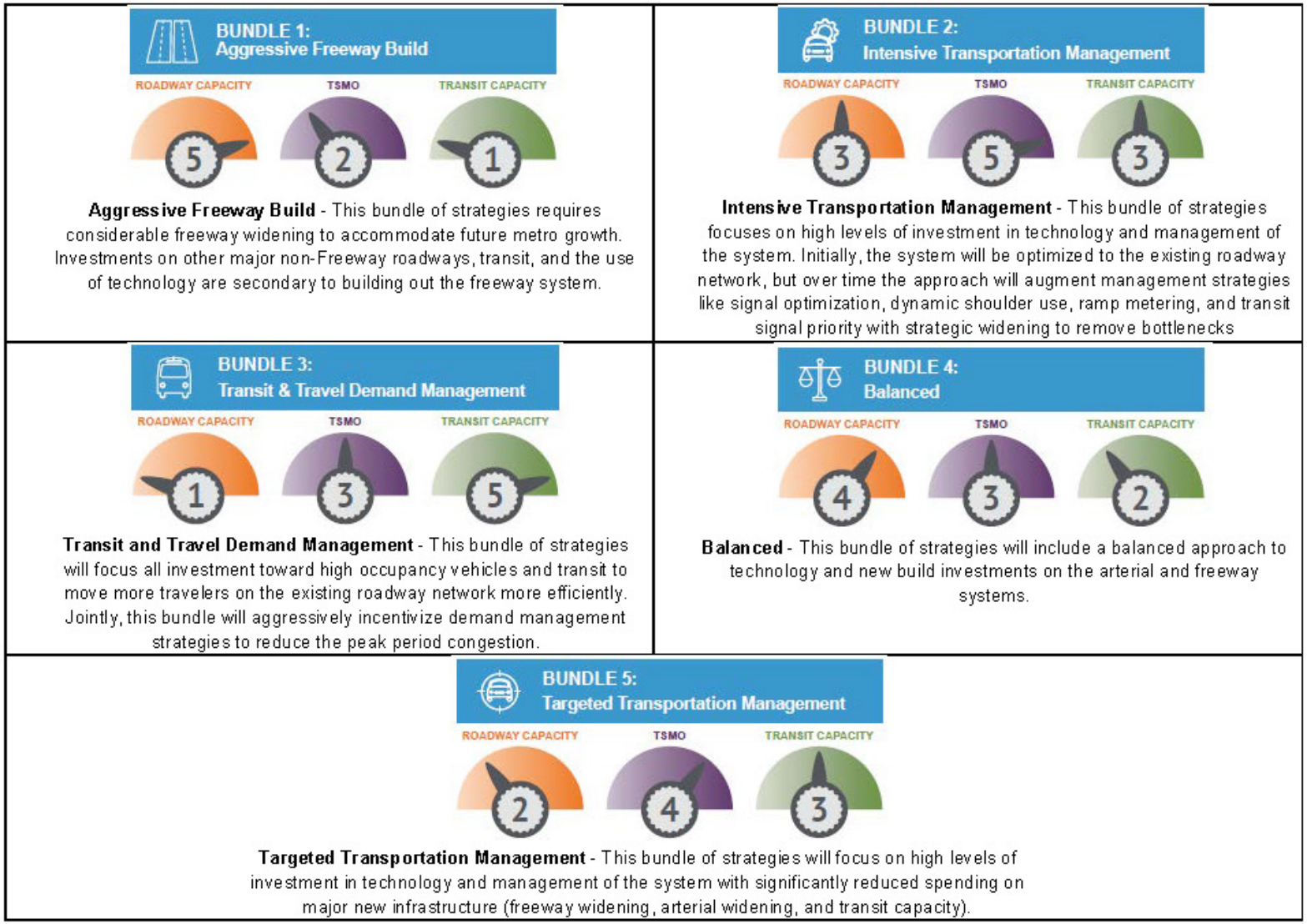
- **Aggressive Freeway Build**: Significant focus on widening the interstates and providing capacity improvements.
- **Intensive Transportation Management**: Significant focus on technology and management of arterial and freeway operations, including event management and bottleneck reduction.
- **Transit and Travel Demand Management**: Significant focus on high-occupancy transportation through transit service improvements and trip reduction efforts through travel demand management.
- **Balanced**: Focus split between capacity improvements (interstate and arterial) and technology / operations management.
- **Targeted Transportation Management**: Similar to Intensive Transportation Management but at a lower investment level particularly in terms of arterial traffic management.

A graphic comparison of the level of investment between the five bundles is provided in **Table 1**. More details on the strategies associated with each of the bundles is provided in Chapter 2 of the report.

The five bundles were analyzed against a number of performance measures and compared to two reference scenarios:

- **Future No-Build Scenario -** This scenario assumes population and employment growth through 2050 according to projections in the Des Moines MPO *Mobilizing Tomorrow* plan, and no additional transportation system investments beyond those currently committed in Iowa DOT and MPO short-term improvement programs.
- **Planned Scenario** - This scenario assumes population and employment growth through 2050 according to projections in the Des Moines MPO *Mobilizing Tomorrow* plan, and that the roadway recommendations in the Des Moines MPO Long-Range Transportation Plan are part of the future regional system.

Table 1. Bundle Descriptions



The performance measures utilized for the analysis focus on goals set previously in the planning phase of the Des Moines ICM project. The following goals were used to direct the selection of performance measures:

- **Safety** - Reduce fatalities and serious injuries on public roads in the region.
- **Mobility** - Provide options to travelers that minimize time spent traveling.
- **Reliability** - Improve efficiency and predictability of travel in the region.
- **Integration and Connectivity** - Provide transportation that allows travelers to make efficient and seamless multi-modal trips throughout the region.
- **Accessibility** - Improve traveler's overall ability to reach key destinations such as jobs, schools, libraries, health care, shopping, and entertainment.
- **Systems Management** - Improve the efficiency of the surface transportation system.

The following goal areas were beyond the scope of the analysis, but will be factors planned for future monitoring to confirm that ICM improvements are generating the desired outcomes related to the program vision:

- **Regional Economic Vitality** - Use the regional transportation system to foster a thriving, competitive regional economy.
- **System Preservation** - Maintain transportation infrastructure in a state of good repair.

The analysis utilized multiple predictive tools to evaluate competing packages of ICM improvements. This document provides the details of applying the processes / tools, the prepared input data, and the resulting performance measures. Additionally, comparisons are made between bundles based on the performance measures. **Table 2** provides a comparison of the bundles across multiple performance measures.

Table 2. Bundle Performance Measures – Percentage Improvement from Reference Scenario

	Safety	Mobility	Reliability	Integration and Connectivity	Accessibility	Systems Management
Balanced	**10%**	**28%**	**6%**	< 0.5%	**6%**	**<1%**
Intensive Transportation Management	**9%**	**26%**	**6%**	0.5%	**6%**	**1%**
Transit and Travel Demand Management	**8%**	4%	0%	**2%**	**8%**	**1.5%**
Aggressive Freeway Build	**3%**	**16%**	**4%**	< 0.5%	2%	-1%
Targeted Transportation Management	**7%**	**20%**	**5%**	< 0.5%	**6%**	**> 0.5%**

Legend
Green – Large Benefit from Bundle
Blue – Medium Benefit from Bundle
Black **–** Negligible / Negative Change due to Bundle

Stakeholder workshops resulted in the development of a hybrid bundle that balanced agency priorities with strategy performance and bundle costs. The Intensive Transportation Management bundle forms the basis of the hybrid bundle with modifications made based on the preferred strategy implementation packages. Subsequent to the refinement, planning-level costs were developed for the hybrid bundle as shown in **Table 3**.

Table 3. Hybrid Bundle Costs

Des Moines ICM - Hybrid Bundle				
Implementation Package	Assumed Scope	Capital Cost	Operating Cost (annual)	Maintenance Cost (annual)
Basic/Enhanced Traffic Data and Communication	TMC enhancement (addition of active freeway management)	$ 320,000	$ 225,000	$ -
	Remaining efforts are included in other strategies.	$ -	$ -	$ -
Event Management	Expand Highway Helper and incident response (scope unknown)	$ -	$ -	$ -
	Enhance road weather management, work zone, and special event management (scope unknown)	$ -	$ -	$ -
Advanced Freeway Management	Ramp metering (61 ramps at $145,000/ea)	$ 8,845,000	$ 368,000	$ 305,000
	Dynamic shoulder use and junction control (28 miles at $3 M/mi)	$ 84,000,000	$ 59,500	$ 2,240,000
	Dynamic queue warning and speed advisories (62 locations at $500,000/ea)	$ 32,000,000	$ 119,000	$ 560,000
Traffic Signal Control	Traffic signal management (800 signals at $3,000/ea/yr)	$ 72,000,000	$ -	$ -
	Adaptive signal control (800 signals at $50,000/ea)	$ 40,000,000	$ -	$ 3,200,000
Parking Management	**No additional funding for downtown parking strategies beyond the current plans (wayfinding, pricing) by the City.**	$ -	$ -	$ -
Enhanced Traveler Information	**Postpone comparative and predictive travel time strategies until assessment of the new ATIS is complete.**	$ -	$ -	$ -
	Remaining efforts are included in other strategies.	$ -	$ -	$ -
Infrastructure Enhancement	Freeway bottleneck elimination (250 projects at $400,000/ea)	$ 100,000,000	$ -	$ 3,750,000
	Arterial roadway improvements (62.5 miles at $1 M/mi)	$ 62,500,000	$ -	$ 1,562,500
Travel Demand Management	Enhance/establish TMA	$ -	$ 200,000	$ -
	Employer-based incentives (scope/funding not identified)	$ -	$ -	$ -
	Carpool/vanpool (scope/funding not identified)	$ -	$ -	$ -
	Bike sharing (300-bicycle deployment)	$ 2,400,000	$ 600,000	$ -

Des Moines ICM - Hybrid Bundle				
Implementation Package	Assumed Scope	Capital Cost	Operating Cost (annual)	Maintenance Cost (annual)
Transit Operational Management	Transit signal priority (100 intersections at $6,000/ea)	$ 600,000	$ 200,000	$ -
	BRT operations and fare strategies (scope/funding not identified)	$ -	$ -	$ -
Transit Preferential Management	Transit lanes and queue jumping (15 intersections at $800,000/ea)	$ 12,000,000	$ -	$ 300,000
	Park-n-ride lots, bus on shoulder, and express bus service (scope unknown)	$ -	$ -	$ -
TOTAL		**$ 414,665,000**	**$ 1,771,500**	**$ 11,917,500**

The implementation of the hybrid bundle and associated strategies is considered Phase 2 of the overall Des Moines ICM Program. While Phase 2 represents the mid- to long-term timeframe, specific timing of each strategy will depend on many factors including funding, available resources, required processes/approvals, and in some cases legislative or executive approvals. While the exact timeframes are not known, the individual strategies were evaluated in terms of ease of implementation, ICM benefits, and sequential order to determine relative timing – "mid-range" or "long-range". **Table 4** shows the individual strategies within the implementation packages and the relative timeframe including the near-term efforts underway as part of the Phase 1 pilot projects.

Table 4. Hybrid Bundle Implementation

Des Moines ICM - Hybrid Bundle						
Implementation Package	Near-Term	Lead Responsibility or Process to Determine	Mid-Term	Lead Responsibility or Process to Determine	Long-Term	Lead Responsibility or Process to Determine
Basic/Enhanced Traffic Data and Communication			Traffic data collection Network surveillance/monitoring TMC enhancement	Detection/monitoring: Strategy lead agency or infrastructure owner. TMC: Affected agencies that would participate in the TMC		
Event Management	Median barrier pilot Ramp naming convention	Iowa DOT	Highway Helper expansion Smart work zones	Iowa DOT		
Advanced Freeway Management	Queue spillback pilot	Iowa DOT with concurrence by appropriate jurisdiction(s)	Ramp metering Shoulder use Dynamic speed advisories Queue warning Overdimensional truck restrictions	Iowa DOT (For ramp metering, should have concurrence from local jurisdictions where the ramps are located)	Dynamic junction control	Iowa DOT
Traffic Signal Control	Traffic signal optimization pilot	Signal owners/operators	Traffic signal management Adaptive signal control	Signal owners/operators		
Parking Management					Dynamic parking reservation Dynamic parking pricing	City of Des Moines
Enhanced Traveler Information			Comparative travel time messaging	Iowa DOT	Predictive traveler information	Iowa DOT
Infrastructure Enhancement			Access control Bottleneck removal Alternative intersections	Infrastructure owners	Park and ride lots	DART
Travel Demand Management			DMAMPO TMA Carpooling/Vanpooling Telecommuting Bike sharing Flexible work hours	DMAMPO with support from DART and Iowa DOT	Dynamic routing Dynamic ridesharing Mobility as a service	DART with support from DMAMPO
Transit Operational Management			Transit signal priority	DART, signal owner/operators with support from DMAMPO and Iowa DOT	Bus rapid transit Fare strategies	DART
Transit Preferential Management			Bus on shoulder	Iowa DOT and DART	Transit lanes (queue jump)	Infrastructure owners and DART

1. Introduction

1.1 DOCUMENT PURPOSE

In an effort to improve traffic management in the Des Moines metropolitan area, the Iowa DOT initiated a project to evaluate integrated corridor management (ICM) strategies in partnership with other area jurisdictions and stakeholders. Through collaborative workshops and activities, a number of ICM-related strategies have been identified that aim to address regional needs in a cost-effective and proactive manner. The initial development of these strategies has been documented in previous project efforts. The purpose of this report is to recommended specific strategies for implementation in the mid- to long-term timeframe (2026-2050), the bundling of complementary strategies, and the anticipated benefits and costs of each bundle.

The organization of this document is as follows:

- Chapter 1: Introduction
- Chapter 2: Scenarios and Bundles
- Chapter 3: Goals and Performance Measures
- Chapter 4: Methodology
- Chapter 5: Bundle Results
- Chapter 6: Conclusions

1.2 BACKGROUND

The Des Moines Metropolitan Area Integrated Corridor Management (ICM) project was initiated to develop operational strategies for both near-term and longer-term timeframes to enhance safety, mobility, and travel time reliability, and reduce the environmental impacts of travel in the corridor. The ICM approach is based on the notion of proactively managing and operating the regional transportation system as an integrated system rather than as individual roadway networks. As traffic volumes grow and as incidents and construction activities occur, managing the Des Moines Metro Area holistically will allow the DOT and other local and regional agencies to more effectively manage transportation demand using available capacity where it exists, either by leveraging capacity on adjacent or parallel networks and/or by promoting the use of transit to move greater numbers of people using less vehicles.

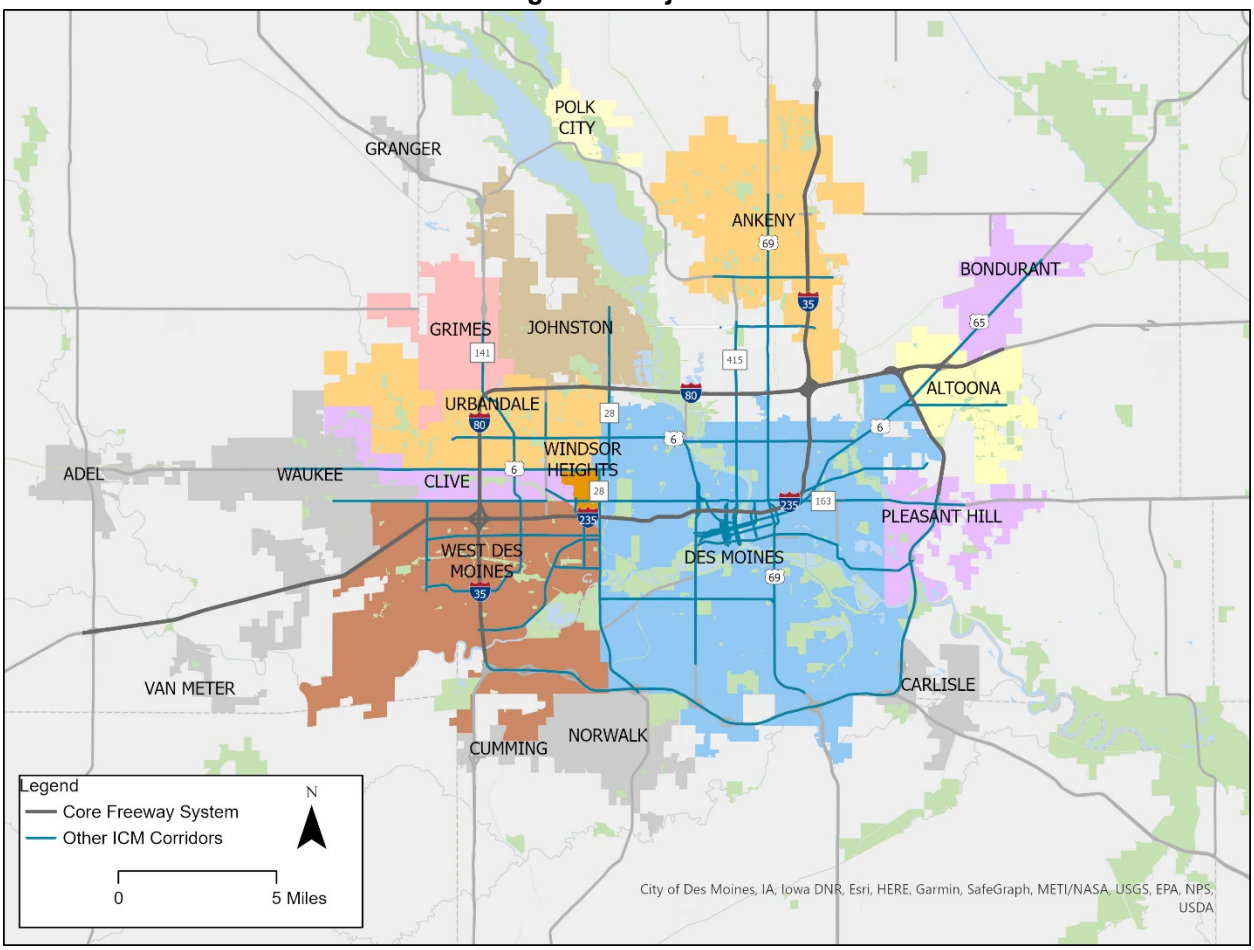
The following sections provide an overview of the geographic area, stakeholders, and general timeframe related to the ICM Program.

1.2.1 Program Area

The focus of this Integrated Corridor Management (ICM) Program is the Des Moines Area Metropolitan Area. As shown in **Figure 1**, the approximate project limits include:

- I-235 Southwest Junction to Northeast Junction with I-35/I-80
- I-80 US Hwy 169 (Desoto) to 1st Avenue (Bondurant/Altoona)
- I-35 – Iowa 5 (West Des Moines) to 36th Street (Ankeny)
- US 65 – I-80 to Iowa 163 (Pleasant Hill)
- Non-Interstate highways and arterials connecting to roadways above
- Selected parallel arterials to the freeway system

Figure 1. Project Limits



1.2.2 Stakeholders

In terms of ICM program development, the core "stakeholder" group includes those agencies that have a role in the installation, operation or maintenance of infrastructure (i.e., traffic management technologies, pavement, communications, and other equipment that may be used to improve operations along transportation networks). This includes any agency that may collect, contribute, convey, process, or distribute information or data in support of the ICM vision, goals, and objectives.

The Iowa Department of Transportation is the lead agency for the Des Moines Metropolitan Area ICM program. The external stakeholders, those outside the Iowa DOT that will be impacted by ICM projects, are municipal or responder organizations within the Des Moines Metropolitan Area. Specially, the following stakeholder organizations have been identified within the core group:

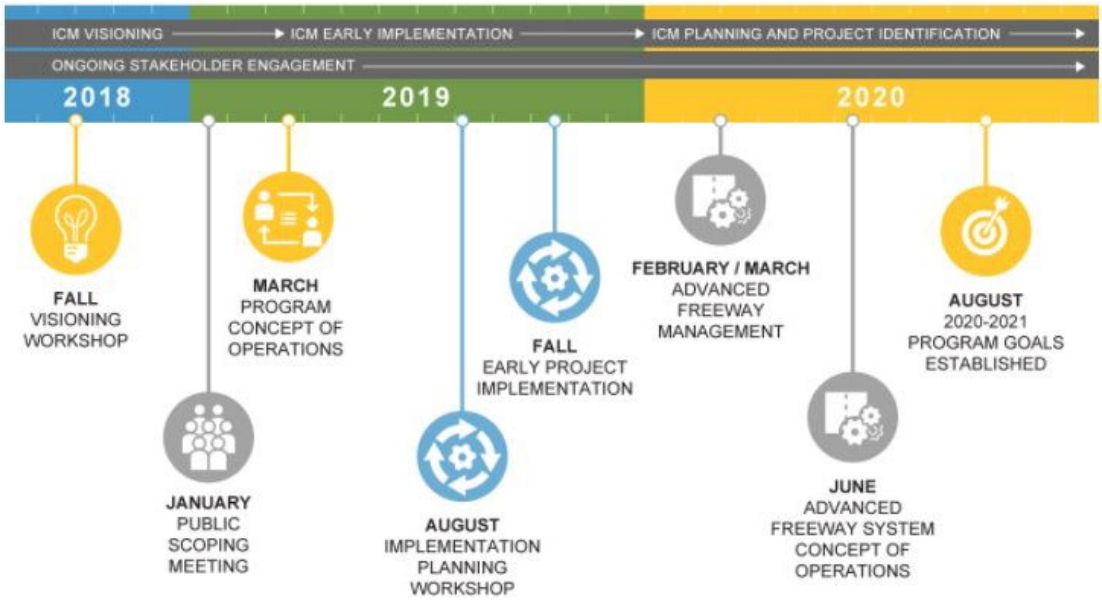
- State/Regional/Federal Transportation Management
    - Iowa Department of Transportation
    - Des Moines Area Metropolitan Planning Organization
    - Federal Highway Administration - Iowa Division
    - Greater Des Moines Partnership
- Local Municipality Publics Works/Engineering/Planning
    - City of Altoona
    - City of Ankeny
    - City of Bondurant
    - City of Clive
    - City of Des Moines
    - City of Grimes
    - City of Johnston
    - City of Pleasant Hill
    - City of Urbandale
    - City of Waukee
    - City of West Des Moines
    - City of Windsor Heights
    - Dallas County
    - Polk County
    - Warren County
- Emergency Response
    - Polk County Emergency Management
    - City of Des Moines Police
    - City of Des Moines Fire
    - Dallas County Sheriff's Office
    - Dallas County Emergency Medical Services
    - Iowa State Patrol
    - Madison County Sheriff's Office
    - Polk County Sheriff's Office
    - Warren County Sheriff's Office

- Public Transportation
  - Des Moines Area Regional Transit (DART)
  - Heart of Iowa Regional Transit (HIRTA)
  - Iowa Interstate Railroad
- Other Regional Transportation Operating Agencies
  - Iowa DOT Highway Helper
  - Iowa Motor Truck Association

1.2.3 Schedule and Progress

The ICM Project began in October 2018 with a stakeholder workshop that kicked off the project. Since the initial workshop, the Iowa DOT has developed an existing conditions assessment, identified and prioritized specific ICM strategies, and developed an ICM program level Concept of Operations. For short-term needs, project-level Concept of Operations and Implementation Plans have been completed for several early strategies that can be implemented in the first 2 years. Currently, the focus is on developing and evaluating mid- to long-term ICM strategies.

Figure 2. Project Schedule



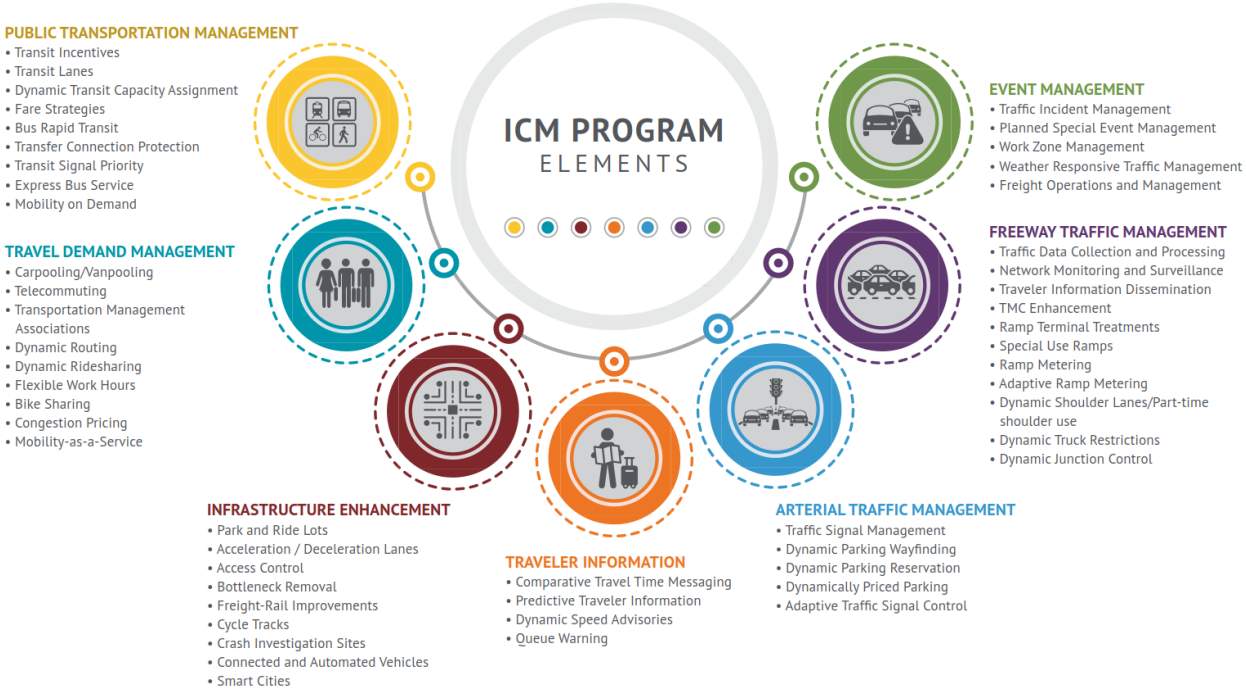
1.3 STRATEGY PHASING

As part of the initial ICM development, individual strategies were identified that could successfully address safety, mobility, and efficiency of the Des Moines Metropolitan region. Previous documentation highlights the ICM strategy identification process and includes detailed descriptions and benefits of each. For reference, all individual strategies were categorized within one of seven functional areas based on the primary strategy focus as shown in **Figure 3**.

Initial efforts to identify early winner strategies were based on several key factors such as cost, timeframe, and ownership. The intent of Phase 1 (early winner) strategies was to implement individual strategies within the first two years that were low-cost and could illustrate the benefit of ICM within the region. These Phase 1 strategies are further described in Section 1.3.1.

The remaining ICM strategies remain in consideration for medium-term and long-term deployment (Phase 2). The refinement and evaluation of these strategies is the focus of this document.

Figure 3. ICM Strategies



1.3.1 Phase 1 Strategies

The Phase 1 strategies identified earlier in the ICM Program were selected based on multiple criteria with a focus to:

- Deploy ICM strategies that address needs based on the Existing Conditions analysis.
- Deploy ICM strategies with visible benefits in a timely manner to garner project support from stakeholders and the public.
- Deploy ICM strategies that reinforce the Des Moines ICM vision.

The strategies that passed the criteria screening and identified as Phase 1 were further developed through Project-Level Concept of Operations and Implementation Plans. Those strategies where additional interagency coordination and/or technical research was needed required a Concept of Operations prior to the Implementation Plan. The Project-level Concept of Operations expanded upon the Program-level Concept of Operations document and focused in greater detail how the project will fit within the ICM program and how stakeholders will implement/operate the specific project. Those strategies where the scope and/or operations were better defined proceeded directly to an Implementation Plan. Each Phase 1 Implementation Plan defines the process and approach developed for the pilot application as well as the required resources, costs, and on-going management responsibility.

The following are the final Phase 1 strategies and their refinement:

Project-Level Concept of Operations and Implementation Plan

- Regional Traffic Signal Optimization
- Median Barrier Gates

Implementation Plan

- Overdimensional Freight Permitting
- Ramp Queue Spillback Mitigation

1.3.2 Phase 2 Strategies

Those strategies not selected for Phase 1 require further refinement and development prior to implementation. As part of this document, the remaining strategies will be prioritized, bundled, and evaluated against the ICM Program goals and objectives.

2. Performance Measures

2.1 ICM PROGRAM VISION, GOALS, AND OBJECTIVES

2.1.1 Vision Statement

The Des Moines ICM project vision statement articulates a shared purpose for the regional stakeholders to work towards. It is oriented towards high-level outcomes and reflects the needs of the range of stakeholders involved in the project. This helps to ensure that it reflects the overall visions and missions of the individual agencies. Key principles guiding the development of the Des Moines ICM vision statement are that it be:

- Future oriented,
- Leads to a better future,
- Represents stakeholder values,
- Sets standards of excellence,
- Rooted in the purpose and direction of the region,
- Inspires stakeholder enthusiasm, collaboration and commitment,
- Reflects unique aspects of the region, and is
- Ambitious.

The Des Moines metropolitan area will benefit from a safe, efficient, reliable and sustainable transportation system that supports economic growth and promotes equitable transportation services and a healthy community. ICM strategies will assist the state and area communities to proactively manage multi-modal transportation systems in a safe and efficient manner using proven technologies and operational strategies while maximizing the use of existing infrastructure and services. ICM will offer travelers more opportunities to make convenient trips to meet social and economic needs.

2.1.2 Goals

Goals that have been identified for the Des Moines ICM project are broad aspirations or outcomes for the region and directly relate to factors important to stakeholders (e.g., safety, mobility, and system preservation). **Table 5** lists the goals that have been identified for this effort.

Table 5: Des Moines ICM Goals

Factors	Goals
Safety	Reduce fatalities and serious injuries on public roads in the region.
Mobility	Provide options to travelers that minimize time spent traveling.
Reliability	Improve efficiency and predictability of travel in the region.
Integration and Connectivity	Provide transportation that allows travelers to make efficient and seamless multi-modal trips throughout the region.
Accessibility	Improve traveler's overall ability to reach key destinations such as jobs, schools, libraries, health care, shopping, and entertainment.
Regional Economic Vitality	Use the regional transportation system to foster a thriving, competitive regional economy.
System Preservation	Maintain transportation infrastructure in a state of good repair.
Systems Management	Improve the efficiency of the surface transportation system.

2.1.3 Objectives

Objectives for the Des Moines ICM project support specific goals and provide additional details, or strategies, on how the goal will be achieved. **Table 6** provides an overview of the objectives that have been identified for the Des Moines ICM initiative.

Table 6: Des Moines ICM Objectives

Factors	Objectives
Safety	• Reduce number of traffic fatalities. • Reduce number of serious injuries. • Reduce pedestrian and bicycle fatalities.
Mobility	• Reduce congestion in key commuter corridors. • Reduce congestion in key freight corridors. • Provide travel options for transportation system users. • Provide transit service connecting major activity centers within the Des Moines metropolitan area. • Provide more dedicated bicycle facilities. • Provide more sidewalks for pedestrians. • Reduce single occupancy vehicle (SOV) trips.
Reliability	• Reduce the variability of travel time on key commuter routes and modes. • Improve average on-time performance for transit services.
Integration and Connectivity	• Improve multi-modal connections between bicycle, pedestrian, transit, and private vehicle travel. • Improve system connectivity through improved multimodal connections and reduced network gaps.
Accessibility	• Provide transit service throughout the Des Moines metropolitan area. • Improve proximity to multi-modal transportation. • Improve ADA accessibility. • Improve service for traditionally underserved populations.
Regional Economic Vitality	• Facilitate the efficient and safe movement of freight and goods.
System Preservation	• Preserve and maintain pavement. • Preserve and maintain bridges. • Preserve and maintain bicycle trail systems. • Preserve and maintain sidewalks. • Support urban development projects with necessary transportation investments.
Systems Management	• Implement metro-wide demand management strategies. • Implement employer-based demand management programs at major employers. • Implement ITS technologies along priority commuter and freight corridors. • Implement advanced operational strategies along priority commuter and freight corridors.

2.2 PERFORMANCE MEASURES

FHWA defines performance measurement as the use of statistical evidence to determine progress toward specific defined organizational objectives. In the context of ICM projects effective performance measures should be:

- Accepted by and meaningful to the range of stakeholders involved in the project,
- Explain how the goals and objectives are being met,
- Simple, unambiguously defined, understandable, logical and repeatable.[1]

Performance measures were selected with consideration of existing federal, state, and local performance monitoring and the availability of tools and methods capable of generating predicted outcomes for the proposed improvements. The following performance measures were chosen.

2.2.1 Safety

Within transportation, crashes are the primary indicator of safety performance. In some cases, safety is measured by the number of crash occurrences (crash frequency) and in other cases by the number of crashes per unit of exposure (crash rate). In this particular evaluation, ***crash frequency*** was selected as the primary performance measure to align with the goal of reducing fatalities. Analysis methods were developed to predict crashes by the full range of crash severity (property damage only, minor injury, incapacitating injury, and fatal) but only the most severe (incapacitating injury and fatal) are used for comparative purposes. This aligns with the focus of national performance reporting legislation.

2.2.2 Mobility

Mobility encompasses many aspects of transportation and the program goal for mobility is a composite of 1) providing travel options and 2) minimizing time spent traveling. To reflect the stated goal, the selected performance measure for mobility was ***peak period vehicle hours traveled***. To quantify mobility in this sense, a regional analysis tool was utilized to simulate a condition where travelers are able to consider all their travel options and then select the combination of mode and route that yields the shortest time duration. The summation of all network trips is used as the comparison between the bundles. The implications of this method are that:

1) Diminished mobility occurs predominantly in the peak period, so:
    a. Non-peak time traveling is ignored.
    b. Travel during the peak periods, even on underutilized facilities, is included.
2) Vehicle hours of travel is a reasonable surrogate for person hours of travel.

2.2.3 Reliability

Reliability in the transportation network relates to predictability, or the "spread", of corridor travel time across different travel days. In terms of a performance measure, reliability is typically represented as an index denoting the ratio between average travel time and the XXth percentile travel time on a particular route (typically 85th to 95th). To compare an entire network, the performance measure selected was the ***percent acceptable travel time reliability***. The definition and analysis of "acceptable" relied on an index of 1.5 between the worst travel day of a week (80th percentile) and the median travel time. All routes below that threshold are considered reliable and increase the percent system reliability.

[1] https://ops.fhwa.dot.gov/perf_measurement/fundamentals/

2.2.4 Integration and Connectivity

The goals identified for this program around integration and connectivity emphasize multi-modal trips including transit, bicycling, and walking. For this focus, the performance measure selected for integration and connectivity was the ***percent transit mode share***. This percentage reflects the number of trips completed by multi-modal travel compared to the total trips. While analysis tools are available to predict transit mode usage, there are limitations on the ability to predict walking and biking mode usage. To counter the technical limitations, assumptions were made relative to the positive correlation between transit mode share and walking / biking mode share.

2.2.5 Accessibility

Accessibility relates to traveler's ability to reach key destinations which promotes a strong, diverse workforce and a connected and inclusive economy. The relative value of a "key destination" depends on the unique needs of each individual trip and traveler. However, limitations in the analysis tools and data reduces the available measures. As such, the performance measure is limited to the number of ***employment opportunities within a one hour transit trip***. The one hour threshold includes time spent walking to and from transit and wait and/or transfer times. The number of employment opportunities also serves as a surrogate measure to other key services like health care, education, and shopping. In comparing bundles, the results are expressed as an index rather than raw measurable units.

2.2.6 Systems Management

The focus of systems management is the efficiency of the network from the perspective of the system operator. In assessing that efficiency, there are many factors that are challenging to predict or measure and were therefore omitted for this exercise. To simplify the analysis, a performance measure was selected that focuses on reducing the amount of ***miles that vehicles travel during peak periods***. This includes shifting some travel to outside of the peak period, and shifting some travel from congested corridors to less congested corridors. Travel that shifts outside of the peak period or onto less congested routes will allow priority corridors to operate at higher levels of service.

2.2.7 Summary

A summary of the performance measures selected for analysis and comparative evaluations and how they align with ICM Factors, Goals, and Objectives is provided in **Table 7**.

Table 7: Des Moines ICM Performance Measures

Factors	Goals	Objectives	Performance Measures
Safety	Reduce fatalities and serious injuries on public roads in the region.	• Reduce number of traffic fatalities. • Reduce number of serious injuries. • Reduce pedestrian and bicycle fatalities	Crash frequency
Mobility	Provide options to travelers that minimize time spent traveling.	• Reduce congestion in key commuter corridors. • Reduce congestion in key freight corridors. • Provide travel options for transportation system users. • Provide transit service connecting major activity centers within the Des Moines metropolitan area. • Provide more dedicated bicycle facilities. • Provide more sidewalks for pedestrians. • Reduce single occupancy vehicle (SOV) trips.	Peak period vehicle hours traveled
Reliability	Improve efficiency and predictability of travel in the region.	• Reduce the variability of travel time on key commuter routes and modes. • Improve average on-time performance for transit services.	Percent acceptable travel time reliability
Integration and Connectivity	Provide transportation that allows travelers to make efficient and seamless multi-modal trips throughout the region.	• Improve multi-modal connections between bicycle, pedestrian, transit, and private vehicle travel. • Improve system connectivity through improved multimodal connections and reduced network gaps.	Percent transit mode share
Accessibility	Improve traveler's overall ability to reach key destinations such as jobs, schools, libraries, health care, shopping, and entertainment.	• Provide transit service throughout the Des Moines metropolitan area. • Improve proximity to multi-modal transportation. • Improve ADA accessibility. • Improve service for traditionally underserved populations.	Employment opportunities within a one-hour transit trip
Systems Management	Improve the efficiency of the surface transportation system	• Implement metro-wide demand management strategies. • Encourage employer-based demand management programs at major employers. • Implement ITS technologies along priority commuter and freight corridors. • Implement advanced operational strategies along priority commuter and freight corridors.	Vehicle miles traveled during peak periods

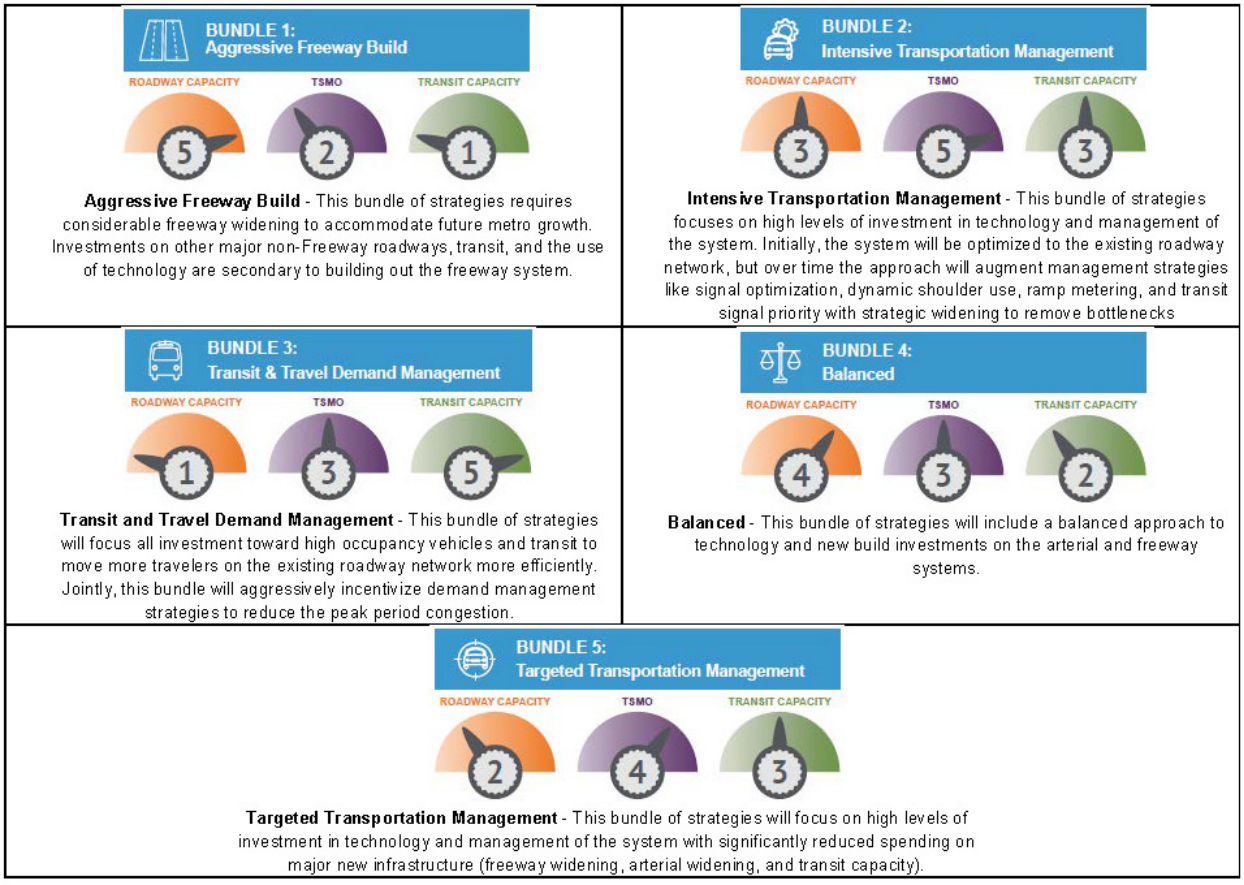
3. Phase 2 Strategy Bundles

3.1 BUNDLING CONCEPT

To evalaute the long-term deployment of ICM strategies beyond Phase 1 and to determine the required level of investment to achieve the program goals, five funding/strategy concepts were developed by varying investment levels within each of the seven functional strategy areas shown in **Figure 3**. The initial organization was to create distinct concepts that differed significantly on their focus/intent through the bundling of strategies within each functional area. The wide separation of these bundling concepts will allow for better understanding of the investment impacts through modeling efforts and allows for easier evaluation and scoring of the alternatives. The five bundles, described in **Figure 4**, include:

- **Aggressive Freeway Build**: Significant focus on widening the interstates and providing capacity improvements.
- **Intensive Transportation Management**: Significant focus on technology and management of arterial and freeway operations, including event management and bottleneck reduction.
- **Transit and Travel Demand Management**: Significant focus on high-occupancy transportation through transit service improvements and trip reduction efforts through travel demand management.
- **Balanced**: Focus split between capacity improvements (interstate and arterial) and technology/operations management.
- **Targeted Transportation Management**: Similar to Intensive Transportation Management but at a lower investment level particularly in terms of arterial traffic management.

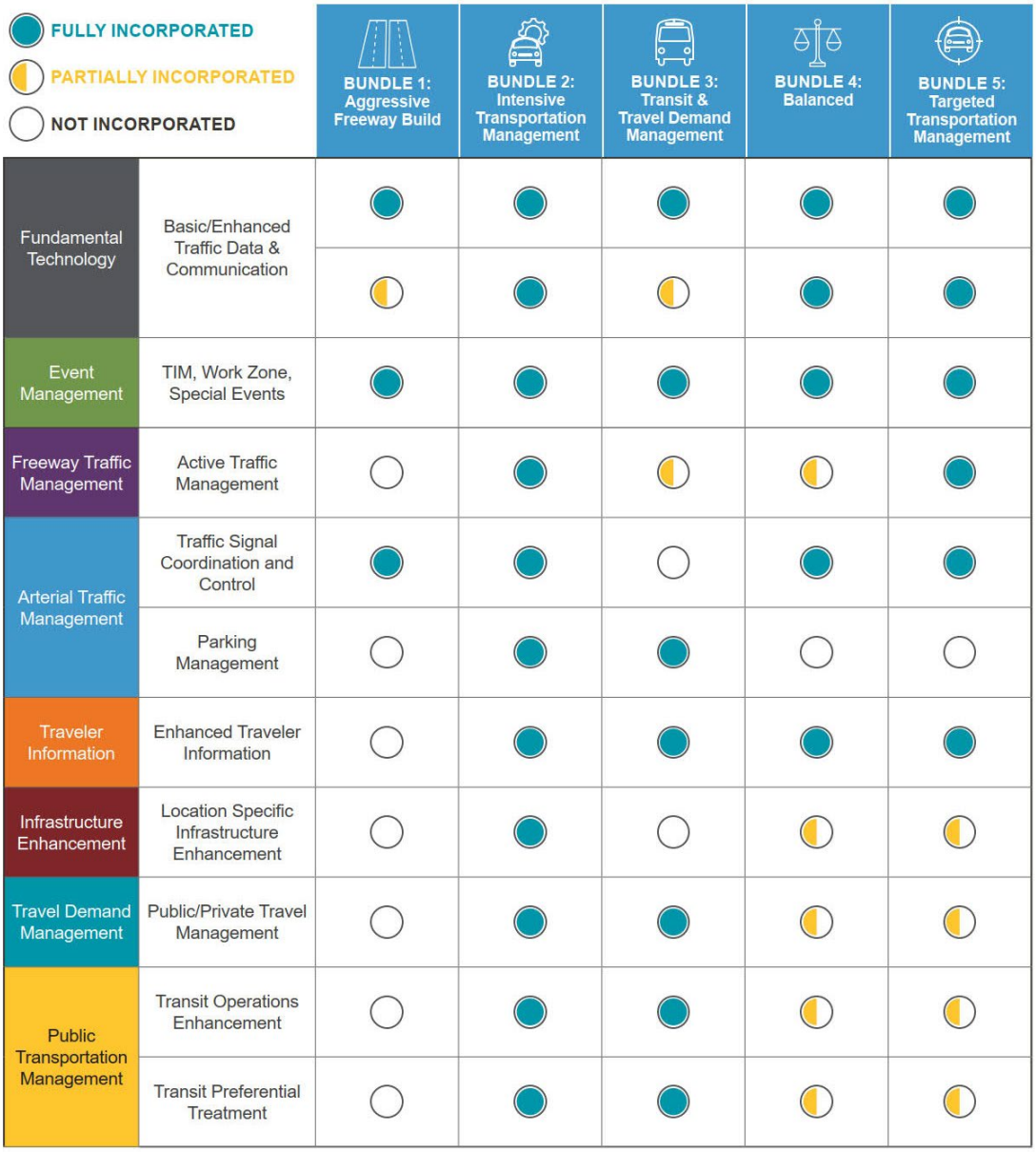
Figure 4: ICM Bundle Descriptions



It is not anticipated that any of these original bundling concepts will result as the preferred long-term solution but that they will serve as baseline alternatives that allow futher refinement and synthesis to a single preferred solution.

The following graphic highlights the new/expanded applications within each of the functional strategy areas. In bundles where a strategy is significantly expanded or fully developed, a solid circle is provided. In bundles where a strategy is added/expanded only on a limited basis, a partially-filled circle is provided. In instances where a strategy is maintained at existing levels, an empty circle is shown.

Figure 5. ICM Phase 2 Strategy Bundles



More detailed descriptions of each bundling concept are provided in the subsequent subsections.

3.1.1 Agressive Freeway Build

This bundle of strategies assumes considerable freeway widening to accommodate traffic growth in the Des Moines Metropolitan Area. Investments in other major area roadways, transit, and the use of technology are secondary to increasing capacity on the freeway system. In terms of investment levels, the primary focus is roadway capacity with little to no investment in Transportation Systems Management and Operations (TSM&O) or transit capacity. Outside the ICM strategies, other characteristics include:

- All projects with committed funding from the 2020-2024 Iowa Transportation Improvement Program
- I-35/I-80 would include 2 additional lanes in each direction
- I-235 would include 1 additional lane in each direction
- Northeast Junction would include a full build out of the interchange
- Southwest Junction would include a full build out of the interchange
- Arterial capacity would include construction/new build (limited to supporting the freeway)

3.1.2 Intensive Transportation Management

This bundle of strategies assumes a high level of investment in technology and operational management to improve the efficiency of the existing transportation network. The system would be optimized using management strategies like signal optimization, dynamic shoulder use, ramp metering, and transit signal priority with strategic widening to remove bottlenecks. In terms of investment levels, the primary focus is TSM&O with some minor investment in roadway capacity and transit capacity. Outside the ICM strategies, other characteristics include:

- All projects with committed funding from the 2020-2024 Iowa Transportation Improvement Program
- I-35/I-80 would not include additional lanes
- I-235 would not include additional lanes
- Northeast Junction would include some new and reconfigured ramp (flyover) construction
- Southwest Junction would include some new and reconfigured ramp (flyover) construction
- Arterial capacity would include committed street widening projects and funding to address bottlenecks

3.1.3 Transit and Travel Demand Management

This bundle of strategies assumes most investment is applied toward high occupancy vehicles and transit service to reduce the number of vehicles on the transportation network. In addition, this bundle will aggressively incentivize travel demand strategies to reduce the number of trips during the peak periods. In terms of investment levels, the primary focus is transit capacity with some minor investment in TSM&O but little to no investment in roadway capacity. Outside the ICM strategies, other characteristics include:

- All projects with committed funding from the 2020-2024 Iowa Transportation Improvement Program
- I-35/I-80 would not include additional lanes
- I-235 would not include additional lanes
- Northeast Junction would include projects with committed funding from the 2020-2023 Transportation Improvement Program(1/4 of interchange rebuilt)
- Southwest Junction would include projects with committed funding from the 2020-2023 Transportation Improvement Program (no improvements)
- Arterial capacity would include long-range plan projects that are in the committed portion of the plan and limited additional arterial capacity projects focused on benefitting transit primarily

3.1.4 Balanced

This bundle of strategies assumes a balanced approach between roadway capacity and technology on the arterial and freeway systems. In terms of investment levels, the focus is more evenly split with some investment in roadway capacity, TSM&O, and transit capacity. Outside the ICM strategies, other characteristics include:

- All projects with committed funding from the 2020-2024 Iowa Transportation Improvement Program
- I-35/I-80 would include 1 additional lane in each direction
- I-235 would include 1 additional lane in each direction (west side of corridor only)
- Northeast Junction would include some new and reconfigured ramp (flyover) construction
- Southwest Junction would include some new and reconfigured ramp (flyover) construction
- Arterial capacity would include investments identified in the constrained Long Range Transportation Plan

3.1.5 Targeted Transportation Management

This bundle of strategies is similar to the Intensive Transportation Management bundle, with high levels of investment in technology and management, but with reduced spending on major new infrastructure (freeway widening, arterial widening, and transit capacity). In terms of investment levels, the primary focus is TSM&O with some minor investment in roadway capacity and transit capacity. Outside the ICM strategies, other characteristics include:

- All projects with committed funding from the 2020-2024 Iowa Transportation Improvement Program
- I-35/I-80 would not include additional lanes
- I-235 would not include additional lanes
- Northeast Junction would include projects with committed funding from the 2020-2023 Transportation Improvement Program (1/4 of interchange rebuilt)
- Southwest Junction would include projects with committed funding from the 2020-2023 Transportation Improvement Program (no improvements)
- Arterial capacity would include only projects with committed funding from the 2020-2024 Iowa Transportation Improvement

3.2 IMPLEMENTATION PACKAGES

The bundling concept is weighted based on the level of investment in the seven different strategy functional areas. Within each functional area, there are numerous individual strategies which may include some overlaping or common features or requirements. These strategies may be deployed in combination to take advantage of shared resources or shared functionality. An example would be dynamic priced parking with dynamic parking reservation as both strategies rely on detection, parking availability and demand, and online services. Another example would be dynamic speed advisories and lane use control as both require similar detection and infrastructure on the freeway. Individual strategies were subsequently combined into implementation packages that feature common strategies that would be implemented in conjunction with each other. This grouping adds a level of detail beyond the functional area but maintains a higher planning-level than individual strategies. **Figure 6** illustrates the relationship of the individual strategies to the 10 implementation packages.

Figure 6. ICM Phase 2 Implementation Packages

ICM Strategy Group	Sub Strategy (If applicable)	Implementation Package: Public Transportation Management – Transit Preferential Treatment	Public Transportation Management – Transit Operation Enhancement	Travel Demand Management – Public/Private Travel Management	Infrastructure Enhancement – Location Specific Infrastructure	Traveler Information – Enhanced Traveler Information	Arterial Traffic Management – Traffic Signal Coordination and Control	Arterial Traffic Management – Parking Management	Advanced Freeway Management – Active Traffic Management	Advanced Freeway Management – Shoulder Use	Event Managemtn – TIM, Work Zone, Special Events
Public Transportation Management	Bicycle subsidies			■							
	Vanpool subsidies			■							
	Transit subsidies			■							
	Transfer Connection Protection		■								
	Transit Lanes/Queue Jump	■									
	Express Bus Service	■									
	Transit Signal Priority		■								
Travel Demand Management	Telecommuting			■							
	Dynamic Ridesharing			■							
	Carpools			■							
	Vanpools			■							
	Flexible Work Hours			■							
	Bike Sharing			■							
	Congestion Pricing			■							
	Traffic Management Associations			■							
Infrastructure Enhancement	Exclusive Left Turn Lanes				■						
	Indirect Turns				■						
	Reduced Access Points				■						
	Two-way Left Turn Lanes				■						
	Raised Medians				■						
	Acceleration Lane Extension				■						
	Reduced lane and shoulder widths to add				■						
	Additional lane on the freeway				■						
	Ramp widening				■						
	Cycle Track				■						
Traveler Information	Comparative Travel Time Messaging					■					
	Predictive Traveler Information					■					
	Dynamic Speed Advisories								■		
	Queue Warning								■		

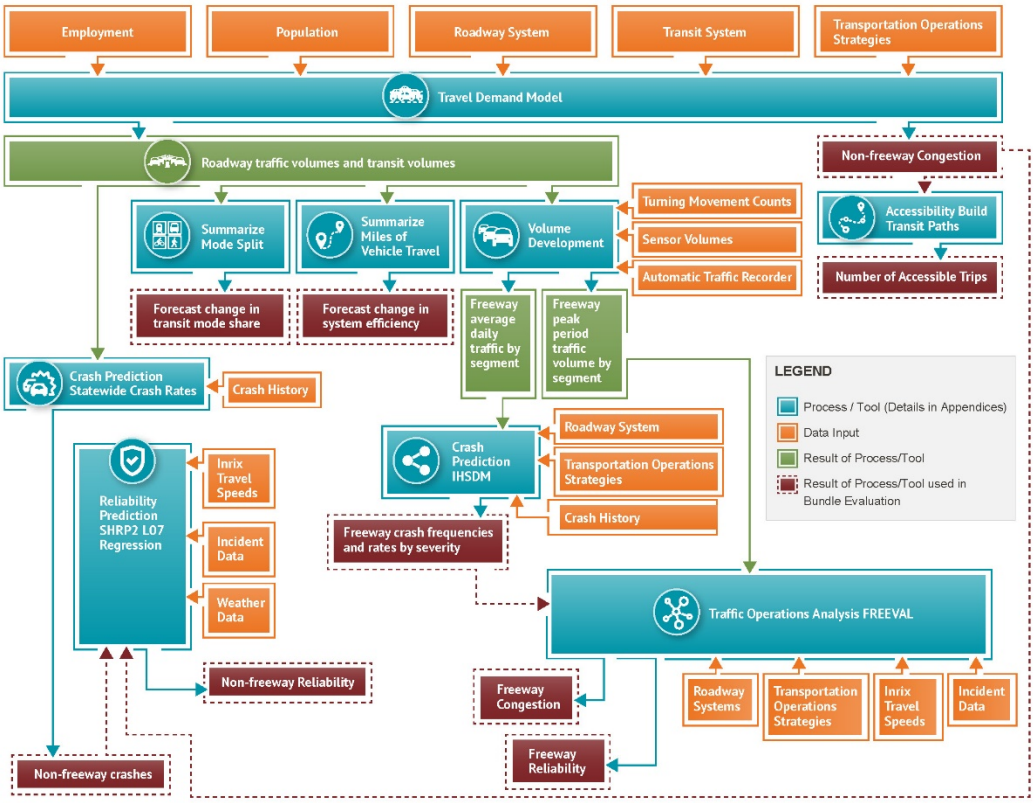
ICM Strategy Group	Sub Strategy (If applicable)	Implementation Package									
		Public Transportation Management		Travel Demand Management	Infrastructure Enhancement	Traveler Information	Arterial Traffic Management		Advanced Freeway Management		Event Managemtn
		Transit Preferential Treatment	Transit Operation Enhancement	Public/Private Travel Management	Location Specific Infrastructure	Enhanced Traveler Information	Traffic Signal Coordination and Control	Parking Management	Active Traffic Management	Shoulder Use	TIM, Work Zone, Special Events
Arterial Traffic Management	Traffic Signal Optimization						■				
	Adaptive Traffic Signal Control						■				
	Contraflow Left Turn Lane (Reversible)				■						
	Dynamic Parking Wayfinding							■			
	Dynamic Parking Reservation							■			
	Dynamic Priced Parking							■			
Freeway Traffic Management	Ramp Metering								■		
	Adaptive Ramp Metering								■		
	Lane Use Control								■		
	Dynamic Shoulder Lanes									■	
	Dynamic Truck Restrictions								■		
	Dynamic Junction Control								■		
	Dynamic Rerouting								■		
Event Management	Traffic Incident Management										■
	Planned Special Event Management										■
	Work Zone Management										■
	Weather Responsive Traffic Management										■
	Freight Operations and Management										■

4. Performance Evaluation

4.1 EVALUATION PROCESS

The evaluation of the defined bundles using the selected performance measures requires multiple tools and steps to quantify performance across a large geographic area. As a single tool or step is not feasible, a process was developed to link the available input data to various tools / processes in order to obtain adequate output measures. The relationship amongst all processes in the methodology is captured in **Figure 7**. An overview of each major process (travel demand forecasting, traffic safety analysis, and traffic operations and reliability analysis) are discussed in subsequent sections. Detailed technical descriptions of these processes are provided in the Appendix.

Figure 7. Evaluation Methodology Flow Chart



For comparative purposes, the evaluation of bundles is based on Year 2050 conditions. This future scenario requires assumptions relative to roadway/transit/operational improvements and driver behavior in the Des Moines region over the next thirty years. Individual sets of assumptions have been developed for each bundle to evaluate 2050 conditions as well as two base cases that provide a point of reference or baseline for the evaluations. The two reference scenarios are described below.

Future No-Build Scenario

- Future population projections and land uses match the Des Moines MPO Mobilizing Tomorrow plan as implemented in the travel demand model.
- Transportation projects in the 2020-2023 Transportation Improvement Program documented by the Des Moines Area MPO and 2020-2024 Iowa Transportation Improvement Program documented by Iowa DOT are constructed / implemented and function as part of the transportation system.
- Transportation spending / projects beyond those two documents are assumed to only focus on maintenance, rehabilitation, repair, or replacement without enhancements.

Planned Scenario

- Future population projections and land uses match the Des Moines MPO Mobilizing Tomorrow plan as implemented in the travel demand model.
- Transportation projects in the 2020-2023 Transportation Improvement Program documented by the Des Moines MPO and 2020-2024 Iowa Transportation Improvement Program documented by Iowa DOT are constructed / implemented and function as part of the transportation system.
- Transportation spending / projects beyond those two documents are focused on the roadway capacity projects defined in the Des Moines MPO Mobilizing Tomorrow plan and maintenance, rehabilitation, repair, or replacement without enhancements.

The comparison of results provided in each sub-section were carried out in a relative manner. The change in performance measures between the Planned scenario and the Future No Build scenario provided one lens for determining how much individual performance measures were likely to change at the regional level. A second lens for comparison was the clustering of the results of the five bundles. In most cases, one or two bundles have better performance metric results than the other bundles. Three levels of comparative performance are used across all metrics:

- Negligible or negative benefit
- Medium benefit
- Large benefit

The breakpoints for each performance metric vary considerably and are documented in the individual analysis sub-section.

The results reported in this memo reflect the level of precision supported by the evaluations conducted. The raw outcomes of tools and processes are available in electronic format with project data but are not included in the written documentation due voluminous quantity and limited readability. Access to more precise results is expected to be handled on an as needed basis.

4.2 TRAVEL DEMAND FORECASTING

4.2.1 Methods

The Des Moines Area Metropolitan Planning Organization maintains a regional travel demand model that supports their planning activities, especially the *Mobilizing Tomorrow* long-range metropolitan transportation plan approved in 2019. The MPO's travel demand model is documented on their web site at: https://dmampo.org/wp-content/uploads/2019/12/Appendix-J-TDM-Validation.pdf. The project evaluation required updates to the travel demand model to forecast trip making changes due to ICM. The details of those changes are documented in Travel Demand Model Appendix.

The travel demand model is a tool that outputs the amount of travel on all regional roadways and transit lines based on projected growth in regional population and employment. The travel demand model also projects time traveled (vehicle-hours of travel) on each of those roadways and transit lines, which allows for both regional and facility-specific analyses. The travel demand model provides outputs for multiple time periods that when combined compose an average weekday (and separately an average weekend day that was not used in analysis); in some cases the daily travel outputs were used and in others peak period output was utilized.

Volume Development

The Des Moines regional travel demand model projects the traffic volume that will use each facility in the model. To provide a more refined analysis of key freeway facilities, the travel demand model traffic volumes were treated by a method known as post-processing to enhance their accuracy by reducing model bias. For more detail on post-processing, refer to **Appendix D**.

The downstream processes utilizing the volumes developed are:

- **Crash Prediction** - Interactive Highway Safety Design Model (IHSDM) – Discussed in Safety Analysis.
- **Traffic Operation Analysis** - FREEVAL – Discussed in Traffic Operations and Reliability Analysis

Non-freeway Congestion

The Des Moines regional travel demand model also generates by facility an estimate of impacts to travel time and level of congestion. The travel times for each facility allow travel paths to be generated within the model to determine how well two points are accessible to each other. In this process, the congested travel times were used from the home location (zone) to determine if jobs were accessible within a reasonable travel time to that home. The parameters on the reasonable travel time were that the trip had to be completed by the walk-to-transit mode to account for those in the region without vehicles at home. The number of jobs counted as accessible were then expressed as a percentage of total jobs in the region. In so defining the accessibility, a map was generated to allow review of each home location's (zone's) accessibility. As some home locations (zones) are very populous and others have limited population, the population of the home location (zone) was used to weight these accessibility indices to combine the accessibility for the entire region into an aggregate measure.

4.2.2 Results

The travel demand model generated regional traffic volumes on roadways and transit ridership that were used directly in assessing the scenarios / bundles for the performance measures of:

- **Integration and Connectivity** - Transit Mode Shift. Results shown in **Table 8**.
- **System Management** - Peak Period Vehicle Miles Traveled. Results shown in **Table 9**.

For the transit mode shift, the Future No Build scenario showed that transit mode share was only 1.3% of all trips. The scenarios show that few of the scenarios generate a change of mode share by more than 0.1%. The following category breakpoints were established for simplified reporting in project workshops:

- **Negligible or negative benefit** – Transit mode increase less than 0.5%
- **Medium benefit** – Transit mode increase between 0.5% and 1.5%
- **Large benefit** – Transit mode increase 1.5% or greater

Table 8. Integration and Connectivity: Transit Mode Share Results by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
Transit Mode Share	1.3%	1.3%	1.4%	1.8%	3.4%	1.4%	1.4%
Change Compared to No Build		<0.1%	+0.1%	+0.5%	+2.1%	+0.1%	+0.1%
Relative Benefit			Negligible	Medium	Large	Negligible	Negligible

For the measure of vehicle miles travelled (VMT), all scenarios show that the combined AM peak period and PM peak period generate over 11 million miles of regional travel per weekday. The range in scenarios and bundles outcomes is approximately 0.3 million miles of travel and the scenario that was chosen as the base was the Planned scenario as future expansions to the roadway network in the Planned scenario would be traded off against the philosophies and improvements present in the five bundles.

The following category breakpoints were established for simplified reporting in project workshops:

- **Negligible or negative benefit** – Peak period VMT decrease of less than 0.5%
- **Medium benefit** – Peak period VMT decrease between 0.5% and 1.5%
- **Large benefit** – Peak period VMT decrease of 1.5% or greater

Table 9. System Management: Peak Period Vehicle Miles Traveled (VMT) Results by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
AM + PM VMT in Millions	11.1 M	11.2 M	11.1 M	11.0 M	11.0 M	11.3 M	11.1 M
Change compared to Planned	N/A		-0.9%	-1.2%	-1.5%	+1.0%	-0.7%
Relative Benefit			Medium	Medium	Large	Negative	Medium

The travel demand model also estimates travel time and level of congestion by facility. These travel times allow travel paths to be generated within the model to determine how well two points are accessible to each other. In this process, the congested travel times were used from the home location (zone) to determine if jobs were accessible within a reasonable travel time to that home. The population of the home location (zone) was used to weight these accessibility values to form an indices as shown in **Table 10.**

The following category breakpoints were established for simplified reporting in project workshops:

- Negligible or negative benefit – Job accessibility index increase of less than 3%.
- Medium benefit – Job accessibility index increase between 3% and 7%.
- Large benefit – Job accessibility index increase of 7% or greater.

Table 10. Accessibility: Jobs Accessibility Index by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
Jobs Accessibility Index	43,000	44,000	45,000	45,000	46,000	>43,000	45,000
Change compared to No-Build		+2.9%	+6.5%	+6.2%	+8.0%	+1.9%	+5.8%
Relative Benefit			Medium	Medium	Large	Negligible	Medium

The travel demand model traffic volumes were also utilized as part of several downstream processes. Those downstream processes will be discussed in later sub-sections, but include:

- **Crash Prediction for Statewide Crash Rates** – Discussed in Safety Analysis (Section 4.3)
- **Volume Development for Traffic Operations Analysis** – Discussed in Traffic Operations and Reliability (Section 4.4)

Non-freeway congestion also contributes to one downstream tool process: Reliability Prediction SHRP2 L07 Regression – Described in Traffic Operations and Reliability section.

4.3 SAFETY ANALYSIS

4.3.1 Methods

The safety analysis consisted of two processes / tools: Crash Prediction Statewide Rates and Crash Prediction IHSDM. Each process predicts the change in crash frequency at multiple crash severity levels. The difference between the two processes are that the rate-based method provides a good approximation on limited available data, whereas the IHSDM tool provides more robust data that can be more reliable at the individual facility level.

Crash Prediction Statewide Rates

Iowa DOT published statewide crash rates were utilized to determine how changes in the amount of regional travel impact crash frequency. In the reference scenarios the only input to the method are traffic vehicle miles travelled (VMT) at the level of roadway class types: Municipal freeway, Municipal US Highway, Municipal Iowa Highway, and Municipal Local Road. The crash rates were gathered from https://iowadot.gov/crashanalysis/pdfs/crash_rate-density_comparables_segments_2007-2016_20170718_statewide.pdf.

In the bundles, several improvements are implemented that affect some roadway class rates based on the methods from Part D of the AASHTO Highway Safety Manual. The changes to crash rates based on safety research of crash modification factors (CMFs) are documented in Safety appendices. Maps describing the geographic coverage of certain improvements are in Bundle Maps.

Crash Prediction IHSDM

On key freeway corridors, crash prediction was completed utilizing the methods in the AASHTO Highway Safety Manual Part C using safety performance functions. Safety performance functions describe the relationship between predicted crash frequency, traffic volume, geometry, and operating parameters. Again, the reference scenarios were able to be evaluated with the standard IHSDM procedure, but the evaluation of some bundles required the use of crash modification factors (CMFs) in conjunction with safety performance functions. The details of the evaluation within IHSDM are documented in Safety appendices. Maps describing the geographic coverage of certain improvements are in Bundle Maps.

4.3.2 Results

The ultimate regional safety results are a composite outcome of the two processes / tools. The effectiveness of scenarios / bundles were determined by the combined frequency of annual fatal crashes and annual serious injury crashes across all regional facilities as shown in **Table 11**.

Table 11. Safety: Annual Fatal and Serious Injury Crash Frequency by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
Annual Fatal & Serious Injury Crash Frequency	280	N/A	250	<250	260	270	>250
Change compared to No-Build		N/A	-10%	-11%	-8%	-2%	-9%
Relative Benefit			Large	Large	Large	Medium	Large

The following category breakpoints were established for simplified reporting in project workshops:

- Negligible or negative benefit – Reduces fatal + injury crashes by less than 2%.
- Medium benefit – Reduces fatal + injury crashes 2% and 5%.
- Large benefit – Reduces fatal + injury crashes by 5% or greater.

4.4 TRAFFIC OPERATIONS AND RELIABILITY

4.4.1 Methods

Traffic operations and reliability evaluation of scenarios and bundles is interrelated, though the processes / tools allow for a separate evaluation of the goal areas of mobility and reliability. The tools / processes utilized are as follows:

- Reliability Prediction SHRP2 L07 Regression

- Non-Freeway Congestion
- Traffic Operations Analysis FREEVAL

Reliability Prediction SHRP2 L07 Regression

Reliability at the regional level is difficult to project. The processes / tools that allow evaluation of reliability for planning contexts are at a low level of maturity and focus on freeway-type facilities. One such process was developed for the Second Strategic Highway Research Program (SHRP2) under a project denoted as L07. This process has been used elsewhere for Iowa DOT and is published https://transops.s3.amazonaws.com/uploaded_files/SHRP2%20S2-L07-RR-1.pdf. The key inputs for each facility are the level of congestion, quantity of lane hours lost due to the impact of crashes and non-crash incidents, and the impact of weather. Weather was treated uniformly on all network facilities. The level of congestion is based on the Des Moines Area MPO regional model demand-to-capacity ratio.

The L07 regression equation generates a travel time reliability curve. From that curve, the impact of variation in travel times can be compared to determine if facilities are reliable or not reliable. In predicting the spread of future travel times by bundle, the threshold chosen for unacceptable reliability was a facility that takes more than 1.5 times to travel on approximately the worst travel day of a week (80th percentile) versus the normal travel time for that facility (median, 50th percentile). All facilities that stay below that threshold are considered reliable and add to the reliable system mileage. In this portion of the analysis, only the non-freeway system was considered, but the results were combined with the freeway mileage evaluated to be reliable to report on the reliability at the system level. More information on the steps taken to apply the L07 regression equation can be found in **Appendix D**.

Non-Freeway Congestion

Non-freeway congestion was previously utilized to determine trip accessibility but is also utilized for the mobility metric. The process for determining non-freeway mobility is simply to sum the regional travel demand model output of vehicle hours traveled (VHT) for all non-freeway facilities for each of four time periods and all travel directions. The VHT for non-freeway facilities is reported as part of the digital Performance Measures Summary Appendix and also retained to be added to the FREEVAL results for freeway VHT as part of the assessment of regional mobility.

Traffic Operations Analysis FREEVAL

The Highway Capacity Manual (HCM) published by the Highway Capacity and Quality of Service committee of the Transportation Research Board is the pre-eminent reference on transportation (particularly vehicle traffic) operations analysis. In recent iterations of the HCM, processes have been advanced through the publication of computational engines, one of which is FREEVAL. FREEVAL focuses on assessing freeway facilities based on quantitative analysis from past research on the field-observed relationships of traffic volume, speed, and facility density. The project team used FREEVAL as downloaded from: http://freeval.org/.

FREEVAL uses geometrics, traffic volumes, speeds, crash and non-crash incident occurrences, and weather to develop a detailed evaluation of traffic flow and congestion for a freeway system. FREEVAL has some limitations to freeway system length; as such the following freeway systems were analyzed:

- Interstate 235 – Southwest MixMaster to Des Moines River
- Interstate 35 / 80 – Southwest MixMaster to Des Moines River (NW Beaver Drive Overpass)
- Interstate 35 / 80 – Des Moines River (NW 6th Drive) to US 6 / US 65 (NE Hubbell Ave)

The freeway sub-systems were analyzed individually by direction and for AM and PM peak periods. Note, the AM peak period was set to a two-hour timeframe based on Iowa DOT traffic count availability, though this time period does not directly match the Des Moines regional travel demand model duration of three hours for the AM peak. Freeway sub-systems not included in FREEVAL were included in the non-freeway congestion calculations previously described. Refer to **Appendix D** for more detail on the application of FREEVAL in the evaluation process.

4.4.2 Results

Upon completing this process, the performance measures for mobility and reliability were compared across scenarios and bundles.

Table 12 summarizes the mobility results. The following category breakpoints were established for simplified reporting in project workshops:

- Negligible or negative benefit – Reduces peak period VHT by less than 4%.
- Medium benefit – Reduces peak period VHT between 4% and 12%.
- Large benefit – Reduces peak period VHT by 12% or greater.

Table 12. Mobility: Peak Period Vehicle Hours Traveled (VHT) by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
Peak Period VHT (Thousands)	450	400	380	380	430	410	390
Change compared to No-Build	0%	-11%	-16%	-16%	-4%	-9%	-13%
Relative Benefit			Large	Large	Negligible	Medium	Large

Table 13 summarizes the reliability results. The following category breakpoints were established for simplified reporting in project workshops:

- Negligible or negative benefit – Increases the portion of system deemed reliable by less than 2%.
- Medium benefit – Increases the portion of system deemed reliable between 2% and 5%.
- Large benefit – Increases the portion of system deemed reliable by 5% or greater.

Table 13. Reliability: Portion of System Deemed Reliable by Scenario

Performance Measure	Future No Build	Planned	Balanced	Intensive Transportation Mgmt	Transit & Travel Demand Mgmt	Aggressive Freeway Build	Targeted Transportation Mgmt
Percent of System Reliable	83.1%	91.5%	91.3%	88.6%	81.1%	92.6%	87.7%
Change compared to No-Build		+8.4%	+8.2%	+5.5%	-2.0%	+9.5%	+4.6%
Relative Benefit			Large	Large	Negative	Large	Large

4.5 SUMMARY

This section combines the separate performance measures reported throughout the Chapter into a single table format allowing comparison across all performance measures. **Table 14** lists the performance measure changes as a percentage and adds color indicators to improve interpretation. The individual performance measure tables are provided early in the Chapter and provide more numerical comparison if the reader requires further information when comparing. It should be noted that evaluation results are still open to interpretation as the ICM program can trade off impacts to many different vision elements.

Table 14. Bundle Performance Measures – Percentage Improvement from Reference Scenario

	Safety	Mobility	Reliability	Integration and Connectivity	Accessibility	Systems Management
Balanced	**10%**	**28%**	**6%**	< 0.5%	**6%**	**<1%**
Intensive Transportation Management	**9%**	**26%**	**6%**	0.5%	**6%**	**1%**
Transit and Travel Demand Management	**8%**	4%	0%	**2%**	**8%**	**1.5%**
Aggressive Freeway Build	**3%**	**16%**	**4%**	< 0.5%	2%	-1%
Targeted Transportation Management	**7%**	**20%**	**5%**	< 0.5%	**6%**	**> 0.5%**

Legend
Green – Large Benefit from Bundle
Blue – Medium Benefit from Bundle
Black – Negligible / Negative Change due to Bundle

5. Cost Estimates

5.1 COST ESTIMATING

The development of planning-level costs for the various bundles is dependent on individual strategies included within each bundle and the range/extent of the deployment. As previously described, individual strategies were grouped into implementation packages that contain similar strategies that would likely be deployed together.

5.2 INDIVIDUAL STRATEGY COSTS

For each individual strategy, planning-level costs were developed based on previous knowledge, project cost estimates, and research from online resources. Costs were separated into initial capital costs and ongoing annual operations costs based on an appropriate unit (for example, per location or per mile). In addition, replacement costs were developed based on assumed lifecycle for equipment and/or infrastructure and converted to an annualized amount.

There are several strategies that do not lend themselves to planning-level costs at this time due to either a wide variation in costs or unknown factors in the scope. An example of this are Transportation Demand Management (TDM) strategies which rely on partnerships between public- and private-sector and subsidies to travelers. These costs can vary significantly based on employee/employer participation, monetary value, and funding source.

A summary of the individual cost estimates are provided in **Table 15**. It is important to note that many of these strategies may overlap, both in capital and operational costs, and the combination of those costs will be determined in the bundling cost estimates.

Table 15. Strategy Cost Estimates

ICM Strategy Group	Sub Strategy (If applicable)	Design	Construction/ Implementation	Operation (Annual)	Maintenance/ Replacement (Annual)	Description	Source
Public Transportation Management	Bicycle subsidies					Depends on subsidies, participation	
	Vanpool subsidies						
	Transit subsidies						
	Transfer Connection Protection						
	Transit Lanes/Queue Jump ($/signal)	$ 70,000	$ 720,000	$ -	$ 20,000	Assume additional pavement and reconstruction of traffic signal.	
	Express Bus Service					Depends on vehicle needs and level of service	
	Transit Signal Priority ($/signal)	$ -	$ 6,000	$ 2,000	$ -	Assume addition of signal priority equipment to existing controller.	
Travel Demand Management	Telecommuting					Depends on subsidies, participation	
	Dynamic Ridesharing						
	Carpools						
	Vanpools						
	Flexible Work Hours						
	Bike Sharing		$ 2,400,000	$ 600,000		Various business models but average $8,000 per bike for bike, docking stations, systems. Assume 300 bike initial deployment.	FHWA, OST-R
	Congestion Pricing					Congestion Rebate concept	
	Traffic Management Associations		$ 200,000	$ -		Operating costs could be recovered through dues.	TTI Mobility
Infrastructure Enhancement	Exclusive Left Turn Lanes ($/intersection)	$ 60,000	$ 500,000		$ 15,000	Assume two per intersection on main roadway.	TTI Mobility
	Indirect Turns ($/intersection)	$ 90,000	$ 750,000		$ 20,000	Assume reconstruction of traffic signals	TTI Mobility
	Reduced Access Points ($/mile)	$ 10,000	$ 64,000		$ 1,600	Assume elimination of 8 driveways/mile per side	TTI Mobility
	Two-way Left Turn Lanes ($/mile)	$ 72,000	$ 600,000		$ 20,000	Assume new pavement but no major intersection reconfiguration.	TTI Mobility, FHWA Office of Safety
	Raised Medians ($/mile)	$ 120,000	$ 1,000,000		$ 25,000	Assume new pavement but no major intersection reconfiguration.	FHWA Office of Safety
	Acceleration Lane Extension ($/location)	$ 48,000	$ 400,000		$ 15,000	Assume new pavement but no major intersection reconfiguration.	TTI Mobility
	Reduced lane and shoulder widths to add a new lane ($/mile)	$ 36,000	$ 300,000		$ 7,500	Assume freeway restriping with thermoplastic and obliteration but no new pavement.	Consultant estimate
	Additional lane on the freeway ($/mile)	$ 480,000	$ 4,000,000		$ 60,000	Asume 1 additional lane in each direction without major infrastructure.	TTI Mobility, Arkansas Cost per Mile
	Ramp widening	$ 36,000	$ 300,000		$ 10,000	Assume new pavement but no major intersection reconfiguration.	TTI Mobility
	Cycle Track ($/mile)	$ 36,000	$ 300,000		$ 10,000	Wide range from restriping to reconstruction.	FHWA, TTI Mobility

ICM Strategy Group	Sub Strategy (If applicable)	Design	Construction/ Implementation	Operation (Annual)	Maintenance/ Replacement (Annual)	Description	Source
Traveler Information	Comparative Travel Time Messaging	$ -	$ -	$ 20,000		Assume messaging only and not new DMS.	Iowa DOT
	Predictive Traveler Information						
	Dynamic Speed Advisories ($/location)[1]	$ 36,000	$ 300,000	$ 2,000	$ 10,000	Assume permanent overhead structure, muliple signs per location.	Consultant esimate, OST-R
	Queue Warning ($/location)[1]	$ 54,000	$ 450,000	$ 2,000	$ 10,000	Assume freeway overhead DMS with loops. Use existing fiber.	Consultant estimate, OST-R
Arterial Traffic Management	Traffic Signal Optimization ($/signal)	$ 3,000	$ -	$ -		Assume annual re-timing via outside service	Consultant estimate
	Adaptive Traffic Signal Control ($/signal)	$ 5,000	$ 45,000	$ -	$ 4,000	Assume upgrades for controller and upstream and downstream detection.	Consultant estimate
	Contraflow Left Turn Lane (Reversible) ($/mile)	$ 30,000	$ 250,000	$ 10,000	$ 7,000	Assume overhead blankout signs for 3 lanes at 1/6 mi spacing	Consultant estimate
	Dynamic Parking Wayfinding					Already in place in downtown.	
	Dynamic Parking Reservation	$ 120,000	$ 1,000,000	$ 20,000	$ 20,000	Wide range, depends on parking garage, street side, etc. Average $450/spot.	OST-R
	Dynamic Priced Parking					Can be combined with above.	
Freeway Traffic Management	Ramp Metering ($/ramp)	$ 25,000	$ 120,000	$ 5,000	$ 5,000	Assume 2 meters per interchange with no fiber backhaul.	Consultant estimate, OST-R
	Adaptive Ramp Metering ($/ramp)	$ 25,000	$ 120,000	$ 5,000	$ 5,000	Similar to traditional ramp metering if new install.	
	Lane Use Control ($/mile)[1]	$ 180,000	$ 1,500,000	$ 2,000	$ 80,000	Assume active control, monitoring, overhead DMS signs.	OST-R
	Dynamic Shoulder Lanes ($/mile)[1]	$ 324,000	$ 2,700,000	$ 2,000	$ 80,000	Assume active control, monitoring, overhead DMS signs, and pavement widening.	TTI Mobility (WashDOT), Minnesota
	Dynamic Truck Restrictions ($/mile)[1]	$ 180,000	$ 1,500,000	$ 2,000	$ 50,000	Assume active control, monitoring, overhead DMS signs.	OST-R
	Dynamic Junction Control ($/location)	$ 42,000	$ 350,000	$ 2,000	$ 10,000	Assume overhead lane control with detection at ramp junctions.	
	Dynamic Rerouting	$ 360,000	$ 3,000,000	$ 2,000	$ 100,000	Assume colored DMS overhead on all 4 entering approaches to Des Moines freeway loop.	Consultant estimate
Event Management	Traffic Incident Management					Depends on range of services, extent of existing resources.	
	Planned Special Event Management						
	Work Zone Management						
	Weather Responsive Traffic Management						
	Freight Operations and Management						

Sources:
FHWA: Federal Highway Administration
OST-R: USDOT Office of Research and Technology
TTI Mobility: Texas A&M Transportation Institute
Consultant estimate: WSP work based on past projects

5.3 IMPLEMENTATION PACKAGE EXTENTS

Individual strategies, as mentioned in **Section 3**, were subsequently combined into implementation packages that feature common strategies that would be implemented in conjunction with each other. Where applicable, similar strategies deployed in the same area would share capital costs as well as recurring operating costs. An example would include overhead freeway variable speed limits and queue warning – the capital costs of each, if installed on the same segment, would not be additive as the strategies would share detection and infrastructure.

As part of the bundle modeling and evaluations, assumptions were made in terms of magnitude within each implementation package. Those features which have well defined scopes and costs are organized by implementation package and bundle and shown in **Table 16**.

Table 16. Bundle and Implementation Package Extents

Assumed Magnitude		Bundle				
		Aggressive Freeway Build	**Intensive Transportation Management**	**Transit and Travel Demand Management**	**Balanced**	**Targeted Transportation Management**
Implementation Package	Advanced Freeway Management	-	28 miles dynamic shoulder lanes and junction control	28 miles bus on shoulder	4.2 miles dynamic shoulder lanes and junction control	28 miles dynamic shoulder lanes and junction control
		-	28 miles queue warning and variable speed limits			28 miles queue warning and variable speed limits
		-	61 ramp meters	61 ramp meters	61 ramp meters	61 ramp meters
	Traffic Signal Control	800 traffic signals - annual retiming, upgrade to adaptive operation	800 traffic signals - annual retiming, upgrade to adaptive operation	-	800 traffic signals - annual retiming, upgrade to adaptive operation	800 traffic signals - annual retiming, upgrade to adaptive operation
	Infrastructure Enhancement	-	500 bottleneck projects - arterial and freeway	-	200 bottleneck projects - arterial and freeway	350 bottleneck projects - arterial and freeway
	Transit Preferential Treatment	-	14.5 miles Bus Rapid Transit - queue jump	42.2 miles Bus Rapid Transit - queue jump	14.5 miles Bus Rapid Transit - queue jump	14.5 miles Bus Rapid Transit - queue jump
	Transit Operation Enhancement	-	14.5 miles Bus Rapid Transit - transit signal priority	42.2 miles Bus Rapid Transit - transit signal priority	14.5 miles Bus Rapid Transit - transit signal priority	14.5 miles Bus Rapid Transit - transit signal priority

5.4 IOWA DOT AND DES MOINES AREA MPO FUNDING

Through reviewing anticipated future expenditures by the Iowa DOT and Des Moines Area MPO on the region's transportation system, a baseline for understanding the magnitude of costs and relative regional investment levels associated with the ICM project bundles is established. The Iowa DOT's 2021-2024 Statewide Transportation Improvement Program offers a short-term window into which a general funding picture of transportation funding on state transportation facilities in the Des Moines Metro Area. The Des Moines Area MPO's Mobilizing Tomorrow transportation plan provides funding forecasts that provide a longer-term overview of the region's transportation funding.

5.4.1 Sources of Federal Funds

Federal sources provide a reliable stream of funds for programming and planning transportation improvements on the ICM system. While there are many types of Federal funds that can be used, the region receives congressionally authorized Federal funding from several formula-based sources which include:

- Surface Transportation Block Grant Program (STBG): Flexible funding for projects located on Federal-Aid routes, bridges, bicycle and pedestrian projects, transit capital improvements, and transportation planning.
- Surface Transportation Block Grant Program for Transportation Alternatives (STBG-TA): Funding for projects that provide transportation alternatives such as bicycle and pedestrian facilities, trails, Safe Routes to Schools programs, historic preservation, and environmental mitigation.
- Federal Aid SWAP Policy: Iowa DOT policy allowing certain locally sponsored projects to swap Federal Aid funding for state Primary Road Fund dollars. The policy allows for greater flexibility in how programmed dollars are spent on transportation projects.
- Transit Programs: Funding for transit projects, including operations, maintenance, and capital improvements. Typical Federal transit funding programs include Section 5307: Urbanized Area Formula Program, Section 5310: Enhanced Mobility of Seniors and Individuals with Disabilities, Section 5311: Formula Grants for Rural Areas, and Section 5339: Bus and Bus Facilities.

On a typical Federal aid project, local agencies contribute 10% to 20% of project costs while the remaining 80% to 90% is paid for through Federal sources. The Des Moines Area MPO assumed a 70/30 percent federal to local split when identifying STBG and STBG-TAP funding for future improvements in the Mobilizing Tomorrow plan.

5.4.2. Federal Funding Programmed in the 2021-2024 STIP

Iowa DOT's 2021-2024 Statewide Transportation Improvement Program (STIP) outlines transportation improvements, and their funding sources, planned for the state transportation system over the next five years. The STIP includes highway, bicycle and pedestrian, rail, and aviation projects. **Table 17** below presents the breakdown of STBG, STBG-TA, SWAP-STBG, and Transit funding programmed for state system projects in the DMAMPO region for the years 2021-2024. The amounts shown include Federal and State/local matching amounts.

Table 17: Iowa DOT 2021-2024 STIP Programmed Funding Amounts

Program	Total
STBG	$11.3 M
STBG-TAP	$9 M
SWAP-STBG	$157 M
Transit	$91 M
Total	$269.3 M

5.4.3. Des Moines Area MPO Identified Funding, 2025-2050

As part of the update to its Long-Range Transportation Plan, the Des Moines Area MPO is required to identify anticipated Federal funding for transportation improvements through the year 2050. With a population exceeding 200,000, the DMAMPO is considered a Transportation Management Area (TMA) and receives a dedicated proportion of the STBG and STBG-TAP funds allocated to the state from the Federal government for the Des Moines area each year.

Table 18 shows the total STBG funding the DMAMPO anticipates receiving between 2025 and 2050 that will be used for transportation improvements within the region. Due to the discretionary nature of other Federal non-STBG funding programs, they are not shown in the table as they are not a reliable annual funding source for improvements in the MPO region.

Table 18: DMAMPO Identified STBG and STBG-TAP Funding Amounts, 2025-2050[2]

Funding Source	2025-2029	2030-2034	2035-2050	Total
STBG Total Revenue	$277 M	$328 M	$1.4 B	**$2.0 B**
System Capacity	$83 M	$98 M	$418 M	**$600 M**
Bridge	$55 M	$66 M	$279 M	**$400 M**
Major Reconstruction / Replacement	$69 M	$82 M	$348 M	**$500 M**
System Optimization	$42 M	$49 M	$209 M	**$300 M**
Transit	$28 M	$33 M	$139 M	**$200 M**
TAP Funds	$20 M	$24 M	$101 M	**$144 M**
Total Revenue Available	**$297 M**	**$352 M**	**$1.5 B**	**$2.14 B**

Based on the identified funding outlined in Mobilizing Tomorrow, DMAMPO anticipates receiving $2.14 billion in STBG and STBG-TAP funding between 2025 and 2050. The $2.14B shown above includes local and state matching funds, which are 30% of total project costs.

[2] Funding amounts sourced from Mobilizing Tomorrow Appendix D- Fiscal Analysis Methodology

Table 19 shows the forecasted transit revenues DMAMPO anticipates receiving between 2025 and 2050. In addition to funding from the Federal funding programs described in this section, projected State and local transit revenues are included.

Table 19: DMAMPO Identified Transit Funding Amounts, 2025-2050[3]

Funding Source	2025-2029	2030-2034	2035-2050	Total
Federal Sources	$34 M	$15	$56	**$105**
Section 5307 / 5340	$39 M	$43	$168	**$249**
Section 5311	$0	$0	$0	**$0**
Section 5310	$2	$2	$8	**$13**
Section 5339	$4	$4	$16	**$24**
Discretionary / Competitive Federal Funds	$20	$0	$0	**$20**
Surface Transportation Funds	$8	$9	$32	**$49**
State Funds	$2	$0	$0	**$2**
Local Funds	$11	$9	$38	**$58**
Total Funding	**$85**	**$67**	**$262**	**$414**

Based on the funding amounts identified in Mobilizing Tomorrow, DMAMPO expects to receive a total of $414 million in Federal, State, and local transit revenues between 2025 and 2050. Note that DMAMPO estimates a portion of their anticipated STBG revenues will be allocated to transit improvements, in addition to the $414 million shown in **Table 19**.

5.5 BUNDLE COSTS

For each bundle, capital costs and operating costs for the major strategy implementation packages were developed based on the strategy costs and modeled extent. In instances where strategies share common infrastructure, the costs were adjusted. A summary of the capital and operating costs for each bundle are provided in **Table 20** and **Table 21**.

[3] Funding amounts sourced from Mobilizing Tomorrow Appendix D- Fiscal Analysis Methodology

Table 20. Bundle Capital Cost Estimates

Capital Costs		Bundle				
		Aggressive Freeway Build	**Intensive Transportation Management**	**Transit and Travel Demand Management**	**Balanced**	**Targeted Transportation Management**
Implementation Package	Advanced Freeway Management	-	$124 M	$54 M	$21 M	$121 M
	Traffic Signal Control	$112 M	$112 M	-	$112 M	$112 M
	Infrastructure Enhancement	-	$162 M	$4 M	$65 M	$114 M
	Transit Preferential Treatment	-	$58 M	$169 M	$58 M	$58 M
	Transit Operation Enhancement	-	$0.5 M	$1 M	$0.5 M	$0.5 M
Total		**$112 M**	**$457 M**	**$229 M**	**$258 M**	**$406 M**

Table 21. Bundle Operational Cost Estimates

Operational Costs		Bundle				
		Aggressive Freeway Build	**Intensive Transportation Management**	**Transit and Travel Demand Management**	**Balanced**	**Targeted Transportation Management**
Implementation Package	Advanced Freeway Management	-	$555k	$405k	$377k	$546k
	Traffic Signal Control	-	-	-	-	-
	Infrastructure Enhancement	-	-	-	-	-
	Transit Preferential Treatment	-	-	-	-	-
	Transit Operation Enhancement	-	$154k	$450k	$154k	$154k
Total		**$0**	**$709k**	**$855k**	**$531k**	**$700k**

It is important to note that these bundle costs include only those strategies with well-defined scope and costs. Strategies related to event management or travel demand management, while likely part of many bundles, are not included in the costs due to the wide range of potential operations.

In addition to the above costs associated with the bundle strategies, each bundle differs in the extent of traditional roadway infrastructure. As described in **Section 2.1**, all bundles include those projects with committed funding from the 2020-2024 Iowa DOT Highway Program but some add additional lanes on I-35/I-80 and/or I-235 as well as improvements to the two system interchanges (Mixmasters). The cost of these infrastructure improvements are provided in **Table 22**.

Table 22. Bundle Capital Costs with Programmed Projects

Capital Costs with DOT Infrastructure	Bundle				
	Aggressive Freeway Build	**Intensive Transportation Management**	**Transit and Travel Demand Management**	**Balanced**	**Targeted Transportation Management**
DOT Roadway Infrastrucure	$2.65 B	$387 M	$72 M	$2.04 B	$72 M
ICM Strategies	$112 M	$457 M	$229 M	$258 M	$406 M
Total	**$2.76 B**	**$0.84 B**	**$0.30 B**	**$2.30 B**	**$0.48 B**

In combination with the identified STBG funding amounts, the proposed bundle capital costs show stark differences in fiscal impact. Capital costs on more freeway and roadway widening (e.g. Aggressive Freeway Build or Balanced) would require a level of investment nearly equal to all of the money accounted for in the region's long-range transportation plan. However, the other three bundles have much lower capital costs that fit reasonably within that same regional planning budget. As described in the following chapter, this comparison of the bundle costs to the relative level of transportation capital spending in the region was a significant factor in the ultimate bundle preference.

6. Preferred Strategy Bundle

6.1 STAKEHOLDER BUNDLE PREFERENCE

Stakeholders play an important role in the development and success of the ICM Program. In many cases, the stakeholders will be responsible for championing and implementing the individual strategies and working with the public to achieve successful deployments. A workshop was held on March 4th, 2020 to present the Phase 2 strategy bundles to the stakeholders and solicit input on the prioritization of the various bundles and strategies.

6.1.1 Initial Survey

The stakeholder group was provided an overview of each initial bundle with specifics on the primary focus and included strategies. A qualitative evaluation and quantitative evaluation were developed to describe the benefits of each bundle in relation to ICM objectives. The quantitative evaluation provided information relative to the following performance measures: safety, mobility, reliability, integration and connectivity, accessibility, and systems management. For each performance measure, the benefit was portrayed as a percent change relative to a future no-build scenario. The qualitative assessment was framed around the potential impact that may occur to a hypothetical user under each bundle. These impacts revolved around work schedules, trip mode options, trip duration and reliability, and routing options.

Participants were divided into 4 separate groups and asked to rank the bundles in numeric order based on their preference after reviewing the above information. The responses were then averaged resulting in the following stakeholder ranking:

1. Intensive Transportation Management
2. Balanced
3. Targeted Transportation Management
4. Transit and Travel Demand Management
5. Aggressive Build

6.1.2 Secondary Survey

A second stakeholder evaluation of the bundles was completed after providing the participants a summary of estimated costs for each bundle, including the capital costs for the ICM strategies and the programmed roadway costs. The responses from this second group exercise were then averaged resulting in the following stakeholder ranking:

1. Intensive Transportation Management
2. Targeted Transportation Management
3. Balanced
4. Transit and Travel Demand Management
5. Aggressive Build

As shown, the aggregate rankings were relatively consistent with only one switch between the #2 and #3 rankings of Targeted Transportation Management and Balanced. It should be noted that the individual scores, while not detailed above, did not significantly change – 55% of the group individual scores remained unchanged between the exercises, 35% of the scores moved up/down one ranking, and only 10% of the individual scores moved up/down two or more rankings.

6.2 IMPLEMENTATION PACKAGE REFINEMENT

Within each bundle, there are numerous individual strategies that are grouped into implementation packages (see graphic within "Bundle Comparison" section). Participants were provided information on each of the implementation packages, including: individual strategies, prerequisite/complementary strategies, typical benefits, approximate capital costs, and recurring operating costs.

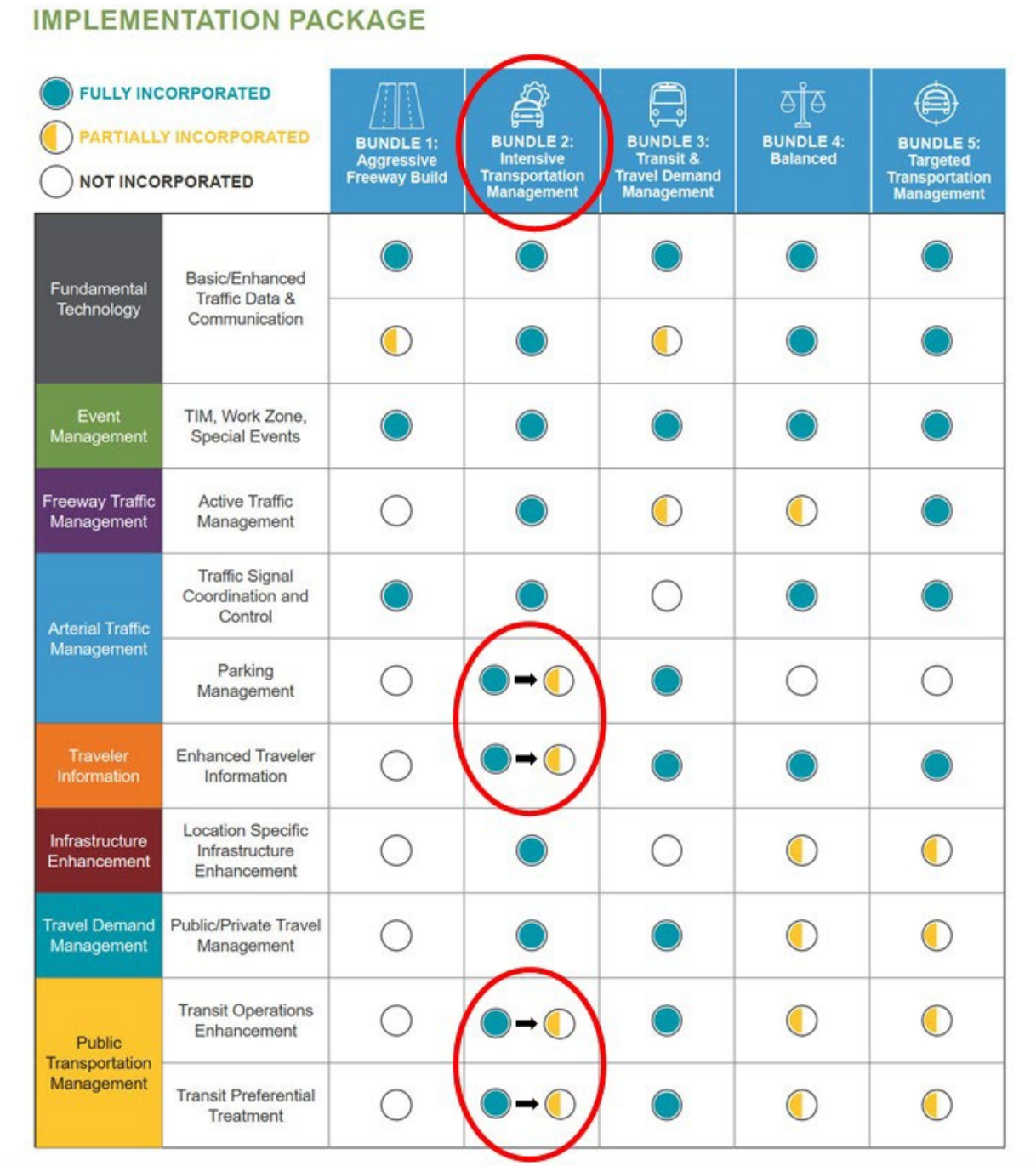
As part of the workshop, participants voted for their top five implementation packages based on the provided information and the preferred bundle (Intensive Transportation Management). The collective ranking of strategy implementation packages was as follows:

1. Advanced Freeway Management
2. Traffic Signal Control
3. Event Management
4. Infrastructure Enhancement
5. Transportation Demand Management
6. Parking Management
7. Transit Preferential Treatment
8. Enhanced Traveler Information
9. Transit Operational Enhancement

6.3 HYBRID BUNDLE

The overall intent of the stakeholder workshop was to develop a hybrid bundle based on stakeholder feedback on the initial five concept bundles and the strategy implementation packages. Based on the workshop feedback, the Intensive Transportation Management bundle forms the basis of the hybrid bundle with modifications made based on the preferred strategy implementation packages. **Figure 8** shows the relative changes resulting from the workshop.

Figure 8: Stakeholder Workshop Bundle Preference



As part of the hybrid development, each implementation package was reviewed based on stakeholder feedback and the scope of the strategies were refined. Details for each implementation package are provided below.

6.3.1. Basic/Enhanced Traffic Data & Communication

The basic/enhanced traffic data and communication implementation package is the combination of data collection, network surveillance, and traveler information technologies required to detect traffic conditions, monitor and adjust operations, assess performance, and communicate with drivers. The package also includes the TMC enhancements required to support all future operational strategies. The stakeholders were not required to vote on this implementation package during the workshop as all strategies will include traffic data and communication as part of the strategy.

The primary next step required for this package is to determine the needs for the TMC in terms of functions, technology, and staffing. Future deployment of any operational strategy may require additional scope or coverage from the TMC. The hybrid bundle's focus on intensive management of system operations will in particular test the capabilities of the existing, statewide TMC. The focus on an intensive management approach for the region calls for improved arterial surveillance and signal management for standard operation and during events. The next step to delivering this hybrid bundle will be to plan for the envisioned TMC, which may take any of the following forms:

- Additional capabilities at the statewide TMC focused on Des Moines Metro Area operations for arterial roadways and other supporting systems.
- A new Des Moines Metro Area TMC with connectivity to the statewide TMC to allow for integration at the urban area boundary.
- A network of multiple TMCs with appropriate connectivity to the statewide TMC. This option may leverage currently planned work on the western suburb operations center and City of Des Moines ITS master plan to leverage dispersed management centers for a unified strategy.

In conjunction with any increase in scope or coverage, the TMC staffing needs should be assessed in terms of staff number and technical skills. Any additional detection/surveillance needs for new operational strategies, and the integration of such systems, will be funded and implemented within that strategy.

6.3.2. Event Management

The event management implementation package is the combination of strategies that mitigate impacts caused by incidents, weather, construction, special events, and/or other temporary events. The individual strategies include the Highway Helper, incident response team(s), quick clearance, scenario planning, road weather management, intelligent work zones, and special event management. Based on stakeholder feedback from the workshop, the range of investment within this implementation package is recommended to remain the same as was proposed in the original intensive transportation management bundle.

The next steps required for this package involve the evaluation of existing teams/resources and the identification of expanded resource needs. Recurring efforts such as Highway Helper or incident response teams will need to be assessed in terms of coverage (geography, duration) while road weather management and special event management will need to be assessed in terms of scope. There may be some event management strategies that could be affected by the implementation of other strategies. For example, if dynamic shoulder use is implemented, additional Highway Helper patrols may be warranted to focus on freeway segments with part time shoulder use to make sure the shoulder is free of disabled

vehicles or debris prior to opening and to provide quicker clearance of any incident when the shoulder is open to traffic. A secondary task will be to evaluate the outcome of the near-term pilot projects for median barrier gates and ramp naming for improved emergency responder dispatch. This future evaluation will allow agencies to determine lessons learned, actual benefits, and refine the application for future locations.

6.3.3. Advanced Freeway Management

The advanced freeway management implementation package includes the combination of freeway-based dynamic strategies that improve detection and control. The individual strategies include lane use control, queue warning, dynamic speed advisories, ramp metering, and dynamic shoulder use. Based on stakeholder feedback from the workshop, the range of investment within this implementation package is recommended to remain the same as was proposed in the original intensive transportation management bundle.

The primary next step required for this package is to determine the scale of deployment for the advanced freeway management strategies both in terms of specific strategies to implement and locations to implement each. This effort will be completed through the Concept Refinement Report which is already scoped and under contract. Advanced freeway management priorities will be identified within the Concept Refinement Report that will recommend programming specific capital projects. A secondary task will be to evaluate the outcome of the near-term pilot project for queue spillback. This future evaluation will allow agencies to determine lessons learned, actual benefits, and refine the application for future locations.

6.3.4. Traffic Signal Control

The traffic signal control implementation package includes the upgrade and coordination of arterial traffic signals to improve operations and control across jurisdictions. The individual strategies include annual traffic signal management (retiming) and implementation of adaptive traffic signal control. Based on stakeholder feedback from the workshop, the range of investment within this implementation package is recommended to remain the same as was proposed in the original intensive transportation management bundle.

A next step for this package is to evaluate the outcome of the near-term pilot project for regional traffic signal timing optimization. This future evaluation will allow agencies to determine lessons learned, actual benefits, and refine the application for future locations. Another next step will be to develop a regional strategy for upgrading corridors to adaptive traffic signal control. Local agencies, along with Iowa DOT and DMAMPO, will develop a process for funding and prioritizing equipment upgrades including cabinet/controllers, detection, and communication. It is recommended, regardless of a responsive or adaptive control strategy, that partner agencies plan for upgrades to traffic signal equipment that allow automated traffic signal performance measures (ATSPMs) via high resolution data logs. The ATSPMs data is envisioned as long-term performance measurement strategy to support the intensive management philosophy.

6.3.5. Parking Management

The parking management implementation package includes the combination of strategies used to match parking demand with available capacity through routing, pricing, and reservation techniques. The individual strategies include dynamic parking wayfinding, parking reservations, and dynamically priced parking. Based on stakeholder feedback from the workshop, the range of investment within this implementation package may be reduced compared to what was originally identified in the intensive transportation

management bundle. Existing regional efforts within these strategies should continue but stakeholders did not recommend significant increases in this strategy package beyond what may already be planned.

A next step for this package is to coordinate with the City of Des Moines on recent changes to downtown parking. As the agency with the largest on-street and structured parking inventory, the City underwent an evaluation of their parking assets and management in 2017 and made significant changes in 2018. These changes and their results should be evaluated prior to any additional changes to the parking management system.

6.3.6. Enhanced Traveler Information

The enhanced traveler information implementation package includes the combination of strategies that expand or enhance forms of traveler information to allow users to make more informed decisions while en-route or pre-trip. Individual strategies are those beyond basic traveler information and include comparative travel time messaging and predictive traveler information. Based on stakeholder feedback from the workshop, the range of investment within this implementation package may be reduced compared to what was originally identified in the intensive transportation management bundle. Existing regional efforts within these strategies should continue but stakeholders did not recommend significant increases in this strategy package beyond what may already be planned.

The next step for this package is to evaluate the new Advanced Traveler Information System (ATIS) that Iowa DOT has recently procured. Once the ATIS platform is fully integrated and operational, strategies can be re-evaluated.

6.3.7. Infrastructure Enhancement

The infrastructure enhancement implementation package includes infrastructure modifications to improve traffic flow or reduce crashes along constrained roadways, eliminate bottlenecks, and/or improve safety and traffic flow for all or specific users. The individual strategies include access control, bottleneck removal, freight-rail improvements, cycle tracks, alternative intersection designs, and acceleration/deceleration lanes. Based on stakeholder feedback from the workshop, the range of investment within this implementation package is recommended to remain the same compared to what was originally identified in the intensive transportation management bundle.

The primary intent of this package is to improve infrastructure in support of other strategies. As such, the next steps for this package will focus on coordination/inclusion with the other strategies. For example, advanced freeway management strategies such as ramp metering and/or queue warning may perform better with localized infrastructure enhancement. Arterial traffic signal operations may be optimized with additional turn lanes or access control. For infrastructure enhancements that are not integral to other strategies, a regional process will be required for funding and prioritizing standalone infrastructure enhancement projects.

6.3.8. Travel Demand Management

The travel demand management implementation package includes the combination of public agency and/or private employer strategies that reduce use of single-occupant forms of transportation, shift travel to off-peak periods, and/or eliminate travel altogether. The individual strategies include mobility on demand, transit incentives, carpooling/vanpooling, transportation management associations, dynamic ridesharing, congestion pricing, telecommuting, flexible work hours, bike sharing, mobility-as-a-service. Based on stakeholder feedback from the workshop, the range of investment within this implementation package is

recommended to remain the same compared to what was originally identified in the intensive transportation management bundle.

The next steps in this package require significant involvement from DMAMPO. The Transportation Management Association (TMA) will play a large role in developing and furthering many of the strategies and increased funding and staff resources will likely be required. The study team recommends that additional funding be utilized to create a focused TMA lead as either in-house MPO staff or through a contractor. Early steps may include the improvement of existing employer-based benefits such as telecommuting or flexible work hours. The dedication of a focused TMA lead would allow for a sizable increase in support to key area employers already seeking to provide these workplace benefits to attract talent.

While the TMA is seen as a key investment to improve travel demand management, the ICM should continue to evaluate commuter incentives for adjusting travel departure time, mode, and route. The next step is to evaluate the potential project costs of a regional pilot for commuter incentives and secure federal funding to test this innovative approach to managing demand.

6.3.9. Transit Operational Enhancement

The transit operational enhancement implementation package includes the combination of strategies that enhance transit system efficiency, on-time performance and reliability, and general user experience and acceptance. The individual strategies include transit signal priority, dynamic transit capacity assignment, bus rapid transit, transfer connection protection, and fare strategies. Based on stakeholder feedback from the workshop, the range of investment within this implementation package may be reduced compared to what was originally identified in the intensive transportation management bundle. Existing regional efforts within these strategies should continue; currently, transit signal priority is being analyzed for possible inclusion in the program.

A next step for this package is to coordinate with DART to identify priority corridors for enhanced transit operations. While these corridors may require different strategies/approaches to meet both DART and the ICM needs, the workshop ranking of the package indicates a lower priority for significant expansion of capital-heavy strategies. The deployment of transit signal priority along corridors that support key bus rapid transit routes should be coordinated with DART and the local agencies who own and operate traffic signals along those routes.

6.3.10. Transit Preferential Treatment

The transit preferential treatment implementation package includes the combination of strategies that encourage greater use of transit or other multi-occupancy forms of travel through the application of preferential treatments. The individual strategies include transit lanes, intersection queue jump lanes, express bus service, bus on shoulder, and park-n-ride lots. Based on stakeholder feedback from the workshop, the range of investment within this implementation package may be reduced compared to what was originally identified in the intensive transportation management bundle. Existing regional efforts within these strategies should continue but stakeholders did not recommend significant increases in this strategy package beyond what may already be programmed.

A next step for this package is to identify potential locations for bus-on-shoulder through the Concept Refinement Report which is already scoped and under contract. The bus-on-shoulder application will be the first in the state and may require changes to legislative language to allow the operation. The workshop

ranking of the package indicates a lower priority for expanding bus rapid transit routes/service or extensive transit lanes. However, spot infrastructure investments such as intersection queue jump lanes may be considered to support current and planned bus rapid transit. And while new park-n-ride lots were not ranked high, off-system parking options that utilize potential partners (private or public) to provide available land/space may be considered.

6.4 HYBRID BUNDLE COSTS

The hybrid bundle was evaluated for planning-level costs based on the associated changes to the implementation packages. As previously described, each implementation package contains similar strategies that would likely be deployed together or share capital costs and/or recurring operating costs.

A summary of the hybrid scope and associated costs in provided in **Figure 9**. For each implementation package, the assumed scope and magnitude is provided in the following table. Those features which have well defined scopes, capital costs and recurring annual operating and maintenance costs were developed.

Figure 9: Preferred Hybrid Bundle Cost Estimate

Des Moines ICM - Hybrid Bundle				
Implementation Package	Assumed Scope	Capital Cost	Operating Cost (annual)	Maintenance Cost (annual)
Basic/Enhanced Traffic Data and Communication	TMC enhancement (addition of active freeway management)	$ 320,000	$ 225,000	$ -
	Remaining efforts are included in other strategies.	$ -	$ -	$ -
Event Management	Expand Highway Helper and incident response (scope unknown)	$ -	$ -	$ -
	Enhance road weather management, work zone, and special event management (scope unknown)	$ -	$ -	$ -
Advanced Freeway Management	Ramp metering (61 ramps at $145,000/ea)	$ 8,845,000	$ 368,000	$ 305,000
	Dynamic shoulder use and junction control (28 miles at $3 M/mi)	$ 84,000,000	$ 59,500	$ 2,240,000
	Dynamic queue warning and speed advisories (62 locations at $500,000/ea)	$ 32,000,000	$ 119,000	$ 560,000
Traffic Signal Control	Traffic signal management (800 signals at $3,000/ea/yr)	$ 72,000,000	$ -	$ -
	Adaptive signal control (800 signals at $50,000/ea)	$ 40,000,000	$ -	$ 3,200,000
Parking Management	**No additional funding for downtown parking strategies beyond the current plans (wayfinding, pricing) by the City.**	$ -	$ -	$ -
Enhanced Traveler Information	**Postpone comparative and predictive travel time strategies until assessment of the new ATIS is complete.**	$ -	$ -	$ -
	Remaining efforts are included in other strategies.	$ -	$ -	$ -
Infrastructure Enhancement	Freeway bottleneck elimination (250 projects at $500,000/ea)	$ 125,000,000	$ -	$ 3,750,000
	Arterial roadway improvements (75 miles at $1 M/mi)	$ 75,000,000	$ -	$ 1,562,500
Travel Demand Management	Enhance/establish TMA	$ -	$ 200,000	$ -
	Employer-based incentives (scope/funding not identified)	$ -	$ -	$ -
	Carpool/vanpool (scope/funding not identified)	$ -	$ -	$ -
	Bike sharing (300-bicycle deployment)	$ 2,400,000	$ 600,000	$ -

Des Moines ICM - Hybrid Bundle				
Implementation Package	Assumed Scope	Capital Cost	Operating Cost (annual)	Maintenance Cost (annual)
Transit Operational Management	Transit signal priority (100 intersections at $6,000/ea)	$ 600,000	$ 200,000	$ -
	BRT operations and fare strategies (scope/funding not identified)	$ -	$ -	$ -
Transit Preferential Management	Transit lanes and queue jumping (15 intersections at $800,000/ea)	$ 12,000,000	$ -	$ 300,000
	Park-n-ride lots, bus on shoulder, and express bus service (scope unknown)	$ -	$ -	$ -
TOTAL		**$ 452,165,000**	**$ 1,771,500**	**$ 11,917,500**

6.5 STRATEGY TIMEFRAMES

The implementation of the hybrid bundle and associated strategies is considered Phase 2 of the overall Des Moines ICM Program. While Phase 2 represents the mid- to long-term timeframe, specific timing of each strategy will depend on many factors including funding, available resources, required processes/approvals, and in some cases legislative or executive approvals. While the exact timeframes are not known, the individual strategies were evaluated in terms of ease of implementation, ICM benefits, and sequential order to determine relative timing – "mid-range" or "long-range". **Figure 10** shows the individual strategies within the implementation packages and the relative timeframe including the near-term efforts underway as part of the Phase 1 pilot projects. It should be noted that the timeframe identified represents the initiation of the particular strategy and such effort would continue through the subsequent periods though not specifically repeated in the table.

Figure 10: Preferred Hybrid Bundle Implementation

Des Moines ICM - Hybrid Bundle								
Implementation Package	Immediate (2020-2021)		Short-Term (2022-2025)		Mid-Term (2026-2030)		Long-Term (Beyond 2030)	
	Scope	Lead Agency	Scope	Lead Agency	Scope (Lead Agency)	Funding Responsibility	Scope (Lead Agency)	Funding Responsibility
Basic/Enhanced Traffic Data and Communication			TMC enhancement	Iowa DOT				
			Traffic data collection, Network surveillance/monitoring (incld in strategy)	n/a	Traffic data collection, Network surveillance/monitoring (incld in strategy)	n/a	Traffic data collection, Network surveillance/monitoring (incld in strategy)	n/a
Event Management	Median barrier pilot	Iowa DOT	Highway Helper expansion	Iowa DOT				
	Ramp naming convention	Iowa DOT	Road weather management, work zones, and special event management	Agency-owner	Road weather management, work zones, and special event management	Agency-owner	Road weather management, work zones, and special event management	Agency-owner
Advanced Freeway Management	Queue spillback pilot	Iowa DOT	Ramp metering	Iowa DOT	Ramp metering	Iowa DOT	Ramp metering	Iowa DOT
			Dynamic shoulder use and junction control	Iowa DOT	Dynamic shoulder use and junction control	Iowa DOT	Dynamic shoulder use and junction control	Iowa DOT
			Dynamic queue warning and speed advisories	Iowa DOT	Dynamic queue warning and speed advisories	Iowa DOT	Dynamic queue warning and speed advisories	Iowa DOT
Traffic Signal Control	Traffic signal optimization pilot	Iowa DOT	Traffic signal management	Agency-owner	Traffic signal management	Agency-owner	Traffic signal management	Agency-owner
			Adaptive signal control	Agency-owner	Adaptive signal control	Agency-owner	Adaptive signal control	Agency-owner
Parking Management			Dynamic parking reservation, Dynamic parking pricing	City of Des Moines				
Enhanced Traveler Information					Comparative and predictive traveler time strategies	Iowa DOT		
			Enhanced traveler information (incld in strategy)	n/a	Enhanced traveler information (incld in strategy)	n/a	Enhanced traveler information (incld in strategy)	n/a
Infrastructure Enhancement			Freeway bottleneck removal	Iowa DOT	Freeway bottleneck removal	Iowa DOT	Freeway bottleneck removal	Iowa DOT
			Arterial roadway improvements	Agency-owner	Arterial roadway improvements	Agency-owner	Arterial roadway improvements	Agency-owner
Travel Demand Management	Congestion pricing pilot	Iowa DOT	Enhance/establish TMA	DMAMPO				
			Employer-based incentives	DMAMPO	Employer-based incentives	DMAMPO		
					Carpool/vanpool	DMAMPO		
					Bike sharing	DMAMPO		
Transit Operational Management			Transit signal priority	Agency-owner	Transit signal priority	Agency-owner		
					Bus rapid transit Fare strategies	DART	Bus rapid transit Fare strategies	DART
Transit Preferential Management			Transit lanes/queue jump	Agency-owner	Transit lanes/queue jump	Agency-owner	Transit lanes/queue jump	Agency-owner
					Park-n-ride lots, bus on shoulder, and express bus service	DART		

7. Online Public Engagement

A virtual public engagement event was hosted from November 12th until December 20th, 2020 to solicit public feedback regarding potential transportation improvements associated with the ICM Program. The format was an online meeting where attendees were asked to participate in several activities including a commuter survey, "Show Us Your Commute" activity where attendees were invited to illustrate their daily commute using an ArcGIS online platform, and an ICM Toolbox activity where attendees were asked to indicate which areas of concern could be addressed through an ICM tool. For more detail on the online meeting see the Online Meeting Appendix.

7.1 COMMUTER SURVEY

The Commuter Survey recorded 41 responses from attendees who shared information regarding their typical daily commute. The majority of attendees stated their commute was 15 miles or less one way, while 20% recorded that their commute was 5 miles or less one way. Another 20% stated that their commute was 21 miles or longer each way; attendees who recorded either short or long commutes indicated that they are receptive to utilizing alternate transportation modes for commuting purposes. Attendees with longer commutes felt that ride sharing or public transit for commuting purposes would reduce stress owing to traffic and congestion while increasing personal time during their day to engage in activities like working, checking emails, or reading. Attendees who state they have short commutes indicated they would consider biking to work, especially if public transit routes aligned with their commuting route.

A second major finding from the Commuter Survey was that over 75% of attendees have flexible work hours. This finding aligns with the ICM strategies for Travel Demand Management as demand on the transportation system during a typical 9 to 5 workday can be greatly reduced through staggered work schedules. The underlying implication is educating employers and employees on the commuting benefits of flexible work schedules can led to positive changes in commuting behaviors.

Regarding transit, which has a mode share of less than 1% per the U.S. Census, nearly 40% of attendees recorded a positive response towards using this mode for future commute purposes. However, opinions on why transit ridership is low in the Des Moines Metro Area indicate that a general lack of knowledge about the transit system and the personal convenience of using a private automobile for commuting purposes hinders transit usage.

7.2 SHOW US YOUR COMMUTE ACTIVITY

The "Show Us Your Commute" activity recorded 17 responses in which online meeting attendees drew their daily commute on an interactive GIS page. Along with their commute path, attendees were invited to comment on their commute. A variety of comments were received, including desire for a regional light rail or bus service, alternative commute paths, and the need for a bikeway or similar facility in the region.

7.3 ICM TOOLBOX ACTIVITY

Attendees were asked to share what areas of concern they believed could be addressed through the use of ICM tools. This activity recorded 65 responses, with the top responses being:

- Reduce congestion
- Improve safety
- Improve bike experience

7.4 PIMA REGISTERED USER RESULTS

Public Involvement Management Application, or PIMA, is a virtual platform used by Iowa DOT for facilitating public engagement events through public comment forums, response management, analytics, and event management. 58 attendees of the online meeting were registered through PIMA while 312 stakeholders expressed interest in the meeting through the platform.

The online meeting sought to gain an understanding of sentiment felt towards the ICM project bundles. The majority of attendees indicated they felt positively about ICM, with 38% saying they are “In Favor” while 21% consider themselves to be “Leaning in Favor.” Those who are neutral or are not in favor of the ICM project wish to see improvements in public transit, bicycle/pedestrian facilities, and ramp safety while minimizing investment in roadway expansions.

Regarding the bundles described in the online meeting, the largest proportion of PIMA-registered attendees selected Bundle 1 (Aggressive Freeway Build) while Bundle 4 (Balanced) was the next highest. Bundle 5 (Targeted Transportation Management) saw the lowest proportion of attendee preference. Several attendees who stated they are neutral or not in favor of the ICM project also commented that they are interested in improvements described in the project such as ramp metering and travel demand management. A major finding from this activity is the potential to garner increased buy-in from stakeholders through communicating the facts of the various ICM improvements.

The responses for PIMA-registered attendees generally support desire for future infrastructure improvements to be multimodal in nature rather than focused on single occupant private vehicle travel. Also, desire to better manage travel demand, encourage telecommuting, and enhance public transit reflect the environmentally conscious attitudes and shifting work culture brought about by the COVID-19 pandemic.

7.5 ONLINE PUBLIC ENGAGEMENT SUMMARY

The resulting feedback from the online meeting show that residents of the Des Moines Metro Area support transportation improvements that do not add freeway capacity but rather enhance public transit, commuter alternatives, and freeway safety improvements throughout the region. Another important result was the need to educate the public on infrastructure changes and disseminate information about the existing system to improve public awareness. Interest in alternative transportation solutions already in place for the Des Moines Metro Area, including travel demand management, public transit, and bike/pedestrian facilities, indicate that greater education on these enhancements can encourage greater mode share for alternate transportation moving into the future.

8. Next Steps

The Hybrid Bundle and associated strategies will continue to be developed as part of the Des Moines ICM Project. The following are the major efforts that have been identified under the current project scope.

8.1. ADVANCED FREEWAY STRATEGY REFINEMENT

Those strategies that are part of the Advanced Freeway Management implementation package will require additional research and refinement due to a lack of prior use in Iowa. For each strategy, effective practices will be identified from other installations/applications nationwide as well as design requirements. A thorough review of existing Iowa legislation and ITS Architecture will be conducted and required changes will be identified to support the strategies. The refinement effort will also include a data-driven evaluation of applicable locations within the Des Moines area for stakeholder input on priorities.

8.2. CONCEPTUAL DESIGN

The Advanced Freeway Management strategies that include infrastructure improvements – such as dynamic shoulder use and ramp metering – will require conceptual design efforts to identify the scope of roadway improvements necessary to support the strategy. Conversely, there may be infrastructure constraints that may physically limit the range of implementation.

8.3. PROGRAM CHARTER

The Des Moines ICM strategies require defined roles and responsibilities in terms of planning/design, implementation, operation, and maintenance. Some strategies may require only one stakeholder agency while others may require a coordinated effort among several agencies. The program charter effort will establish and document an understanding of ownership and involvement from all ICM stakeholders.

8.4. ADVANCED FREEWAY CONCEPT OF OPERATIONS

Subsequent to the Advanced Freeway Strategy Refinement, a Concept of Operations will be developed for the advanced freeway strategies. This effort will establish the system purpose and goals, identify user needs, develop high-level system requirements, and outline how the system and stakeholders operate during various scenarios.

8.5. TRAFFIC MANAGEMENT CENTER (TMC) ENHANCEMENTS

The operation of the Des Moines ICM program will require increased real-time information, communication, and coordination between stakeholders. Many of these processes may take place through the state TMC and local TMCs. A review of the current systems will determine if any technology or process changes are needed to support the Des Moines ICM.