TPM Framework

FINAL TECHNICAL MEMORANDUM FOR THE TRANSPORTATION PERFORMANCE MANAGEMENT (TPM) FRAMEWORK PROJECT

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1 EXECUTIVE SUMMARY

Following the FY2018 *TransNet* Triennial Performance Audit, SANDAG recognized the need to enhance its current performance management practices and move towards establishing a regional Transportation Performance Management (TPM) Framework. SANDAG hired the consultant team of Kimley-Horn and Associates and System Metrics Group to prepare this TPM Framework and Implementation Plan.

The results are summarized in this report. The project seeks to document the relevant program and system performance monitoring and reporting activities and requirements, assess whether the data access and flows can be improved, and seek opportunities to improve transportation system performance through better tools, processes and coordination.

Currently, in FY2021 there are 22 work programs that fully or partially support TPM, which accounts for approximately $9.5 million (21 percent) of the total $46.3 million Overall Work Program (OWP). Of that $9.5 million, $5.7 million is for in-house labor, and $3.8 million for contracted services. In other words, one of every five dollars in the SANDAG OWP funds some type of TPM activity.

TPM elements, as defined for this effort, include:

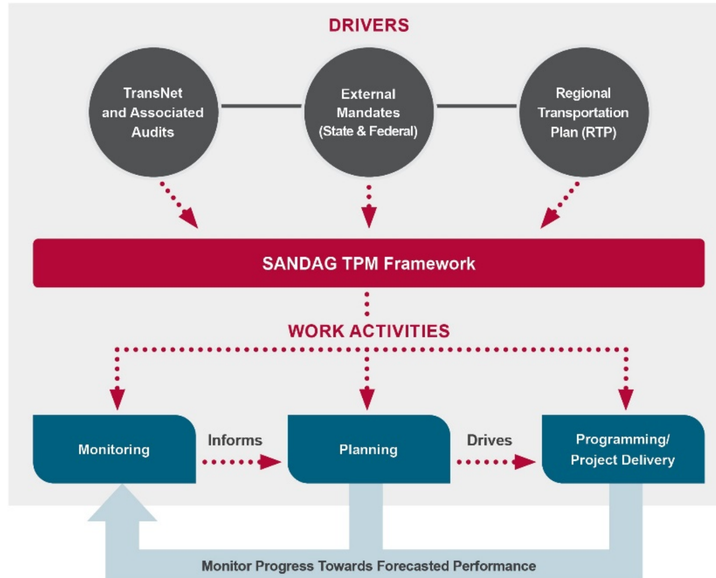
- Goal setting and performance measures
- Target setting
- Data collection
- Analytics and data management
- Performance monitoring and reporting.

SANDAG has made significant progress with TPM since the FY2018 audit. They proactively undertook major organizational changes, restructuring existing and creating new individual work programs, and developed and implemented several relevant initiatives (e.g., Data Governance and Data Governance Catalog). On a regular basis, staff reports progress against the audit recommendations to executive management and to the Independent Taxpayer Oversight Committee (ITOC).

A Visioning exercise led by the consultant team led to the identification of five key goals for TPM:

- Support *TransNet* Audit findings
- Support Executive Director performance objectives (e.g. VMT reduction)
- Strengthen a data-driven organization
- Strive to become a technology forward organization both internally and externally
- Demonstrate transparency and clarity.

TPM applies to all transportation modes regardless of funding source; it is broader than *TransNet*. As illustrated in the graphic on the following page, there are three key drivers for the TPM Framework: *TransNet*, the Federal Regional Transportation Plan (RTP) and external reporting mandates (e.g., from the State or the Federal government). The TPM framework itself covers activities from planning (broadly defined), to the programming and project delivery, to the monitoring of transportation performance. There is a feedback loop where robust monitoring is critically important to the success of a TPM framework. These relationships are illustrated in the graphic to the right.



The consultant team interviewed management staff of 20+ work programs, SANDAG peers, and local jurisdictions. The team also mapped all performance measures related to the TPM Framework drivers, along with identifying candidates for target setting and monitoring. These activities resulted in the generation of TPM framework options for implementation that would benefit SANDAG in the following ways:

- Address FY2018 *TransNet* Triennial Audit recommendations
- Improve RTP performance tracking
- Support Executive management priorities
- Support project formulation and inform decision making
- Align TPM within the organization.

Option		Decision Type			Change Type		
		Policy Decision	Multiple Options	Phased Approach	Process Change	Regional Methodology	Organization
1	**Additional Board Reported Targets**	✓	✓	✓	✓		
2	**Additional Monitoring Reporting**	✓	✓	✓	✓		✓
2.1	*Local Streets Speed Reporting*	✓			✓		
2.2	*Integrated Pavement Reporting*	✓			✓	✓	
2.3	*Integrated VMT Reporting (and possibly GHG)*	✓			✓	✓	
2.4	*Safety and Trends Reporting*	✓			✓		✓
2.5	*Various RTP Performance Measures*	✓	✓	*Depends*	✓		
3	**Before and After Studies**				✓		
4	**Simulation Tools for Operational Improvements**				✓		
5	**Private Data**				✓		
6	**Data Collection Consolidation**				✓		✓

The only two planning-related activities relate to analyses for safety and operational improvement projects. For safety, it will depend on SANDAG's interest in influencing safety project selection and development at Caltrans and local jurisdictions. For operational improvement projects, the SANDAG ABM model typically does not project benefits of such investments. On a case by case basis, more sophisticated tools, especially simulation models can close this gap. However, simulation tool development, as experienced with the I-15 Integrated Corridor Management (ICM), are very resource intensive.

The report presents four conceptual scenarios which are: (1) VMT and eVMT; (2) Safety; (3) Local Roads Pavement Preservation and (4) Congestion. The scenarios provide detailed step by step instructions for implementation and address workflow alignment, costs and other implementation factors. The conceptual scenarios establish a useful roadmap for implementation.

A detailed implementation plan refines each option for implementation in the main body of the report and provides estimates of level of effort, training and licensing details. If SANDAG were to implement all the options, the cost impact would be approximately $200,000 in one-time costs, and from $800,000 to $1.3 million in recurring yearly, incremental costs. Recommendation for implementation phasing is third/fourth quarter of 2021, over a 12-month period.

Finally, Appendix A presents the Triennial Audit recommendations matrix. The key FY2018 *TransNet* Triennial Performance Audit recommendations with respect to TPM are noted along with associated options and comments.

2 BACKGROUND

2.1 FY 2018 *TRANSNET* TRIENNIAL PERFORMANCE AUDIT RECOMMENDATIONS

The FY2018 *TransNet* Triennial Performance Audit conducted by the Independent Taxpayer Oversight Committee (ITOC) recommended that SANDAG implement a performance framework to measure output and performance against the *TransNet* goals. SANDAG recognized the need to enhance its current performance management practices and move toward establishing a regional TPM Framework that would help to accomplish:

- Setting targets to measure *TransNet* performance against the *TransNet* Extension Ordinance goals to meet or exceed federally mandated deadlines for implementation. At a minimum, some narrative could accompany performance reporting to help others understand whether data and results were favorable or unfavorable.

- Capturing performance outcome data related to safety metrics, pavement condition, and bridge condition for highways, local roadways, and bicycle and pedestrian modes.

- Conducting more robust analyses of cause and effect for all performance metrics to provide meaning to results and to help determine if different strategies or projects should be employed to get a better result. For instance, consider using collision heat maps to visually show where high concentrations of severe or fatal collisions occur and work with Caltrans and local jurisdictions to inform solutions and identify future safety projects.

- Providing regular performance monitoring reports that consider past performance in relation to *TransNet* goals through quarterly updates to the SANDAG Board and committees as well as annual public reports on the status of *TransNet*, and website postings.

- Considering allocating funding for additional performance monitoring activities given that SANDAG will likely require more data sources, tools, and resources to track, validate, analyze, ensure quality, and report performance.

- Explore and study public-private partnerships (P3s) with entities such as Google, Waze, Scoop, TomTom, or other third-party data providers to integrate and summarize performance results as well as provide real-time commute information to better inform travel making decisions.

- Enhance the Story Map tool, *TransNet* project status listing, or develop a different tool to capture project output details and track *TransNet* accomplishments over time.

In addition to these, there are other recommendations directly or indirectly tied to TPM implementation, such as the RTIP outcome/output report. Subsequently to the FY 2018 *TransNet* Triennial Report, SANDAG staff began quarterly briefings to ITOC regarding progress for each major finding and recommendation. SANDAG also hired the consultant team of Kimley-Horn and Associates and System Metrics Group to develop this TPM Framework and Implementation Plan.

2.2 DEFINITION OF TPM

Transportation Performance Management (TPM) incorporates five main activities, or groups of activities, illustrated on the left of Exhibit 1. These are: **goal setting and performance measures; target setting; data collection; analytics and data management; and performance monitoring and reporting**. The applications of these activities, examples of performance measurement requirements, and some example applications are shown in the silos to the right of the TPM activities in Exhibit 2-1. The definition is central to the framing of the initiative as it drives the Overall Work Program (OWP) work elements considered in this report.

Exhibit 2-1: Definition of TPM

TPM Activities
Goal Setting / Performance Measures
Target Setting
Data Collection (i.e., collect and measure outcome and output data)
Analytics and Data Management (i.e., validate, analyze and manage transportation data)
Performance Monitoring and Reporting

Applies To	Performance Measurement Requirements	Example Applications
Highways	Internal / External	Quality Assurance
Streets and Roads	Programmatic Level	TransNet
Bridges	Regional Level – SANDAG as MPO	Input to Regional Plan
Transit	Caltrans/State Level	TDA Audit, Regional targets
Environmental Mitigation	Federal (FHWA, FTA)	MAP 21, FAST Requirements

2.3 CURRENT TPM WORK PROGRAMS AT SANDAG

In FY2021 there are 22 work programs that fully or partially support TPM, which accounts for approximately $9.5 million (21 percent) of the total $46.3 million Overall Work Program (OWP). Of that $9.5 million, $5.7 million is for in-house labor, and $3.8 million for contracted services. In other words, one of every five dollars in the SANDAG OWP funds some type of TPM activity.

The list of TPM-related work elements for the FY2021 cycle is shown in the table below. Note the table reflects the main Work Elements associated with TPM in late 2020/early 2021. It is a snapshot in time because each year OWPs are added, dropped and modified. In addition, while these Work Elements capture the vast majority of TPM, they do not reflect absolutely 100 percent of SANDAG's TPM efforts. For example, SANDAG carries out some surveys not captured here because they are not conducted every single year (and not included in the FY2021 budget).

Work Element	Description
1500100	*TransNet* Financial Management
1500300	Funds Management and Oversight
1200100	*TransNet* Project Office

Work Element	Description
2300600	Enterprise Geographic Information Systems
2402000	Data Science, Open Data, Big Data
2300900	Database Administration and Governance
2301100	Transportation Surveys and Other Primary Data Collection
2301200	Regional Economic and Finance Services and Research Services
2301400	Regional Census Data Center Operations
2302300	Data Acquisition and Management
2301900	Quality Assurance and Control
3100400	Regional Plan Implementation
3102000	San Diego Forward: The 2021 Regional Plan and 2020 Federal Regional Transportation Plan
3201200	Advancing Climate Action Plans with Data-Driven Transportation Strategies
3310703	Transportation Demand Management - Program Service and Delivery
3330700	Regional Intelligent Transportation System Planning (Addition)
3310704	Transportation Demand Management – Regional Vanpool Program
3311700	Transportation Performance Monitoring and Reporting
3320100	Transit Planning
3300200	Active Transportation Planning and Programs
3320300	Passenger Counting Program
N/A	Grant Program

3 SANDAG TPM ACTIVITIES ASSESSMENT

This section provides a high-level summary of the consultant's team assessment of SANDAG's progress with TPM since the FY2018 *TransNet* Triennial Performance Audit as well as the interviews of the TPM work programs.

3.1 SANDAG PROGRESS SINCE *TRANSNET* AUDIT

SANDAG has made significant progress in various areas of TPM since the FY2018 *TransNet* audit, which warrants recognition. The agency proactively undertook major organizational changes, restructured existing OWPs, created new OWP's, and developed and implemented several relevant initiatives (e.g., Data Governance and Data Governance Catalog). SANDAG has a proactive and organized approach to the Regional Transportation Plan / Sustainable Communities Strategy (RTP/SCS) development. This cycle was different with a Federal RTP developed first (the 2019 Federal RTP) followed by the full RTP expected at the end of 2021.

Additionally, SANDAG has been tracking the implementation of individual audit recommendations on a quarterly basis and reporting back to management. The paragraphs below summarize SANDAG's progress and accomplishments relative to each TPM audit finding.

- ***Setting targets to measure TransNet performance against the TransNet Extension Ordinance goals in-line with federally mandated deadlines or at a faster pace. At a minimum, some narrative could accompany performance reporting to help others understand whether data and results were favorable or unfavorable.***

  SANDAG has adopted safety targets as part of the federal requirement. The safety targets were adopted in coordination with the development of the State Highway Safety Plan (SHSP). The same approach was used by other MPOs such as SCAG. Targets were also set by Senate Bill 1 (SB-1) for State Highway System (SHS) pavement conditions and local roads pavement conditions. For instance, when jurisdictions reach a Pavement Condition Index (PCI) of 80, they can use their allocations for local roads from SB-1 for other purposes. Whether to set additional targets is a policy decision discussed in subsequent sections.

- ***Capturing performance outcome data related to safety metrics, pavement condition, and bridge condition for highways, local roadways, and bicycle (bike) and pedestrian modes.***

  SANDAG has been coordinating with Metropolitan Transit System (MTS) and North County Transit District (NCTD) on regional public transit safety targets for the FTA.

  In February 2020, the SANDAG Board approved regional Transit Asset Management targets in accordance with MAP-21/FAST Act requirements. In Q1 and Q2 of 2021, the active transportation group also conducted safety analysis to identify active transportation trends. Moreover, SANDAG has conducted a safety analysis as part of the SHSP development and found that the Region is currently performing better than the statewide averages. Some analysis results are presented to its policy bodies (e.g., PM1, PM2, and PM3 data to ITOC). Finally, SANDAG plans to coordinate with Caltrans on Mid Performance Period reports for FHWA on pavement, bridge, system performance, freight, and Congestion Mitigation and Air Quality performance measures on the National Highway System (NHS) and the SHS as a whole.

- ***Conducting more robust analysis of cause and effect for all performance metrics to provide meaning to results or help determine if different strategies or projects should be employed to get a better result. For instance, consider using heat maps to identify where***

the majority or significant severity accidents occur and work with Caltrans and local jurisdictions to inform solutions and future projects.

SANDAG has conducted "before and after" analysis for major capital projects like the I-15 Managed Lanes and conducted the before analysis for the Mid-Coast transit project[1]. For operational projects (safety or mobility related), additional tools will be required to estimate cause and effect. For safety, existing data sources like SWITRS and TIMS have been used internally by SANDAG staff in the past. Additional safety analysis is possible such as safety heat maps to identify hot spots of injury-related collisions and influence Caltrans and local jurisdictions in identifying, developing, and delivering these projects

- ***Providing regular performance monitoring reports that consider past performance in relation to TransNet goals through quarterly updates to the SANDAG Board and committees, annual public reports on the status of TransNet, and website postings.***

  SANDAG reports the State of the Commute to ITOC. SANDAG staff provides quarterly and annual updates on the *TransNet* Major Corridors and Regional Bikeway Programs. SANDAG staff also report on the region's two largest projects – Mid-Coast and North Coast Corridor (NCC) – on a quarterly basis. Staff presented the draft 2021 RTIP in November 2020 (Outputs/outcomes report) in conjunction with the Local Streets and Road Program Report covering prior year results. Additional performance measures, especially related to the *TransNet* ordinance (e.g., congestion relief, local road conditions, safety) can be reported if policy bodies direct staff to do so and provide additional funding.

- ***Considering allocating funding for additional performance monitoring activities given that SANDAG will likely require more data sources, tools, and resources to track, validate, analyze, ensure quality, and report performance.***

  Additional funding will likely be required just to meet federal and state requirements. This report provides options for additional measures and associated costs for additional monitoring activities. If resources are provided, SANDAG can start reporting them.

- ***Explore and study public-private partnerships with entities such as Google, Waze, Scoop, TomTom, or others to integrate and summarize performance results as well as provide information on a real-time basis to travelers identifying different commute times and options.***

  SANDAG staff reported reviewing several private sources such as Replica, StreetLight, and INRIX. SANDAG's Data Solutions recently issued a Request for Proposals for big data vendors to provide licenses for the agency's bid data needs and entered into a one-year agreement with StreetLight. SANDAG previously had an INRIX license but that has expired. To date, this review has not led to conclusions for securing long-term licenses for using these data. INRIX primarily provides speed and travel time data on highways and arterials but has recently developed other packages with traffic volume data. StreetLight primarily provides origin destination and VMT data, but has recently developed packages with travel time, safety and other data and analytics.

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[1] Data collection for the Mid-Coast project was interrupted because of COVID-19.

Replica is primarily a provider of traffic volume data with simulated network assignments that report data by mode share, trip type, and other purposes.

- ***Enhance the Story Map tool, TransNet project status listing, or develop a different tool to capture project output details and track TransNet accomplishments over time.***

  The SANDAG *TransNet* Story Map shows projects completed along with a narrative. However, the Story Map does not generally include transportation performance measures.

On a different front, but also related to progress with TPM, the recently completed San Diego Forward: The 2019 Federal Regional Transportation Plan (RTP) identified three regional goals with TPM performance indicators (Exhibit 3-1). Several of these measures are candidates for target setting and monitoring. The potential approach to monitoring them is discussed in later sections of this memorandum. However, it depends on management and policy boards to decide, especially since some of them require significant resources. In general, mobility measures are easier to monitor if the focus is on the State Highway System. Monitoring them for arterials is more challenging and resource intensive.
Finally, the Federal RTP forecasts how the goal-related performance measures will change once the RTP is implemented. These forecasts could be used as targets if management and policy bodies choose to do so. The Regional Transportation Improvement Program (RTIP) also has TPM elements. In general, for this report, "RTP" is a term that is inclusive of RTIP performance monitoring efforts.

Exhibit 3-1: 2019 Federal Regional Transportation Plan Goals and Regional Transportation Measures

2019 Federal RTP Vision and Goals Category	TPM Performance Indicator	Reported Performance Measures (2018 Regional Monitoring Report)
Healthy Environment & Communities	Air Quality	Number of Days Air Quality Index more than 100
	Fatalities/serious injuries per Vehicle Miles Traveled	Fatality Rate (Per 100,000 VMT)
		Rate of Serious Vehicle Injuries (Per 100,000 VMT)
Vibrant Economy	Travel times to jobs	Travel Time to Jobs (Minutes)
Innovative Mobility & Planning	Commute mode share	Percent of Commuters by Primary Mode of Work Commute
		Drive-Alone Mode Shares
		Alternative Commute Mode Shares (all other modes)
	Annual transit boardings	Annual Transit Boardings
	Border wait times	Average Passenger Vehicle Border Wait Times (Minutes)
		Average Commercial Vehicle Border Wait Times (Minutes)
	Border crossing volumes	Annual Volume (Total Trucks) of Commercial Truck Crossings
		Annual Volume of Personal Vehicle Crossings
		Annual Volume of Bus Crossings
		Annual Volume of Pedestrian Crossings
		Annual Volume of Person Crossings
		Annual Volume via Cross Border Xpress (CBX)
	Travel times and volumes for all modes (Reported as "Travel Times and Volumes for Key Transportation Corridors")	Freeway Travel Times/Volumes by 8AM/5PM Peak Hour for 12 Key Auto Corridors
		Transit Passenger Volumes in 12 Key Transit Corridors
		Bike Volumes (Annual Daily Bidirectional Average) by Regional Bikeway Corridor
	Alternative fuel vehicle ownership	Zero-Emission Vehicle Ownership

Source: 2019 Federal Regional Transportation Plan (RTP)

There is some overlap between *TransNet* and Federal RTP goals and performance measures, understanding that *TransNet* is a subset and the RTP is much broader. By fully addressing performance areas for the RTP, SANDAG effectively will enhance performance management of *TransNet* as well.

3.2 WORK PROGRAM ASSESSMENT RESULTS

The consultant team interviewed representatives from 20 work programs with various levels of alignment with TPM. The assessment of SANDAG's performance monitoring and reporting activities is the subject of a separate report but can be summarized in the following takeaways:

- SANDAG typically has not set or adopted targets beyond those that are mandated by the State or by the Federal Government (for example, safety targets). Targets can be mandatory or not. The important decision for SANDAG is considering how the associated monitoring results would be used if additional targets are adopted. If these results show that the Region is not moving in the right direction, will management and policy bodies change investment decisions previously adopted? As will be shown in later sections, there is a menu of performance measures that can be candidates for target setting and/or monitoring. It will be important to have discussions on the merits of each option, whether setting targets is appropriate, and how monitoring results will be used.

- Bridge and pavement conditions on the State Highway System (SHS) are monitored by Caltrans and could be easily reported to SANDAG. For local roads, SANDAG invests in the California Transportation Commission's statewide local roads monitoring activities. However, these only monitor overall regional conditions and report on the Pavement Condition Index (PCI) by county. If SANDAG wants to assess local roads in more detail, it would need to invest in data collection and analysis, and the associated business processes.

- The SANDAG 2019 Federal RTP includes investments in operational improvements, which, on a case by case basis, could benefit from using more sophisticated simulation models that are very expensive. However, without such tools, it is difficult to estimate the benefits of these investments.

- Concerning VMT and GHG reduction, for monitoring purposes, SANDAG is facing some hurdles. Modeling approaches as using the ABM and Emfac are suitable for forecasting (and indeed required methodology for MPOs) but not for monitoring. VMT monitoring represents an ongoing challenge especially for arterials. Industry-wide, there are promising technologies that report VMT such as Replica and StreetLight among other third-party data providers, but no standard methodology or approach exists yet. Various agencies, such as CARB, Caltrans and SANDAG, have their own methods for estimating GHG. Ideally, there would be the same approach and tools not only for the SANDAG region but statewide.

- With its RTP/SCS responsibilities, SANDAG's work programs naturally favor planning/forecasting activities, but the organization is taking steps to enhance performance monitoring. We estimate SANDAG spends 70 percent of its TPM-related OWPs on planning/forecasting and 30 percent on implementation/monitoring. This emphasis on forecasting, coupled with the challenges of collecting monitoring data, supports the *TransNet* audit findings. Despite this, SANDAG is beginning to expand its efforts in performance monitoring. For instance, a broader application of before and after studies will provide new insights into performance monitoring. These studies ought to have consistency and be applied to all major projects.

- Expanding existing resources to include performance monitoring or other new responsibilities will be challenging without additional resources. Interview results show that several work programs have limited staff resources available to meet existing deliverables, which limits their ability for effective data mining. One example – 3311700 - Transportation Performance Monitoring and Reporting, which houses the State of the Commute report, could be the home for future performance monitoring efforts. However, if existing resources and deliverable expectations remain unchanged, this work program will not have the capacity to provide beyond its current focus: reporting and monitoring highway (and some transit) activity. Staff members expressed enthusiasm for expanding their roles and responsibilities in new directions, but this is tempered by concern over resources.

- Other MPOs also face resource and technology challenges with tracking the performance on their RTP/SCS's. MTC's experience with the Vital Signs program is that the program successfully generates "hits" on the website, but the lag in the time it takes to update performance on the website can sometimes be up to two years. This creates a challenge for staff to regularly maintain and provide updates to the site.

- Data collection occurs in multiple areas and has potential for economies of scale and improved work planning (less reactive). Examples include Data Acquisition and Management, Transportation Surveys and other primary data collection. Analytics also occurs in multiple areas but is more aligned to specific functions.

- Multiple work programs reported strong collaboration amongst their partners, continuously coordinating with those outside their respective teams. Some work programs also appear to work somewhat reactively to others' needs and would benefit from clarified roles and responsibilities.

- Caltrans District 11 and SANDAG have a purposeful relationship with strong collaboration at all levels. There does not appear to be much if any duplication of effort. It is important to note that the goals of the two agencies vary slightly, and because of this difference in focus, multiple outputs are necessary – for example, the Mobility Performance Report for D11 and the State of the Commute Report for SANDAG – both addressing transportation monitoring.

- Outreach to local stakeholders indicated some common perspectives on wanting to leverage more sophisticated technology for performance monitoring and reporting. Note however that many of them monitor measures such as Level of Service (LOS) and traffic flows, which are not part of the Federal RTP measures. Municipalities are more concerned with real-time operations, as opposed to longer term planning or tracking. No duplication of efforts with SANDAG were reported.

This set of findings, coupled with ongoing discussions with SANDAG staff, formed the basis of understanding TPM at SANDAG while formulating a vision and goals for the TPM Framework, covered in the next Chapter.

4 TPM VISION AND GOALS

The consultant held a goals and visioning workshop with SANDAG staff on September 10, 2020. This workshop was designed to propose a vision, goals and objectives for the TPM framework. A key outcome from this exercise was that participants agreed that the TPM framework should be larger and go beyond the *TransNet* Audit recommendations.

4.1 TPM VISION

A vision is a future-focused expression of what SANDAG intends TPM to become over time.

For SANDAG, TPM includes the following elements:

- Setting goals for SANDAG and the ability to determine what is necessary to achieve those goals
- Ensuring that planning activities produce defensible performance forecasts (i.e., quality assurance)
- Using TPM performance data to enhance decision making and ensure SANDAG prioritizes the right projects
- Committing to monitor performance trends and track the causality of these trends
- Modernizing SANDAG's systems and technology to strengthen the agency's transformation into a data-driven organization.

4.2 TPM GOALS

The development of TPM goals needs to address the inter-related perspectives of several groups and organizations including: TPM procurement staff, *TransNet* Triennial auditors, Executive Director performance objectives, other senior management input, and U,S, Department of Transportation (US DOT).

SANDAG Perspective

TPM Framework Objectives Task Order RFP	**FY 2018 *TransNet* Triennial Performance Audit**
• Use data to better inform investment decisions • Better measure progress and project benefits • Provide useful and meaningful reporting processes • Continue efforts to enhance transparency around decision making	• Set targets to monitor *TransNet* programs • Capture performance outcome data (Safety, pavement, commute times) • Conduct more robust cause and effect • Provide regular performance monitoring reports in relation to *TransNet* goals • Consider allocating funding for additional performance monitoring activities • Expand and bolster existing output tracking tools especially for the Local Street and Road Program

Executive Direction

FY2021 Executive Director Performance Objectives	Management comments on Monitoring goals

• Regional Plan
  ○ How portfolio of projects and programs contributes to achieving goals (planning/forecasting)
  ○ How region, including local partners, contribute to achieving goals (monitoring)
	Some of the most important metrics to track related to the regional plan are Vehicle-Miles Traveled (VMT) and Greenhouse Gas (GHG) reduction – are we making progress towards our target? Access and equity are also important. We haven't set a particular goal for these but improving access to quality transportation (as defined in the SANDAG performance metrics) is a priority and a focus of the Plan.

Federal Perspective

Combination of monitoring and adjustment processes is the "bread and butter" of advanced TPM practices, that establishes a critical feedback loop between performance results and future planning, programming and target setting decisions *Source: TPM Guidebook*
Benefits of instituting TPM practices include: • Creation of Unifying Focus for Agency • Prioritization of Investments Based on Performance Needs • Feedback Loop between Decisions and Results • Connect Individual Staff Activity to Agency Goals • Transparent Decision-Making • Linking Funding Requests to System Performance • Communication of the Benefits from Transportation Investments • Fulfillment of Legislative Requirements

The workshop resulted in the following short list of goals.

TPM Goals
Address *TransNet* Audit findings
Support Executive Director performance objectives (e.g., VMT and GHG reduction)
Strengthen a data-driven organization
Strive to become a technology forward organization both internally and externally
Demonstrate transparency and clarity

The next chapter presents the TPM Framework.

5 TPM FRAMEWORK AND IMPLEMENTATION OPTIONS

This section has three parts:

- TPM Framework
- Performance Measures and Monitoring
- Options for implementation

The options for implementation are further detailed in Chapter 6 (Implementation Plan) and several scenarios are presented in Chapter 7 (Conceptual Scenarios).

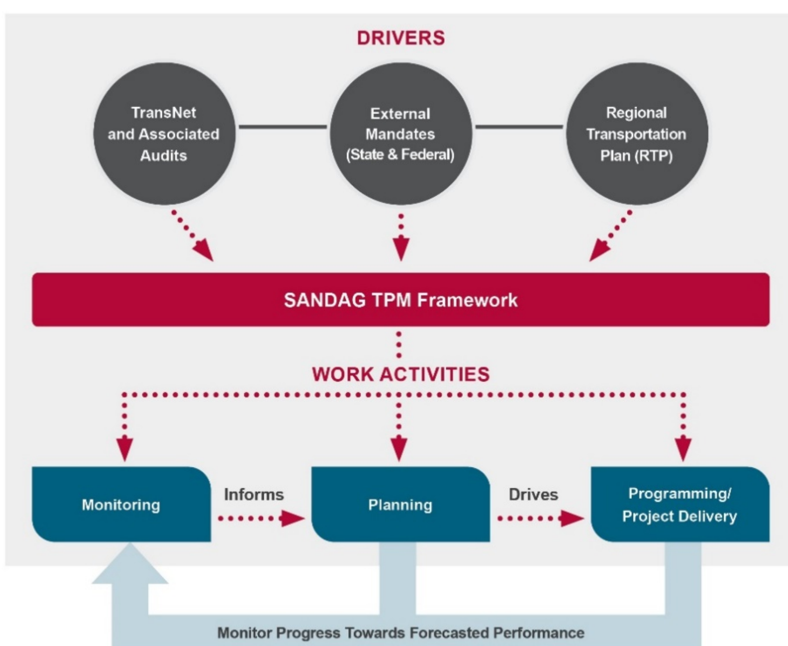
5.1 TPM FRAMEWORK

The TPM framework is driven by three primary mandates/requirements which include:

- ***TransNet*** reporting requirements (including addressing recommendations from the associated Triennial Audit reports)
- **External mandates** (e.g., from the Federal level – FAST, MAP-21, or from the State level – SB1, SB 375)
- **The Regional Transportation Plan/Sustainable Communities Strategy** (RTP/SCS) goals and associated measures.

The TPM framework straddles both Planning (broadly defined) and Monitoring transportation management. The FY2018 *TransNet* Triennial Performance Audit gave impetus to this study and it identified Monitoring as the function that needs the most attention. Monitoring enables SANDAG to gauge the progress made towards forecasted performance from the planning stage. These relationships and the TPM framework are illustrated in Exhibit 5-1, below.

Exhibit 5-1: TPM Framework and Drivers



The TPM work activities encompass goal and target setting, data collection and analytics, and performance monitoring and reporting. As illustrated in Exhibit 3, better monitoring helps not only to inform planning, but in turn, planning drives programming and future project delivery.

The TPM Framework is made up of SANDAG's organizational work programs (OWPs), organized alongside the five core TPM functions: **goal setting and performance measures; target setting; data collection; analytics and data management; and performance monitoring and reporting.**

The SANDAG Work Programs' alignment in the TPM framework is graphically represented in Exhibits 5-2 and 5-3 below. Exhibit 5-2 shows the alignment in the general TPM framework, while Exhibit 5-3 shows the same OWPs, color-coded to illustrate how each OWP aligns to each of the five core TPM functions (e.g., grey boxes for data collection programs; yellow for *TransNet* program management related activities).

The TPM framework begins with each of the five TPM elements (Goal Setting and Performance Measures to Performance Monitoring and Reporting). The framework then contains each of SANDAG's relevant work programs. This is the basis for understanding not only the various alignments, but also the relative TPM-related level of effort. This combination is key to enhance or improve SANDAG's existing performance activities, efforts, and initiatives over time. The framework represents an opportunity for SANDAG to rethink about existing efforts and higher expectations demanded on the agency (i.e., from the *TransNet* audit report recommendations).

In further describing the TPM framework, the consultant would like to acknowledge the following:

- First, the majority of OWPs do not fall cleanly into any one of the five distinct TPM elements. Based on interviews with SANDAG staff assigned to OWPs, fully 70 percent of the OWPs aligned to two or more of the TPM elements. Ten percent aligned to three TPM elements. Just 30 percent aligned to a single TPM element. Note however, the alignments remain subjective and some reviewers might believe that a given OWP should align differently. The individual work programs in the graphic were placed as close as possible to where most of the work effort occurred.

- Second, note the depiction of the different alignments represents a snapshot in time, because each year OWPs are added, dropped and modified. In addition, while the TPM Framework captures the vast majority of TPM activities carried out by SANDAG, it does not reflect 100 percent. For example, SANDAG carries out performance monitoring surveys not captured here because they are not conducted every single year.

Exhibit 5-2: TPM Framework

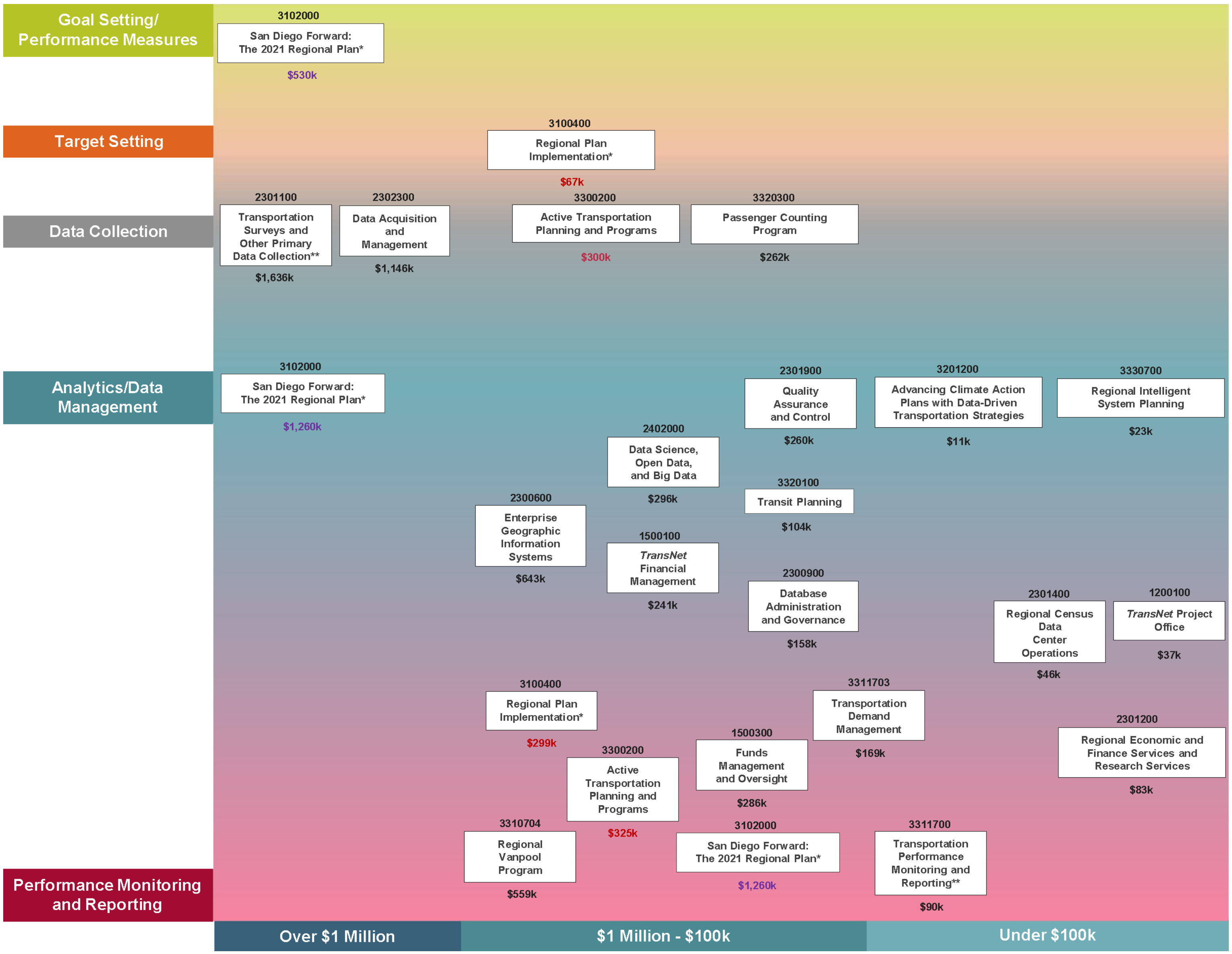
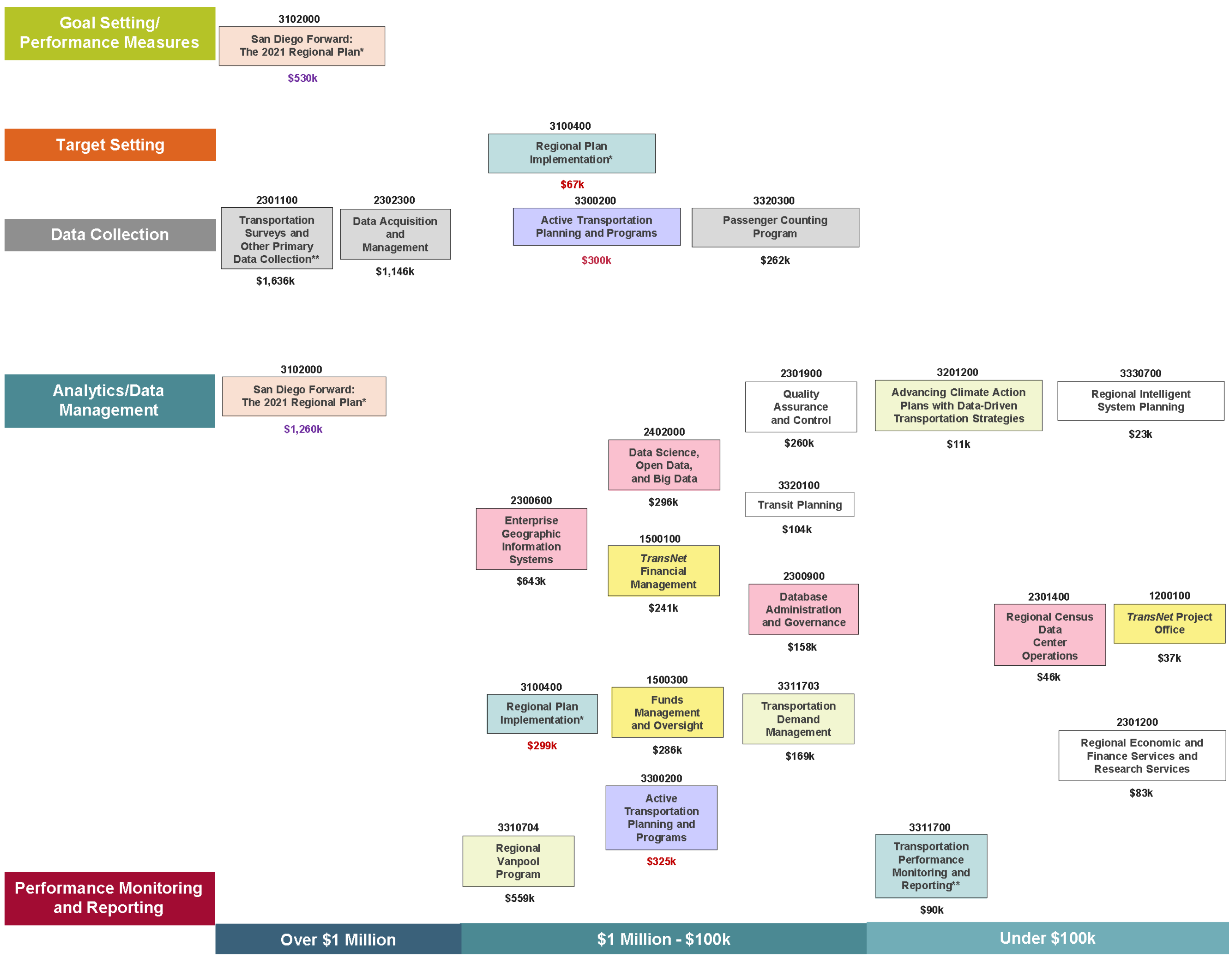


Exhibit 5.3: TPM Framework with Alignments



5.2 PERFORMANCE MEASURES AND MONITORING

Building on the framework discussion above and the study efforts to date, the consultant team developed a mapping of the performance measures related to each of the TPM Framework drivers: *TransNet*, RTP, and external mandates.

For each of these drivers, goals and performance measures were documented. Then, the team identified whether an adopted performance target existed. If an adopted performance target did not currently exist, the team made an assessment about whether each performance measure could potentially be a candidate for a target (in many cases, the answer is no for a multitude of technical or cost reasons). The team also determined whether each measure was a candidate for monitoring and documented the reasons. This analysis enabled the consultant team to add additional detail to the emerging options for implementation and ensure a comprehensive view. One assessment was conducted for each of the TPM framework drivers and is presented next as Exhibits 6, 7 and 8.

5.2.1 TransNet Ordinance

Exhibit 5-4 presents the TPM-related performance measurement areas associated with the *TransNet* ordinance. Note the first header “Goals” in the table is defined as “TPM goal or desired outcome”. Relieving traffic congestion, improving safety, and maintaining/improving local roads are goals straight from the ordinance. Other *TransNet* goals, such as matching State and Federal Funds, are not a TPM type of measure and therefore excluded. Finally, Mobility and Throughput were added as desired outcomes identified in the *TransNet* ordinance extension of 2004. Some measures, such mobility measures that include state highway time on major corridors and average transit speeds, are already tracked in the State of the Commute report and reported to ITOC. This is a monitoring effort year over year, without targets.

Exhibit 5-4: *TransNet* Candidates for Targets and Monitoring

Goals	Performance Measures	Adopted Target?	Candidate for Target?	Candidate for Monitoring?	Comments
Relieve Traffic Congestion		No	Yes	Yes	This can be measured by addressing TransNet Ordinance evaluation measures discussed below in the State of the Commute report. Other mobility performance measures related to congestion reduction are detailed in the RTP and via Federal mandates.
Improve Safety		Yes	SANDAG adopted the same statewide targets	SANDAG will need to monitor and report updates	This can be addressed by meeting RTP, state and federal safety measures.
Maintain / Improve Local Roads		No	Yes	Yes	This is done by MTC and other organizations outside of California. At MTC, all jurisdictions are required to use the same pavement management system and provide its data to MTC. However, MTC also pays for the licenses and maintains a region-wide pavement management system for local streets to use in scenario analysis during their RTP development.
Mobility	Level of Service (LOS)	No	Yes	Yes	Note that SB 743 requires that Level of Service (LOS) or other measures of traffic congestion cannot be considered a significant environmental impact under CEQA. However, LOS is not currently reported by segment by time of day. This analysis can be performed for freeways and expressways on the SHS by using PeMS. However, arterial LOS, even for major corridors, would require volume data that is difficult to obtain, which is required for LOS calculation.
Mobility	Travel Time Comparisons by Mode on Major Commute Corridors	Yes	Yes	Already in place	The State of Commute reports travel times by mode for major corridors.
Throughput	Throughput in Major Travel Corridors	No	Yes	Yes	Throughput is commonly measured as people or vehicles per unit of time (e.g., vehicles per hour) along a segment or corridor. This can be readily reported for freeways and expressways on the SHS by using PeMS. Caltrans produces an annual report on Average Annual Daily Traffic (AADT) at locations for each SHS route in San Diego County.

Appendix A contains a matrix of the audit recommendations and the consultant team assessment and options for implementation.

The 2019 Federal RTP is used as a reference here because it is the latest RTP (SANDAG's 2021 RTP/SCS is not expected until later in 2021). Exhibit 5-5 on the next page shows the 2019 Federal RTP performance measures that relate directly to TPM (there are many other, non-TPM performance measures such as electric consumption and crime rates). These span across three vision and goal areas: Healthy Environment and Communities; Vibrant Economy, and Innovative Mobility and Planning. Candidates for potential target setting are highlighted. SANDAG does monitor these measures and for most of them provide trends in a regional monitoring report.

The 2018 Regional Monitoring Report is a comprehensive effort that presents trend information for most of the performance measures above. While no targets are set for these measures, SANDAG highlights potential areas of improvement and regional performance (travel times to jobs have been flat for over a decade).

Exhibit 5-5: 2019 Federal RTP Candidates for Targets and Monitoring

Goals	Performance Measures	Adopted Target?	Candidate for Target?	Candidate for Monitoring?	Comments
Healthy Environment & Communities	Air Quality: Number of Days Air Quality Index more than 100	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from San Diego County Air Pollution Control District.
	Fatality Rate (Per 100,000 VMT)	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from National Highway Traffic Safety Administration (NHTSA), Fatality Analysis Reporting System (FARS). However, audit findings recommended also reporting "heat maps" to show areas with high concentrations of collisions.
	Rate of Serious Vehicle Injuries (Per 100,000 VMT)	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from California Highway Patrol, Statewide Integrated Traffic Records System (SWITRS); Caltrans
Vibrant Economy	Travel times to jobs: Travel Time to Jobs (Minutes)	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from American Community Survey (ACS), 1-Year Estimates.
Innovative Mobility & Planning	Commute mode share: Percent of Commuters by Primary Mode of Work	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from American Community Survey (ACS), 1-Year Estimates.
	Commute mode share: Drive-Alone Mode Shares	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from American Community Survey (ACS), 1-Year Estimates.
	Commute mode share: Alternative Commute Mode	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from American Community Survey (ACS), 1-Year Estimates.
	Annual transit boardings: Annual Transit Boardings	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from Annual Boardings Data, MTS, NCTD, SANDAG.
	Border wait times: Average Passenger Vehicle Border Wait Times (Minutes)	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from United States Customs and Border Protection, Border Wait Times: Southern Border Ports of Entry.
	Border wait times: Average Commercial Vehicle Border Wait Times (Minutes)	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume (Total Trucks) of Commercial Truck	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume of Personal Vehicle Crossings	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume of Bus Crossings	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume of Pedestrian Crossings	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume of Person Crossings	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from U.S. Customs and Border Protection via USDOT, Bureau of Transportation Statistics (BTS).
	Border crossing volumes: Annual Volume via Cross	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from Cross Border Xpress (CBX).
	Travel times and volumes for all modes: Freeway Travel	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from Caltrans Performance Measurement System (PeMS),
	Travel times and volumes for all modes: Transit Passenger Volumes	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from SANDAG Passenger Counting Program, Regional Metropolitan Transportation System
	Travel times and volumes for all modes: Bike Volumes	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from Bike/Pedestrian Counter Network.
	Alternative fuel vehicle ownership: Zero-Emission Vehicle Ownership	No	Yes	Already in place	Trends currently being monitored in 2018 Regional Monitoring Report using data from Clean Vehicle Rebate Program (ARB) via Williams, Brett and Anderson, John (2016). "Clean Vehicle Rebate Project and EV Market Update" presentation to the SANDAG; Energy Working Group.

Exhibit 5-6 shows Federal and State performance measures. Many of these have targets already in place and monitoring occurs.

Exhibit 5-6: Federal and State Performance Measures

Driver	Goals	Performance Measures	Adopted Target?	Candidate for Target?	Candidate for Monitoring?	Comments
SB375	Environment	Environmental measures - GHG per capita	Yes	Yes	Yes	Potential to monitor using gas consumption for California in a similar way as CARB. However, it would be complex since it requires allocation of statewide gasoline consumption to the county (using vehicle ownership or population). Private sources may also be reasonable such as Replica which CARB and Caltrans District 3 are evaluating. Note that CARB analyzed HPMS and is not satisfied that it provides accurate VMT.
SB1	State Highway System (SHS) Pavement Condition	% of pavement in "good" or "fair" condition	No	Yes	Yes	Intent SB-1 that by 2027, not less than 98 percent of pavement on the SHS in good or fair condition
SB1	Local Pavement	Average Pavement Condition Index (PCI)	No	Yes	Yes	Not a direct target, but SB-1 authorizes a city or county to spend its apportionment of funds under the program on transportation priorities other than those allowable pursuant to the program if the city's or county's average Pavement Condition Index meets or exceeds 80.
MAP21/FAST	Safety	(PM1): Number of Fatalities	Yes	Yes	Yes	Previously discussed under TransNet audit recommended safety monitoring
MAP21/FAST	Safety	(PM1): Rate of Fatalities (per 100M VMT)	Yes	Yes	Yes	Previously discussed under TransNet audit recommended safety monitoring
MAP21/FAST	Safety	(PM1): Number of Serious Injuries	Yes	Yes	Yes	Previously discussed under TransNet audit recommended safety monitoring
MAP21/FAST	Safety	(PM1): Rate of Serious Injuries (per 100M VMT)	Yes	Yes	Yes	Previously discussed under TransNet audit recommended safety monitoring
MAP21/FAST	Safety	(PM1): Number of Non-Motorized Fatalities and Non-Motorized Severe Injuries	Yes	Yes	Yes	Previously discussed under TransNet audit recommended safety monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of Interstate pavements in Good condition	In place (Caltrans)	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of Interstate pavements in Poor condition	In place (Caltrans)	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of non-Interstate NHS pavements in Good condition	No	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of non-Interstate NHS pavements in Poor condition	No	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of NHS bridges in Good condition	In place (Caltrans)	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	Pavement/ Bridge Condition	(PM2): Percentage of NHS bridges in Poor condition	In place (Caltrans)	Yes	Yes	Previously discussed under TransNet audit recommended pavement and bridge condition monitoring
MAP21/FAST	System Performance	(PM3): Percent of reliable person-miles traveled on the Interstate	In place (Caltrans)	Yes	Yes	Requires adoption of a reliability measure such as the buffer index and then using PeMS to compute and report it.
MAP21/FAST	System Performance	(PM3): Percent of reliable person-miles traveled on the Non-Interstate NHS	No	Yes	Yes	For non-NHS part of the SHS, same methodology can be used.
MAP21/FAST	System Performance	(PM3): Percentage of Interstate system mileage providing for reliable truck travel time (Truck Travel Time Reliability Index)	In place (Caltrans)	Yes	Yes	Same as overall reliability, but requires focus on truck routes
MAP21/FAST	System Performance	(PM3): Total emissions reductions by applicable pollutants under the CMAQ program	No	No	No	Difficult to monitor directly
MAP21/FAST	System Performance	(PM3): Annual hours of peak hour excessive delay per capita	No	Yes	Yes	Can be done for the SHS using PeMS
MAP21/FAST	System Performance	(PM3): Percent of non-single occupancy vehicle travel, includes travel avoided by telecommuting	No	Yes	Already in place	Captured in 2019 Federal RTP as part of commute mode shares performance measures (using American Community Survey)
MAP21/FAST	State of Good Repair	Percent of facilities over 3.0	In place (MTS and NCTD)	N/A	Yes	
MAP21/FAST	State of Good Repair	Percent of Vehicles over their Useful Life	In place (MTS and NCTD)	N/A	Yes	
MAP21/FAST	State of Good Repair	Percent of Equipment over their Useful Life	In place (MTS and NCTD)	N/A	Yes	
MAP21/FAST	State of Good Repair	Percent Track with Slow Zones	In place (MTS and NCTD)	N/A	Yes	
MAP21/FAST	Safety	Transit Safety measures	In place (MTS and NCTD)	N/A	Yes	

5.3 OPTIONS FOR IMPLEMENTATION

Options for implementation (potential recommendations) for the TPM framework focus primarily on performance monitoring. Only two relate to planning or investment decision activities. This was done not only because the FY 2018 *TransNet* Triennial Performance Audit recommendations were focused on monitoring, but also because SANDAG already has existing strengths on the planning and forecasting side (with the exceptions of safety and operational improvement project).

The consultant team recognizes some of the options that arose during the project require a policy decision from the full SANDAG Board of Directors. We also recognize that in some cases a spectrum of implementation scenarios is possible. For example, implementing an interim change followed by a full implementation at a later date.

The potential options for implementation that arose from the TPM framework study are summarized below for each of the five TPM elements (Goal setting, target setting, etc.). These options also identify whether the option for implementation relates to: (1) Process improvements; (2) Regional methodology; and/or (3) Organization and governance. We list the options for implementation for each of the TPM elements.

These additional categories are defined as follows:

- ***Process improvements*** represent potential changes to as-is business processes for the OWPs analyzed that may be implemented either independent of or in concert with changes to regional methodology or organization and governance described below. Process improvements tend to involve adoption of new technology and may require new tools, new training, and/or new resources.

- ***Regional methodology*** changes represent changes to either how jurisdictions work with SANDAG or how SANDAG modifies its own methodologies to align with Statewide approaches. One such example would be adopting a similar approach for estimating regional VMT to be consistent with how the California Air Resources Board (CARB) calculates regional VMT. As with process improvements, implementing a change to a methodology may require new tools, new training and/or new resources.

- ***Organization and governance*** options for implementation affect how SANDAG potentially allocates new or different resources to tasks and addresses organization alignment alternatives. Also note this short TPM framework project does not constitute a focused organization study of SANDAG.

Additional details in implementation are provided in the Implementation Plan presented in Section 7. TPM is broader than *TransNet* (some of the options for implementation are not directly related to *TransNet*). The Matrix in Appendix A at the end of this memorandum addresses the specific TPM-related FY2018 Triennial Audit recommendations.

5.3.1 Goal Setting and Performance Measures

Goal Setting is already established through the *TransNet* ordinance and through the 2019 Federal RTP as identified earlier in this report. The Board of Directors can change this as SANDAG moves towards its new vision. No recommendations for goal setting are presented at this time.

5.3.2 Target Setting

SANDAG already complies with a variety of Federal (e.g., FAST, MAP-21) and other external targets (e.g., California's SB1, SB 375). There are no recommendations from the consultant team on SANDAG's current approach to these types of targets.

However, none of the 2019 Federal RTP network modeled performance measures have related performance targets. These are performance measures based on model results to anticipate future performance, not monitored based on observations. For example, there are no targets set for any of the Commute mode share (e.g., alternative mode share, Percent of Commuters by Primary Mode of Work Commute).

Adopting Additional Targets. SANDAG has the option to proactively identify new targets for areas where no targets exist today yet are identified as important RTP/SCS and/or *TransNet* goals. These include *arterial mobility, reliability, safety, environmental and pavement conditions*. For example, SB-1 does not provide a direct target for local pavement, but included in SB-1 is an authorization for a city or county to spend its apportionment of funds under the program on transportation priorities other than those allowable pursuant to the program if the city's or county's average Pavement Condition Index (PCI) meets or exceeds 80. SB-1 also has as its intent that 98 percent of pavement on State Highways should be in "good" or "fair" condition.

The decision to add targets is a major policy decision that comes with ramifications (i.e., additional cost, potential changes to business processes, and the reporting to Board/ITOC). This change would be a policy change and would require process changes, as well as additional resources (detailed subsequently in the Implementation Plan).

5.3.3 Data Collection

Consolidation of Data Collection. SANDAG should consider consolidating data collection functions to achieve cost efficiencies through economies of scale and better workload planning. Candidates for consolidation at some level include Data Acquisition and Management, Transportation Surveys and Other Primary Data Collection, Passenger Counting Program, and Active Transportation Planning and Programs. Given the multiplicity of functions served, the recommendation is not necessarily for a single giant Data Collection OWP, rather for a grouping of like functions where economies of scale can be achieved. This should be accomplished in context of the larger organizational structure, recent efforts at better coordination including the data governance work, and accomplished in such a way as to minimize disruptions within individual departments (e.g., Data Science and Big Data). This change would require organizational changes but likely no change to business processes.

5.3.4 Analytics and Data Management

Safety and Trends Reporting. To more efficiently evaluate trends in fatal and severe collisions, consider using tools that readily provide data based on the California Highway Patrol (CHP) Statewide Integrated Traffic Records System (SWITRS). Consider using the Caltrans Strategic Highway Safety Plan (SHSP) Crash Data Dashboard to access and filter regional crash data, compute safety performance measures for which targets were adopted and show heatmaps for collisions by type to identify "hot spots". Using the Crash Data Dashboard is much easier than using SWITRS. The Crash Data Dashboard is built using SWITRS data and available filters align with State safety goals and focus areas.

These systems rely upon the same source of data, require registration of an account for usage, and are free. This data can be used to evaluate safety trends and to create visual tools such as heatmaps to show high collision locations in the region. This change would require changes to business processes, additional resources and training.

Before and After Studies. SANDAG has conducted some before and after studies for some projects (e.g., I-15 managed lanes, active transportation), but not for others (e.g., I-5 managed lanes). SANDAG has also conducted some before and after studies that were not federally mandated, for instance the South Bay Rapid Before and After Study. SANDAG ought to establish a threshold for capital projects for which it will commit to doing before and after studies (e.g., exceeding $100 million, legislative requirements). SANDAG ought to conclude the Mid-Coast after study once COVID subsides. This change would require changes to business processes, additional resources and training.

Private Data. Continue the exploration and expanded use of private data sources such as INRIX, StreetLight and Replica, but make this part of a broader TPM strategy. Data Solutions recently completed a procurement of StreetLight data with a one-year license. Several third-party data providers are working with other California agencies such as CARB and Caltrans to improve VMT analytics and reporting. This change would require changes to business processes, additional resources, licensing and training.

5.3.5 Performance Monitoring and Reporting

Reporting on Additional Monitoring Information. SANDAG should identify the location/home for additional performance monitoring and reporting information, including arterial mobility, reliability, safety, environmental and pavement conditions. Candidate homes for the new reporting in the future include (a) State of the Commute Report and (b) Regional Monitoring Report (if performed more frequently). This change would require changes to business processes and training.

Pavements. Consider, over time, to use a common platform such as StreetSaver with all jurisdictions under SANDAG (as MTC does it in the Bay Area). This approach would be facilitated by SANDAG paying for the licenses. The resulting data could be also used for future condition forecasting during the next Regional Plan/SCS. This change would require changes to business processes, additional resources, the StreetSaver license and training.

VMT and GHG. There are two general approaches proposed to estimate VMT for monitoring purposes. The first is a proxy approach using readily available data, and the second approach uses a fuel consumption methodology similar to an approach that CARB uses to estimate statewide VMT.

If SANDAG desires to monitor GHG, then it could adopt CARB’s methodology for monitoring performance. Even though CARB’s methodology will most likely evolve over time to take advantage of emerging big data products (e.g., Replica), adopting CARB’s methodology of relying on fuel consumption data for GHG would result in better alignment and benefit SANDAG. This is a regional methodology change requiring a minimal investment.

Local Streets Speed Reporting. Consider using a vetted private data provider such as INRIX, StreetLight, or Replica for speed and travel time reporting. These data providers provide web-based user interfaces with varying degrees of “ease of use”. Private data solutions will require some training, but these providers may offer training and user support services as part of the procurement. This change would require a change to business processes, additional resources, licensing and training on how to use the selected application.

Exhibit 5-7 summarizes these options for implementation along with the principal changes involved. Note that the color-coding corresponds to the color-coding used for Exhibits 5.2 and 5.3 in Section 5.1 above.

Exhibit 5-7: Summary Options for Implementation

TPM Element	Options for Implementation	Driver	Change
Goal Setting and Performance Measures	No recommendations.		N/A
Target Setting	<u>Existing Federal and other external Targets.</u> No change recommendations. <u>Additional Targets for Board Reporting.</u> Consider identifying new targets to better track RTP performance in the areas of arterial mobility, reliability, safety, environmental and pavement conditions.	RTP Monitoring and State mandate for GHG	Business Process
Data Collection	<u>Data Collection and Reporting Consolidation</u>. Consider consolidating data collection and reporting functions to achieve better workload planning and cost efficiencies through economies of scale. This should be accomplished in context of the larger organizational structure and aim to minimize disruptions within individual departments (e.g., Data Science and Big Data). This could be accomplished either with one large group, or if spans of control become challenging, then two groups. Delineation between the groups could be field data collection (e.g., bike/ped, vanpool) versus large data set acquisition (e.g., Survey, SWITRS, INRIX). At the minimum activities need to be coordinated through a single department.	Best practice / organizational efficiency	Organization
Analytics and Data Management	<u>Safety and Trends Reporting</u>. Consider reporting on safety results and trends compared to adopted Safety targets. Consider using the Caltrans Strategic Highway Safety Plan (SHSP) Crash Data Dashboard to access and filter regional crash data, compute safety performance measures for which targets were adopted and show heatmaps for collisions by type to identify "hot spots". <u>Before and After Studies</u>. SANDAG has conducted some before and after studies for some projects (I-15 managed lanes, active transportation) and not for others (I-5 managed lanes). SANDAG has also conducted some before and after studies that were	Triennial Audit Triennial Audit and best practices	Business Process

TPM Element	Options for Implementation	Driver	Change
	not federally mandated, for instance the South Bay Rapid Before and After Study. SANDAG ought to establish a threshold for capital projects for which it will commit to doing before and after studies (e.g., exceeding $100 million, legislative requirements). Conclude the Mid-Coast after study once COVID subsides. <u>Private Data.</u> Continue the exploration and expanded use of multiple private data sources such as INRIX, StreetLight and Replica but make this part of a broader TPM strategy. <u>Simulation Models for Operational Improvements.</u> On a case by case basis, consider using simulation models to estimate benefits arising from operational improvements.	Triennial Audit and enabling enhanced monitoring Enhanced monitoring	
Performance Monitoring and Reporting	<u>Reporting on Additional Monitoring Information.</u> SANDAG should identify the location/home for additional performance monitoring and reporting. Candidate areas include arterial mobility, reliability, safety, environmental and pavement conditions. Candidate homes for the new reporting include (a) State of the Commute Report and (b) Regional Monitoring Report (if performed more frequently). <u>Local Streets Speed Reporting.</u> Consider using a big data solution (e.g., INRIX, StreetLight, etc.) for speed reporting. Will require some training to facilitate skill development. <u>Integrated Pavements Reporting</u>. Consider, over time, to use a common platform such as StreetSaver with all jurisdictions under SANDAG (as MTC does it in the Bay Area). This approach would be facilitated by SANDAG paying for the licenses. The resulting data could be also used for future condition forecasting during the next RTP. <u>Integrated VMT Reporting (and possibly GHG).</u> VMT monitoring is complicated, and it is not feasible to calibrate the SANDAG ABM model every year. The ABM model is used for forecasting VMT, but not on-going monitoring. There are two general approaches	RTP Monitoring and Triennial Audit Triennial Audit Triennial Audit and SB1 State Requirement RTP Monitoring, and	Business Process Business Process Regional Methodology Regional Methodology

TPM Element	Options for Implementation	Driver	Change
	that could be used to monitor VMT for the entire system (highways and arterials): a ***Proxy Approach*** using publicly available traffic volume and VMT data, and a ***Fuel Consumption Approach*** based on fuel consumption data. For performance monitoring of GHG, consider adopting the same GHG estimation methodologies using fuel consumption as the data source: California Air Resources Board. Even though CARB’s methodology will most likely evolve over time to take advantage of emerging data sets (e.g., Replica), adopting CARB’s methodology of relying on fuel consumption data for GHG would result in better alignment and benefit SANDAG.	management emphasis	

6. CONCEPTUAL SCENARIOS

This section contains four conceptual scenarios that illustrate how SANDAG can implement some of the options for implementation discussed in the last section. The scenarios include:

- Scenario 1: VMT and eVMT
- Scenario 2: Safety
- Scenario 3: Pavement
- Scenario 4: Congestion

Each scenario focuses on the methodology employed to carry it out efficiently, demonstrating how performance work program activities, sample tools, workflow assignments and responsibilities, and key decision-making process will be coordinated and carried out under the proposed regional TPM framework.

For each of the conceptual scenarios, SANDAG is working on several fronts beyond what can be captured in a TPM framework to make additional improvements. For instance on safety there is ongoing work with Caltrans related to a safe systems approach, and risk based analysis that is proactive in identifying possible future crash locations.

6.1 VMT AND EVMT

6.1.1 Scenario Context and Description

This scenario corresponds to Option 2.3 in the Implementation Plan (Integrated VMT Reporting).

The need to monitor VMT has become more critical at both the project level and the regional level. With the implementation of Senate Bill 743 (SB 743), increased VMT caused by a project is now a negative impact that must be mitigated for development and roadway projects. At the regional level, SB 375 requires that SANDAG implement strategies to reduce greenhouse gas emissions (GHGs) from passenger vehicles by reducing per capita VMT. The FY2018 *TransNet* Triennial Performance Audit, while not explicitly citing VMT or eVMT, calls for providing regular performance monitoring reports that consider past performance in relation to the *TransNet* goals (e.g., relieving traffic congestion).

Public sector data is not sufficiently available to compute VMT for monitoring and will not likely be available in the future. For example, the California Air Resources Board (CARB) does not currently use Highway Performance Monitoring System (HPMS) data to estimate VMT given perceived weaknesses in that data source.

Private, third-party data aggregators have emerged in recent years and several claim to be able to provide comprehensive VMT monitoring capabilities using a range of crowd-sourced data and volume estimation techniques. Currently, there is no commonly accepted source for accurate VMT estimation from these providers. Until these services are vetted by SANDAG using ground-truth evaluations, this option may remain not available for the near-term.

Until these services are accepted, SANDAG can implement some “proxy” VMT calculation approaches that will be summarized below. This conceptual scenario will provide sample methodologies for developing regional VMT estimates (for both highways and arterials) from a range of data sources. The scenario also presents a proxy approach for estimating eVMT.

6.1.2 Methodology / Approach

For this scenario we propose two general approaches that may be used by SANDAG to estimate VMT:

(1) ***Proxy Approach*** using publicly available traffic volume and VMT data
(2) ***Fuel Consumption Approach*** based on fuel consumption data.

We will also provide a method to estimate the percentage of battery electric vehicle VMT (eVMT) using available data from the California Department of Motor Vehicles (DMV).

Proxy Approach

This approach may not be able to completely capture regional VMT, primarily because of limited arterial data. However, it may be useful to provide percent changes in annual VMT from one year to the next. These percentages potentially could be applied to the most current adopted Regional Transportation Plan (RTP) travel demand model base year VMT to evaluate how VMT is changing over time.

This approach would use three types of data to estimate VMT proxies:

- Caltrans Freeway Performance Measurement System (PeMS)[2]
  - Reports annual VMT on freeways on the State Highway System (SHS) where detection is available.
- Caltrans Traffic Census Program Annual Average Daily Traffic (AADT)[3]
  - Volumes can be used to calculate annual VMT on freeways and other routes on the SHS that do not have PeMS data.
- Arterial Count Data
  - SANDAG has historically reported arterial traffic volumes at select locations[4] and maintains the regional count database[5] that potentially can be utilized to calculate VMT on select corridors to develop arterial VMT growth rates.

The map shown in Exhibit 6-1 shows areas where these data sources and the methods potentially can be applied to estimate VMT. The following sections will detail an approach for using each of these methods.

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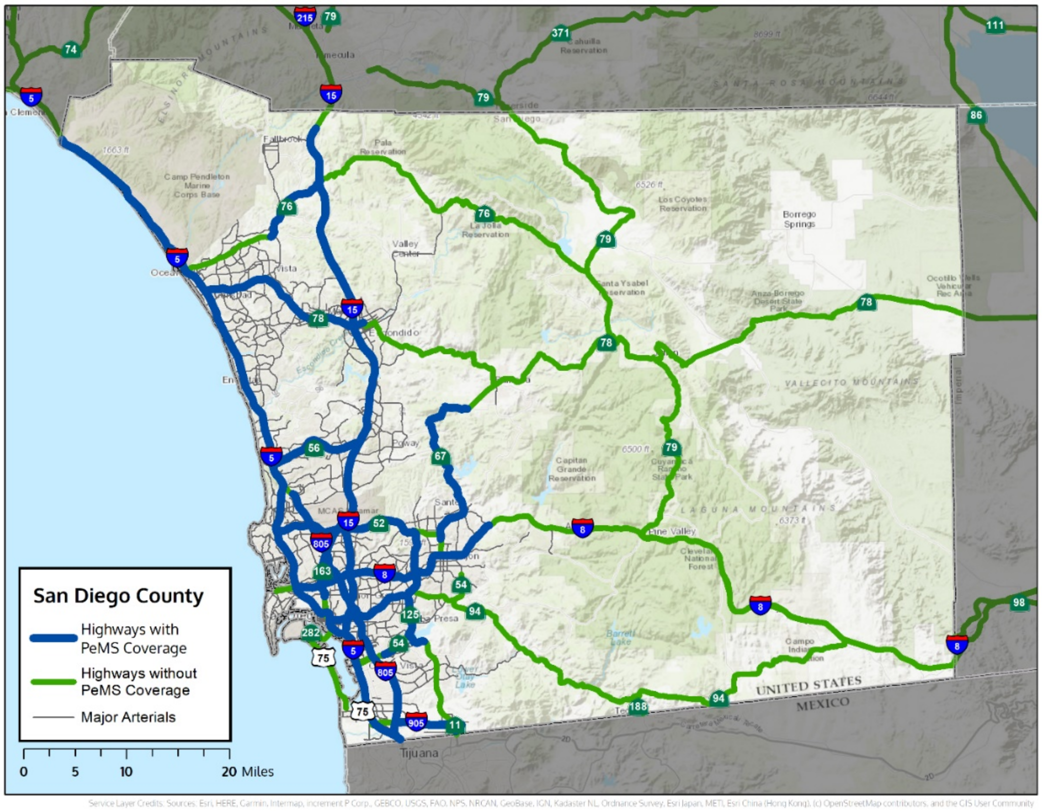
[2] https://pems.dot.ca.gov/
[3] https://dot.ca.gov/programs/traffic-operations/census
[4] https://www.sandag.org/resources/demographics_and_other_data/transportation/adtv/index.asp
[5] https://sandag.public.ms2soft.com/tcds/tsearch.asp?loc=Sandag&mod=TCDS

Exhibit 6-1: Potential Data Sources and Related Roadways



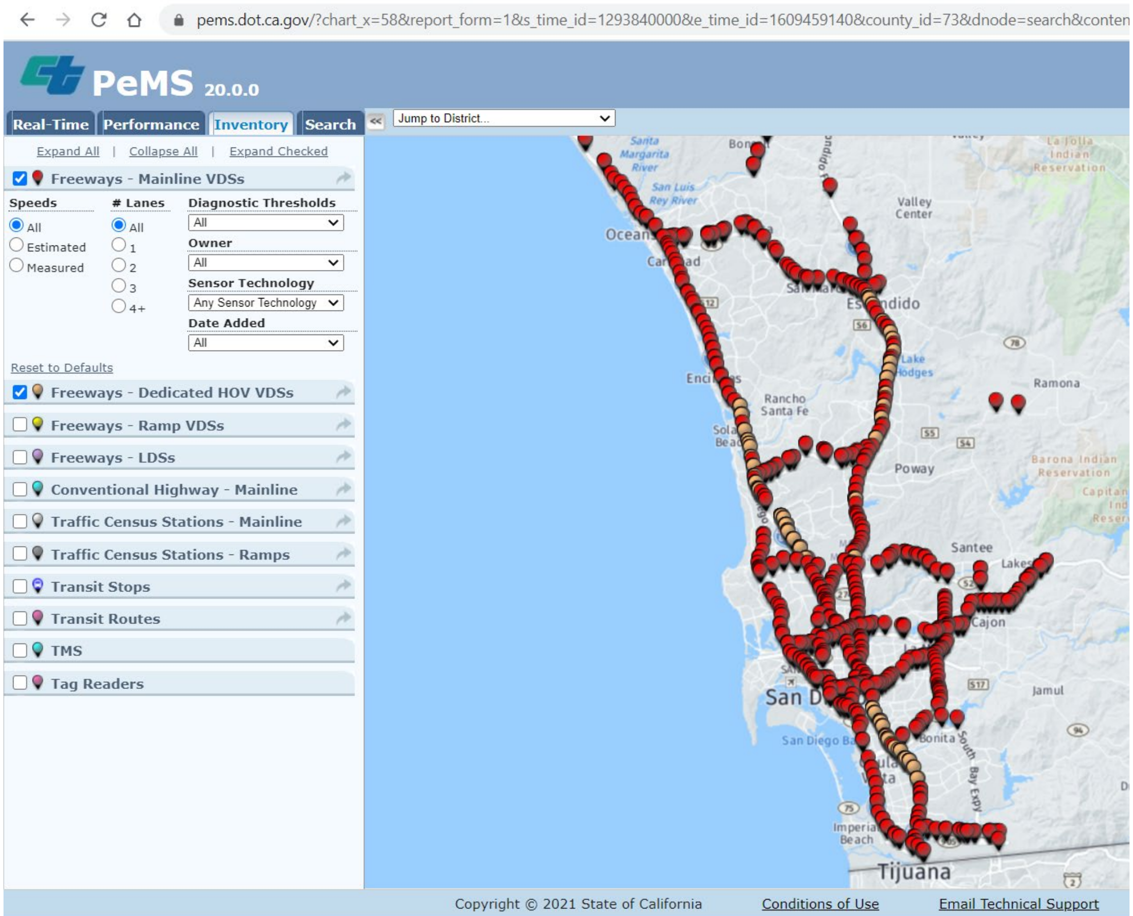
Source: SMG

Caltrans Freeway Performance Measurement System (PeMS)

Caltrans PeMS is the web-based, centralized platform to report Caltrans' real-time and historical traffic data and can report on VMT at the county, city, and corridor level for various time periods where PeMS detection is available. In San Diego County PeMS reports data for nearly 600 miles of freeway along 15 State Highways based on data reported from nearly 4,000 vehicle-detector stations (VDS).

Exhibit 6-2 shows the locations in San Diego County where PeMS has data. Not all freeway locations have detection available, and a limited number of other non-freeway State Highways have detection. For example, over 50 miles of I-8 from the Imperial County line outside of urbanized areas do not have any PeMS-reported data, and the South Bay Expressway Toll Road (SR-125) does not have any PeMS data. For these areas, we propose that Caltrans AADT data can be used to calculate VMT, which will be discussed in the next section.

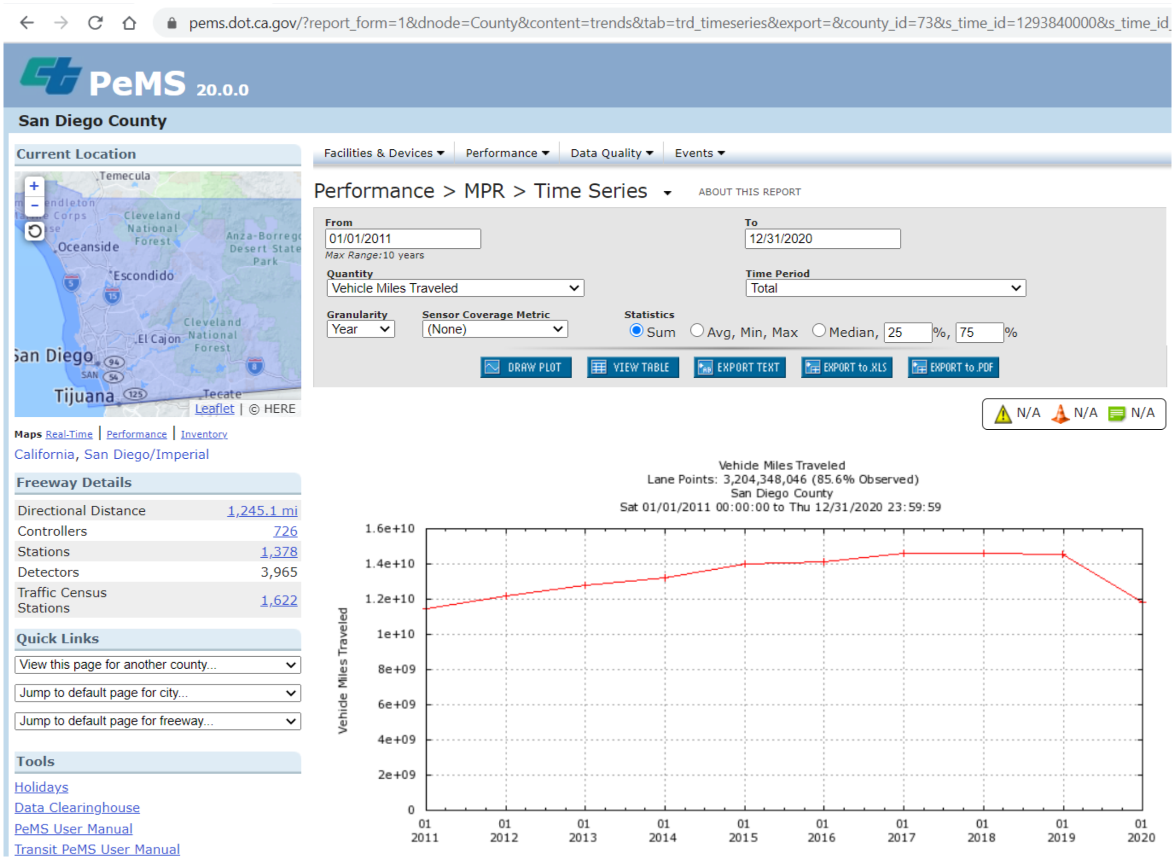
Exhibit 6-2: PeMS Freeway Mainline and HOV Lane Detector Inventory



Source: Caltrans PeMS

However, for the freeways where PeMS does report traffic data, it is relatively easy to obtain annual VMT. Exhibit 6-3 shows the PeMS Mobility Performance Report (MPR) web page that shows a chart of annual 10-year VMT, which can be readily obtained and downloaded to an Excel spreadsheet in a few minutes. Ten years is the maximum range, but data can be tallied for shorter time intervals.

Exhibit 6-3: San Diego County PeMS Reported Annual VMT



Source: Caltrans PeMS

Caltrans Traffic Census Program Annual Average Daily Traffic (AADT)

Should SANDAG desire a more comprehensive estimate of annual VMT on all State Highways, the Caltrans AADT volumes can be used to calculate VMT for those routes that do not have PeMS data available.

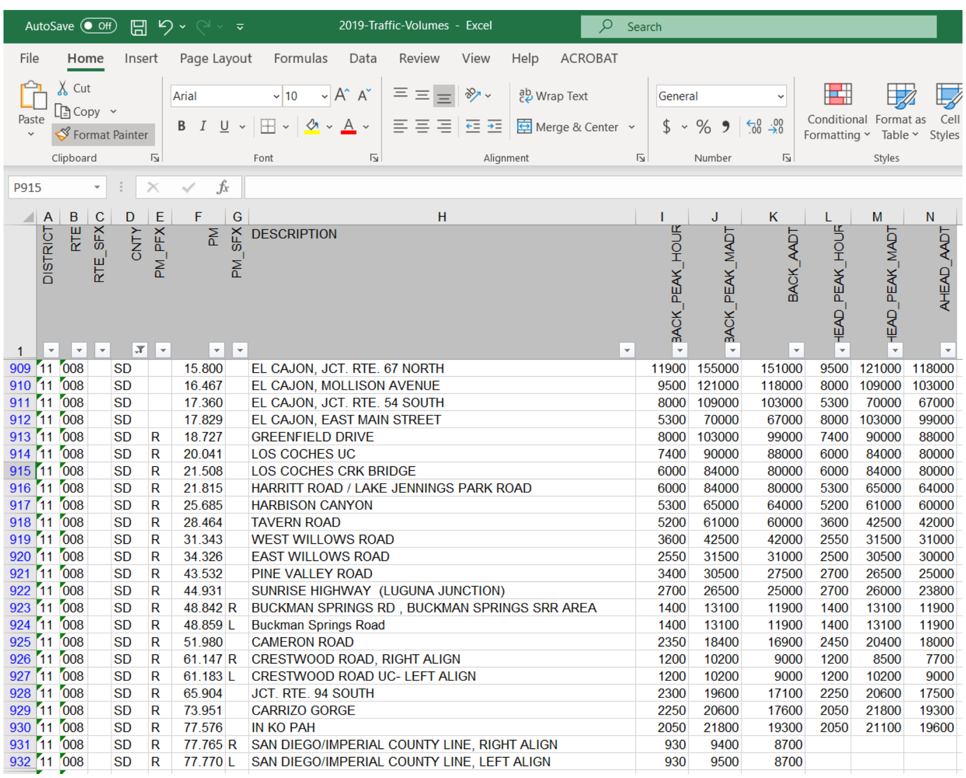
The approach requires manipulation of AADT data to perform this calculation. However, once the approach is developed it can be readily applied to future year data when released by Caltrans. Unlike PeMS, the Caltrans AADT data is only updated periodically, and the dataset typically lags one or two years. For example, as of this memorandum, the most recent Caltrans data available is for the year 2019.

Exhibit 6-4 shows the Caltrans Traffic Census Program landing page where the AADT data can be downloaded in Microsoft Excel format. Exhibit 6-5 shows an example of the 2019 AADT data spreadsheet that illustrates the data available for San Diego County.

Exhibit 6-4: Caltrans Traffic Census Home Page

Source: Caltrans Traffic Census Program: https://dot.ca.gov/programs/traffic-operations/census

Exhibit 6-5: Caltrans AADT Data Spreadsheet



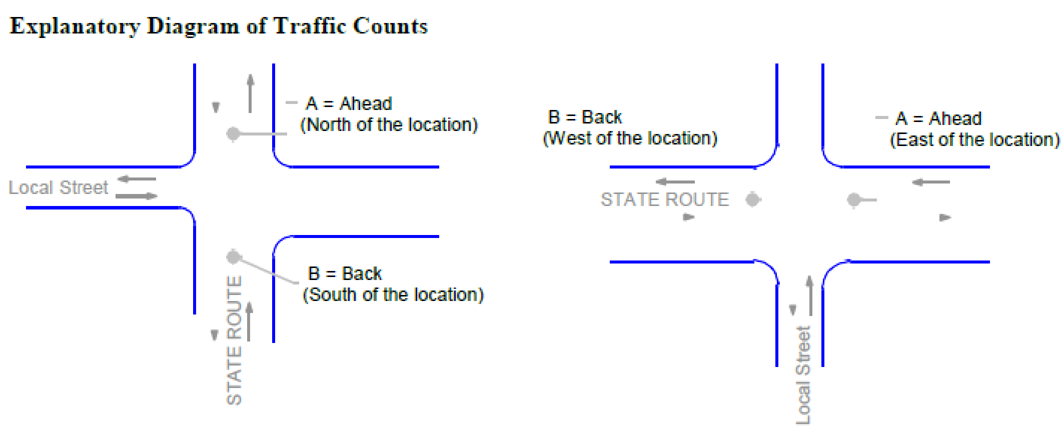
	DISTRICT	RTE	RTE_SFX	CNTY	PM_PFX	PM	PM_SFX	DESCRIPTION	BACK_PEAK_HOUR	BACK_PEAK_MADT	BACK_AADT	HEAD_PEAK_HOUR	HEAD_PEAK_MADT	AHEAD_AADT
909	11	008		SD		15.800		EL CAJON, JCT. RTE. 67 NORTH	11900	155000	151000	9500	121000	118000
910	11	008		SD		16.467		EL CAJON, MOLLISON AVENUE	9500	121000	118000	8000	109000	103000
911	11	008		SD		17.360		EL CAJON, JCT. RTE. 54 SOUTH	8000	109000	103000	5300	70000	67000
912	11	008		SD		17.829		EL CAJON, EAST MAIN STREET	5300	70000	67000	8000	103000	99000
913	11	008		SD	R	18.727		GREENFIELD DRIVE	8000	103000	99000	7400	90000	88000
914	11	008		SD	R	20.041		LOS COCHES UC	7400	90000	88000	6000	84000	80000
915	11	008		SD	R	21.508		LOS COCHES CRK BRIDGE	6000	84000	80000	6000	84000	80000
916	11	008		SD	R	21.815		HARRITT ROAD / LAKE JENNINGS PARK ROAD	6000	84000	80000	5300	65000	64000
917	11	008		SD	R	25.685		HARBISON CANYON	5300	65000	64000	5200	61000	60000
918	11	008		SD	R	28.464		TAVERN ROAD	5200	61000	60000	3600	42500	42000
919	11	008		SD	R	31.343		WEST WILLOWS ROAD	3600	42500	42000	2550	31500	31000
920	11	008		SD	R	34.326		EAST WILLOWS ROAD	2550	31500	31000	2500	30500	30000
921	11	008		SD	R	43.532		PINE VALLEY ROAD	3400	30500	27500	2700	26500	25000
922	11	008		SD	R	44.931		SUNRISE HIGHWAY (LUGUNA JUNCTION)	2700	26500	25000	2700	26000	23800
923	11	008		SD	R	48.842	R	BUCKMAN SPRINGS RD , BUCKMAN SPRINGS SRR AREA	1400	13100	11900	1400	13100	11900
924	11	008		SD	R	48.859	L	Buckman Springs Road	1400	13100	11900	1400	13100	11900
925	11	008		SD	R	51.980		CAMERON ROAD	2350	18400	16900	2450	20400	18000
926	11	008		SD	R	61.147	R	CRESTWOOD ROAD, RIGHT ALIGN	1200	10200	9000	1200	8500	7700
927	11	008		SD	R	61.183	L	CRESTWOOD ROAD UC- LEFT ALIGN	1200	10200	9000	1200	10200	9000
928	11	008		SD	R	65.904		JCT. RTE. 94 SOUTH	2300	19600	17100	2250	20600	17500
929	11	008		SD	R	73.951		CARRIZO GORGE	2250	20600	17600	2050	21800	19300
930	11	008		SD	R	77.576		IN KO PAH	2050	21800	19300	2050	21100	19600
931	11	008		SD	R	77.765	R	SAN DIEGO/IMPERIAL COUNTY LINE, RIGHT ALIGN	930	9400	8700			
932	11	008		SD	R	77.770	L	SAN DIEGO/IMPERIAL COUNTY LINE, LEFT ALIGN	930	9500	8700			

Source: Caltrans Traffic Census Program Website

Once this data is downloaded the spreadsheet can be used to calculate annual VMT for each State Highway. It is important to only use this approach for routes without PeMS detector coverage otherwise VMT will be double-counted.

Caltrans uses “Back” and “Ahead” nomenclature to indicate where the volumes are being counted relative to the intersection or interchange as illustrated in the diagram in Exhibit 6. The Caltrans postmiling system typically ascends in the northbound direction and the eastbound direction. As illustrated in Exhibit 6-6, the “Back” counts are those that “look back toward” the previous count location (i.e., descending postmile) from the current count location. The “Ahead” counts are the volumes in ascending postmile toward the next count location on the roadway. Total annual AADT according to Caltrans is AADT multiplied by 365 days.

Exhibit 6-6: “Back” and “Ahead” Counts Diagram



Source: Caltrans Division of Traffic Operations

Exhibit 6-7 illustrates how to perform the VMT calculation using the Caltrans AADT spreadsheet with added columns for back and ahead distances as well as for back and ahead daily VMTs. The exhibit also describes what formulas should be present in the columns to calculate annual VMT.

The “Back” AADT is assumed to be constant from the current count location to ½ the distance toward the previous count location (this distance is sometime referred to as the “effective distance”). The “Ahead” AADT from that previous location will apply to ½ the distance to the current count location so that the entire distance is covered.

Once back and ahead distances are calculated by using the postmiles in the spreadsheet, the daily back and ahead VMTs can be calculated using the respective AADT multiplied by the appropriate distance (i.e., VMT = AADT x Distance). The sum of the two count VMT calculations is the total daily VMT, and the total annual VMT is the total daily VMT multiplied by 365 days.

Exhibit 6-7: How to Calculate Annual VMT Using Caltrans AADT Data

Back Distance = ½ distance from current count location/postmile to previous count location/postmile

Ahead Distance = ½ distance from current count location/postmile to next count location/postmile

Back Daily VMT = BACK_AADT x Back Distance

Ahead Daily VMT = AHEAD_AADT x Ahead Distance

Total Daily VMT = Back Daily VMT + Ahead Daily VMT

Total Annual VMT = Total Daily VMT x 365 days

	DISTRICT	RTE	RTE_SFX	CNTY	PM_PFX	PM	PM_SFX	DESCRIPTION	BACK_PEAK_HOUR	BACK_PEAK_MADT	BACK_AADT	AHEAD_PEAK_HOUR	AHEAD_PEAK_MADT	AHEAD_AADT	BACK DISTANCE (miles)	AHEAD DISTANCE (miles)	BACK DAILY VMT	AHEAD DAILY VMT	TOTAL DAILY VMT	TOTAL ANNUAL VMT
917	11	008		SD	R	25.685		HARBISON CANYON	5300	65000	64000	5200	61000	60000	1.9	1.4	123,840	83,370	207,210	75,631,650
918	11	008		SD	R	28.464		TAVERN ROAD	5200	61000	60000	3600	42500	42000	1.4	1.4	83,370	60,459	143,829	52,497,585
919	11	008		SD	R	31.343		WEST WILLOWS ROAD	3600	42500	42000	2550	31500	31000	1.4	1.5	60,459	46,237	106,696	38,943,858
920	11	008		SD	R	34.326		EAST WILLOWS ROAD	2550	31500	31000	2500	30500	30000	1.5	4.6	46,237	138,090	184,327	67,279,173
921	11	008		SD	R	43.532		PINE VALLEY ROAD	3400	30500	27500	2700	26500	25000	4.6	0.7	126,583	17,488	144,070	52,585,550
922	11	008		SD	R	44.931		SUNRISE HIGHWAY (LUGUNA JUNCTION)	2700	26500	25000	2700	26000	23800	0.7	2.0	17,488	46,541	64,028	23,370,366

Source: SMG Analysis of Caltrans Traffic Census data

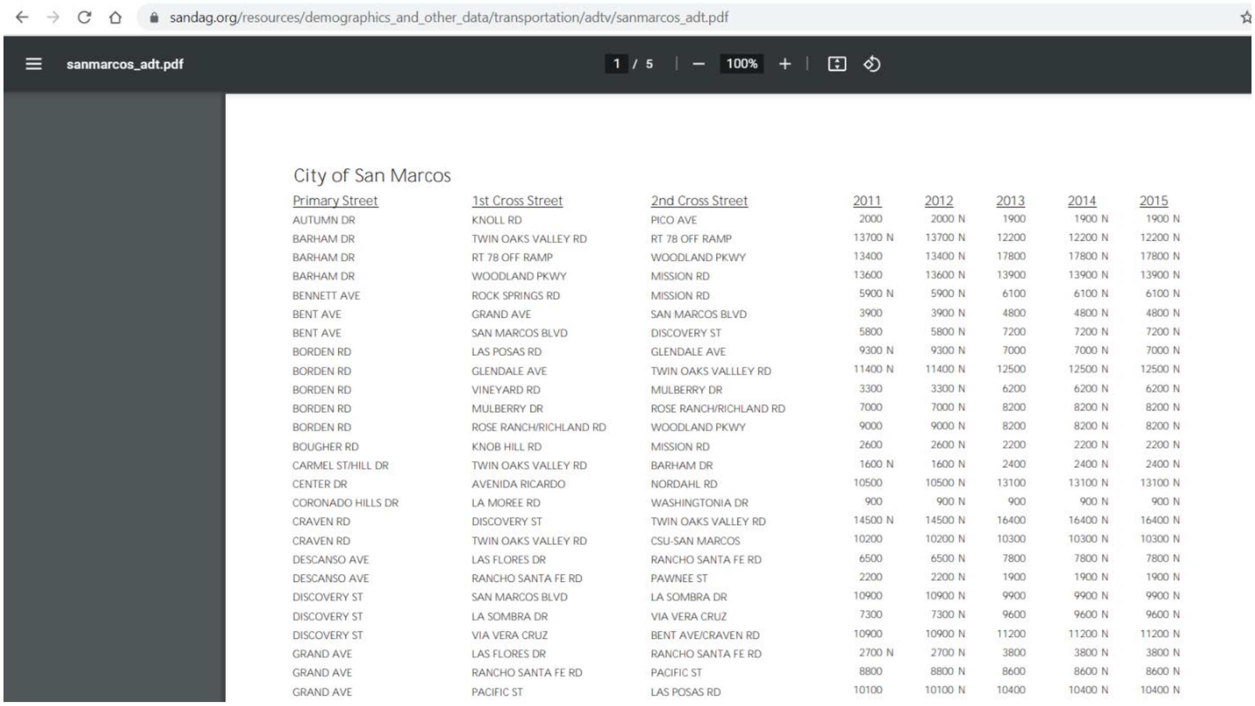
Using the combination of PeMS VMT and Caltrans AADT estimated VMTs will provide an estimate for all State Highways. This method does not require extensive expertise in data analysis, but can be performed by SANDAG staff Microsoft Excel. There is some skill required to download and access the data, but the analyst should have a basic understanding of PeMS and its features and be comfortable navigating and using Excel spreadsheets, including the use of Excel formulas.

Arterial Count Data

As described above, SANDAG has historically reported arterial traffic volumes at select locations by jurisdiction as illustrated in Exhibit 6-8, and SANDAG also maintains the regional count database shown in Exhibit 6-9.

These two sources do not appear to have recently collected data, but these could potentially be leveraged to provide VMT estimates for select locations or corridors. This section highlights an approach that has been implemented by the Los Angeles County Metropolitan Transportation Authority (Metro) that could potentially be applied in the SANDAG region.

Exhibit 6-8: SANDAG Local Jurisdictions Average Traffic Volumes

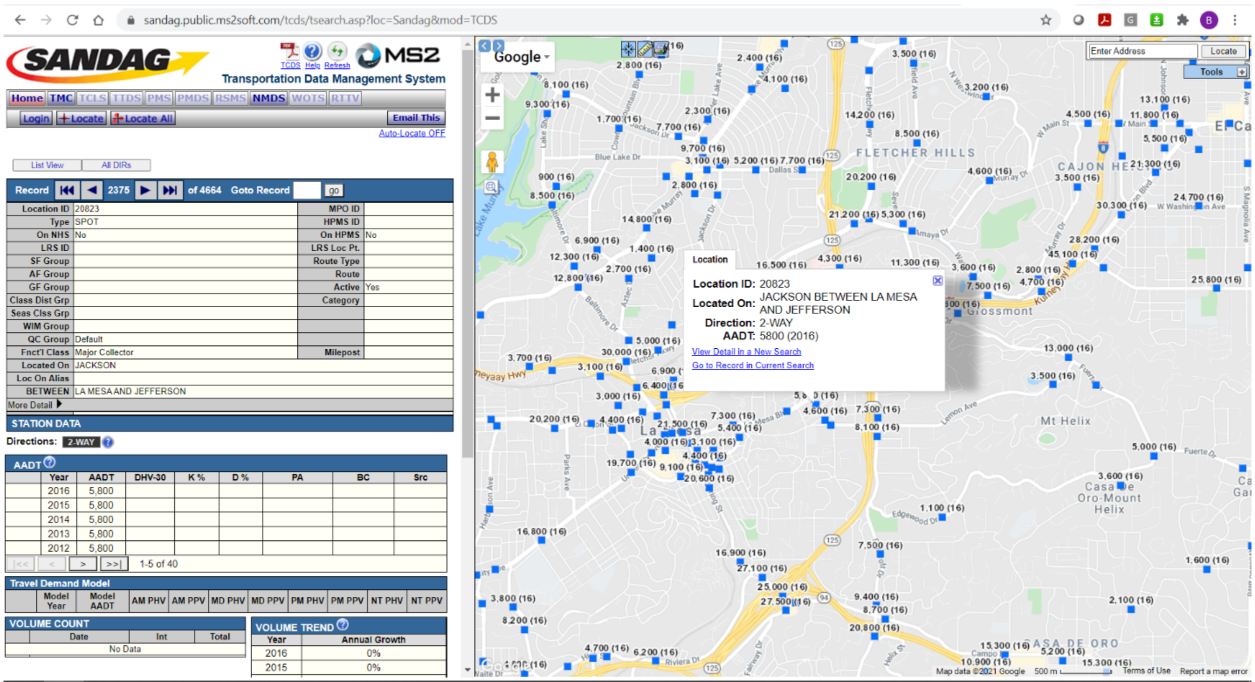


City of San Marcos

Primary Street	1st Cross Street	2nd Cross Street	2011	2012	2013	2014	2015
AUTUMN DR	KNOLL RD	PICO AVE	2000	2000 N	1900	1900 N	1900 N
BARHAM DR	TWIN OAKS VALLEY RD	RT 78 OFF RAMP	13700 N	13700 N	12200	12200 N	12200 N
BARHAM DR	RT 78 OFF RAMP	WOODLAND PKWY	13400	13400 N	17800	17800 N	17800 N
BARHAM DR	WOODLAND PKWY	MISSION RD	13600	13600 N	13900	13900 N	13900 N
BENNETT AVE	ROCK SPRINGS RD	MISSION RD	5900 N	5900 N	6100	6100 N	6100 N
BENT AVE	GRAND AVE	SAN MARCOS BLVD	3900	3900 N	4800	4800 N	4800 N
BENT AVE	SAN MARCOS BLVD	DISCOVERY ST	5800	5800 N	7200	7200 N	7200 N
BORDEN RD	LAS POSAS RD	GLENDALE AVE	9300 N	9300 N	7000	7000 N	7000 N
BORDEN RD	GLENDALE AVE	TWIN OAKS VALLLEY RD	11400 N	11400 N	12500	12500 N	12500 N
BORDEN RD	VINEYARD RD	MULBERRY DR	3300	3300 N	6200	6200 N	6200 N
BORDEN RD	MULBERRY DR	ROSE RANCH/RICHLAND RD	7000	7000 N	8200	8200 N	8200 N
BORDEN RD	ROSE RANCH/RICHLAND RD	WOODLAND PKWY	9000	9000 N	8200	8200 N	8200 N
BOUGHER RD	KNOB HILL RD	MISSION RD	2600	2600 N	2200	2200 N	2200 N
CARMEL ST/HILL DR	TWIN OAKS VALLEY RD	BARHAM DR	1600 N	1600 N	2400	2400 N	2400 N
CENTER DR	AVENIDA RICARDO	NORDAHL RD	10500	10500 N	13100	13100 N	13100 N
CORONADO HILLS DR	LA MOREE RD	WASHINGTONIA DR	900	900 N	900	900 N	900 N
CRAVEN RD	DISCOVERY ST	TWIN OAKS VALLEY RD	14500 N	14500 N	16400	16400 N	16400 N
CRAVEN RD	TWIN OAKS VALLEY RD	CSU-SAN MARCOS	10200	10200 N	10300	10300 N	10300 N
DESCANSO AVE	LAS FLORES DR	RANCHO SANTA FE RD	6500	6500 N	7800	7800 N	7800 N
DESCANSO AVE	RANCHO SANTA FE RD	PAWNEE ST	2200	2200 N	1900	1900 N	1900 N
DISCOVERY ST	SAN MARCOS BLVD	LA SOMBRA DR	10900	10900 N	9900	9900 N	9900 N
DISCOVERY ST	LA SOMBRA DR	VIA VERA CRUZ	7300	7300 N	9600	9600 N	9600 N
DISCOVERY ST	VIA VERA CRUZ	BENT AVE/CRAVEN RD	10900	10900 N	11200	11200 N	11200 N
GRAND AVE	LAS FLORES DR	RANCHO SANTA FE RD	2700 N	2700 N	3800	3800 N	3800 N
GRAND AVE	RANCHO SANTA FE RD	PACIFIC ST	8800	8800 N	8600	8600 N	8600 N
GRAND AVE	PACIFIC ST	LAS POSAS RD	10100	10100 N	10400	10400 N	10400 N

Source: SANDAG

Exhibit 6-9: SANDAG Regional Count Database



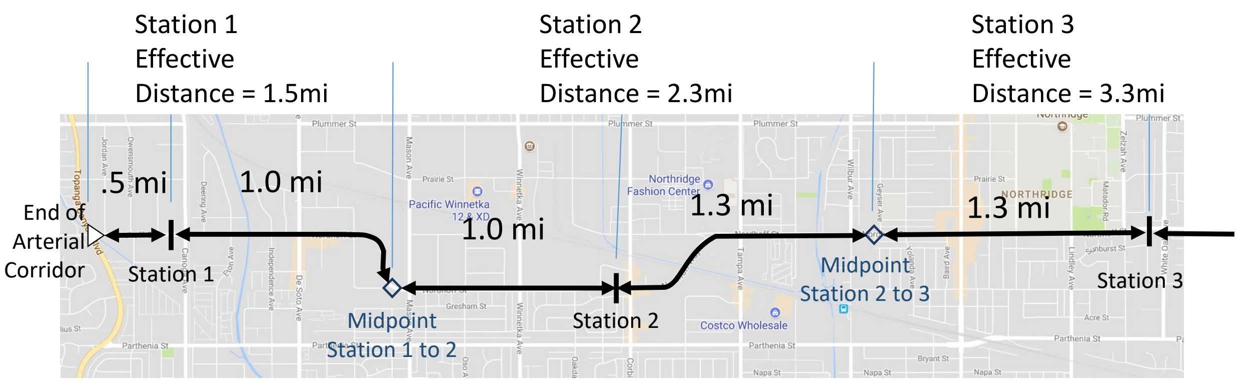
Source: SANDAG Regional Count Database

Ideally, this approach would be performed along several key arterial corridors with traffic volume data that is collected during the same year and season. For example, if Jackson Avenue in La Mesa is used as an analysis corridor (shown in Exhibit 6-9 above), all the count locations along that corridor (e.g., the Location ID 20623 in Exhibit 6-9 above) should have data collected during the same year and season for consistency. This way an arterial performance measurement program could be implemented to monitor corridor-level performance over time.

If this is not feasible given the resource intensiveness of collecting data along several corridors, SANDAG may opt to routinely collect traffic volume data at select locations throughout the region. These locations should be selected to represent a range of arterial classifications and geographies. In its simplest application, the volume data collected from these locations can be assumed to represent the same distance traveled and can be summed to arrive at a total volume. The percent difference between the current year of data collection and the prior year of data collection can be calculated and used to represent the change in arterial demand.

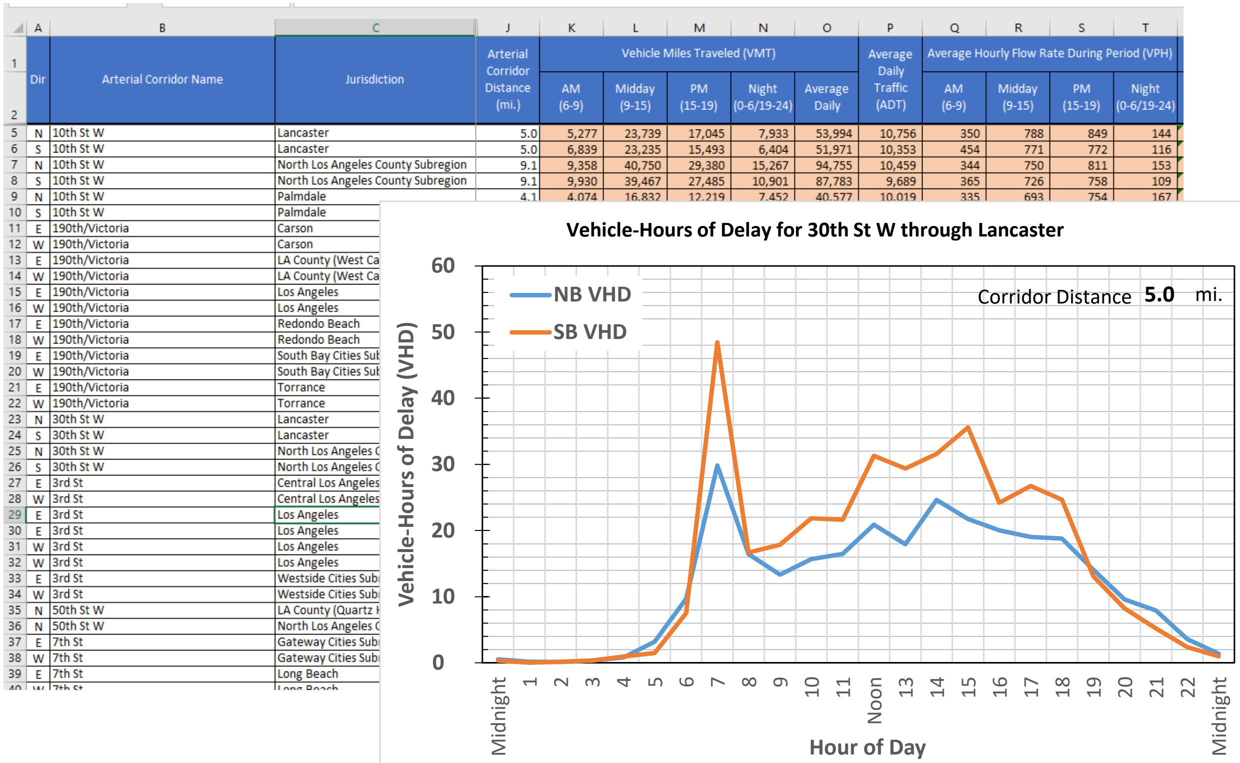
If the corridor approach is used, the VMT estimation method is similar to the approach described above to estimate SHS VMT using Caltrans AADT data. In this case, SANDAG would have to identify the corridors and the count locations to be used and calculate the distance between adjacent count locations as illustrated in Exhibit 6-10. This distance would likely have to be manually measured using GIS tools or web-based tools such as Google Maps. As with Caltrans AADT, the VMT can be calculated once the volume is known from each count station.

Exhibit 6-10: Calculating "Effective Distance" Between Arterial Count Stations



The Los Angeles Metropolitan Transportation Authority (Metro) developed an arterial performance measurement tool for all primary arterials in the county that used this approach to estimate VMT along major arterial corridors in the county. That tool also incorporated third-party speed data to develop a wide range of performance measures beyond VMT (See Scenario 4 discussion of congestion monitoring for an example). Exhibit 6-11, illustrates the tool and shows an example arterial congestion performance measure that was derived by fusing traffic count data with third party speed data.

Exhibit 6-11: Arterial Performance Measurement Tool Example



Source: Los Angeles Metropolitan Transportation Authority (Metro) MeasureUp! Program

Estimating arterial VMT is more resource intensive than estimating VMT from PeMS or by using Caltrans AADT data and requires an understanding of sampling and how to develop linked tools. For example, developing the arterial performance measurement tool for Metro required conducting field data counts at hundreds of arterial locations throughout the county. Given that SANDAG already has a tool to compile and store count data, that resource can be used to provide data for arterial performance measurement.

Fuel Consumption Approach

This approach uses two data sources to derive VMT estimates from fuel sale data for conventional, combustion fueled vehicles:

- CARB EMFAC 2021. v1.0.1 emissions inventory county-level fuel consumption and VMT estimates for gasoline- and diesel-powered vehicles[6]
- California Department of Energy Annual Retail Fuel Outlet Report (CEC-A15)[7] gasoline and diesel fuel sold in San Diego County

This approach will rely on the eVMT estimation approach discussed below to estimate total county VMT. This approach will not be able to account for VMT from natural gas vehicles, but those vehicles account

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[6] https://arb.ca.gov/emfac/

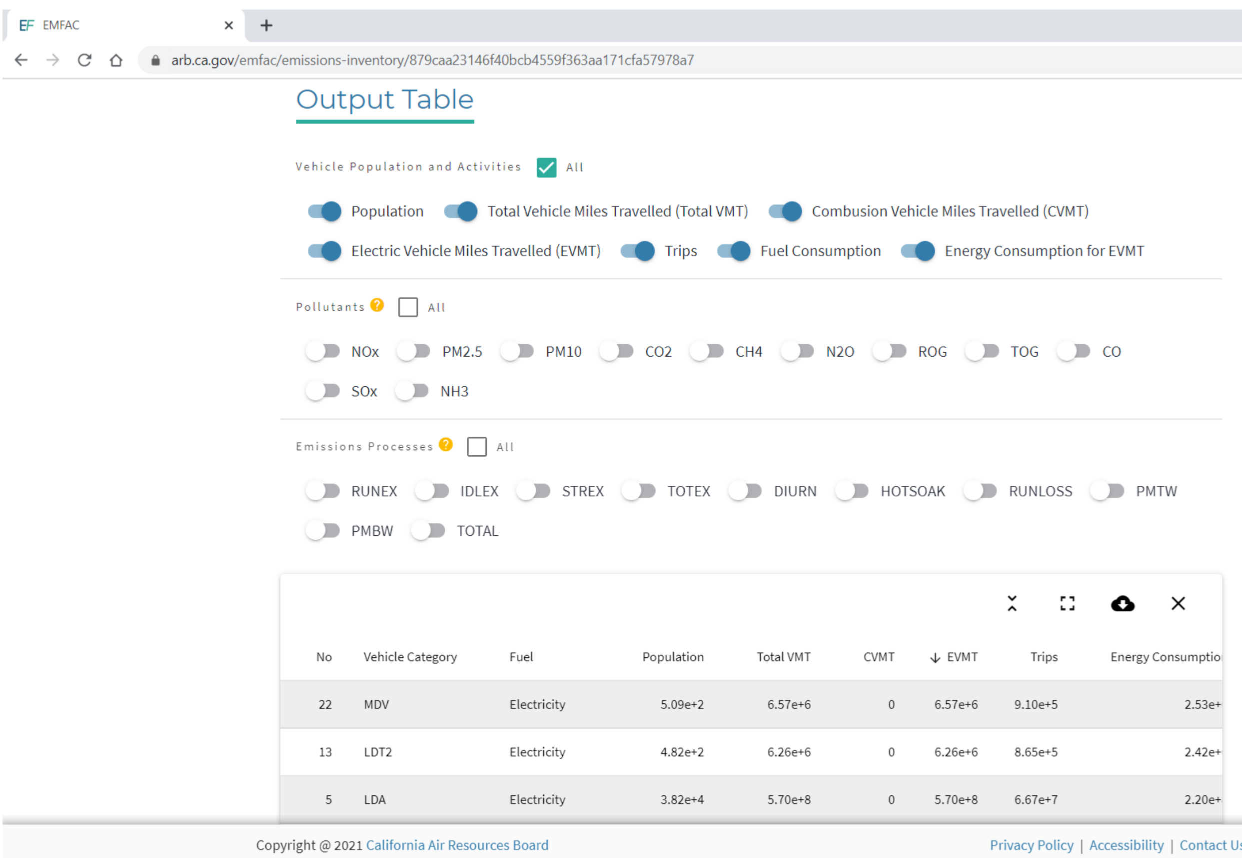
[7] https://www.energy.ca.gov/data-reports/energy-almanac/transportation-energy/california-retail-fuel-outlet-annual-reporting

for around 0.2% of all county VMT according to the CARB EMFAC database. This estimation approach can be used for interim years

Exhibit 6-12 shows an output table from the 2021 emissions inventory. This table was developed by selecting the following parameters:

- Output = Onroad Emissions
- Model Version = EMFAC2021 v1.0.0
- Region Type = County
- Region = San Diego
- Calendar Year = 2021
- Season = Annual
- Vehicle Category = EMFAC202x (All vehicle types selected)
- Model Year = Aggregate
- Speed = Aggregate
- Fuel = All fuel types selected
- Output Unit = tons/year.

Exhibit 6-12: CARB EMFAC 2021 Emissions Inventory



Source: CARB EMFAC - https://arb.ca.gov/emfac/emissions-inventory

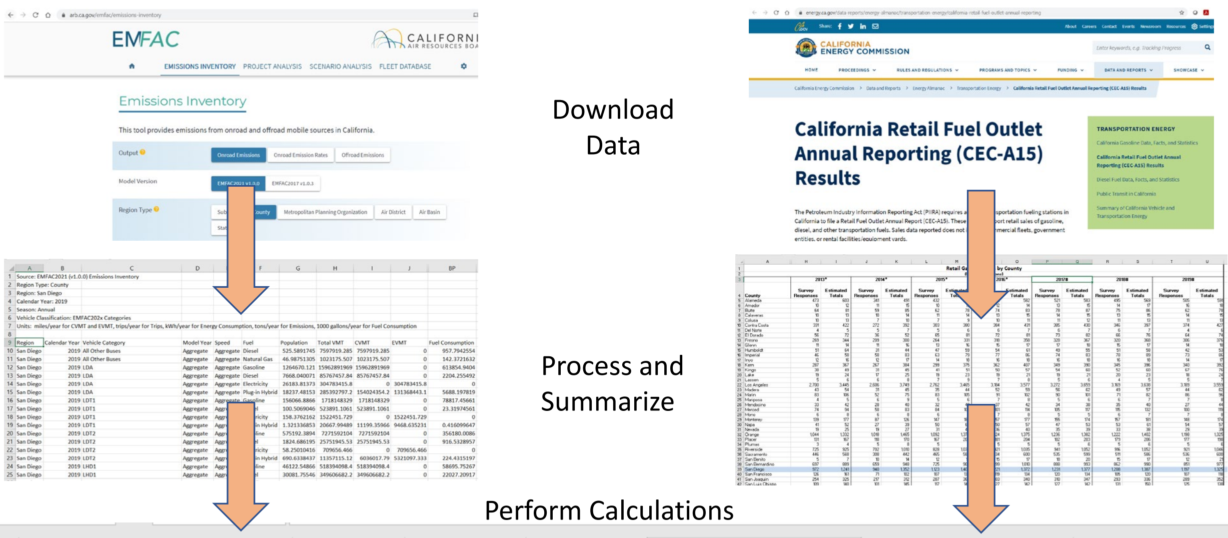
The outputs from this table can be exported to a comma delimited text file that can be processed in Microsoft Excel. The key outputs from this table are combustion vehicle miles traveled (CVMT) and fuel consumption. These two outputs will be summed by fuel type (e.g., Diesel, Gasoline, Plug-In Hybrid

Electric Vehicles or PHEVs) to get average fuel economies in miles per gallon. This approach will be summarized below.

The California Department of Energy Annual Retail Fuel Outlet Report (CEC-A15) provides an estimate of gallons of diesel and gasoline sold by county. This estimate is based on a survey of major fuel distributors in the state, which is adjusted to arrive at an annual total gallons of fuel sold. The CEC-A15 reported gallons will be used directly for this analysis.

Exhibit 6-13 summarizes how the diesel and gasoline VMT estimates can be developed from the two sources. Once downloaded from EMFAC and the Department of Energy, the data can be aggregated as needed to summarize key data items. In this example, shown at the bottom of the exhibit, the Excel pivot table feature was used to summarize the EMFAC CVMT and fuel consumption estimates to calculate fuel economies in miles per gallon. The blue-colored cells in the graphic also show the calculations that are performed in this illustrative analysis.

Exhibit 6-13: Diesel and Gasoline Vehicle VMT Estimate



	A	B	C	D	E	F	G
1	Row Labels	Sum of Fuel Consumption	Sum of CVMT	Sum of Total VMT	Fuel Economy - Miles per Gallon (mpg) Column D/Column B/1000	Gallons Sold Annual Retail Fuel Outlet Report (CEC-A15)	Estimated VMT Column E * Column F
2	Diesel	171,086	1,495,733,348	1,495,733,348	8.7	110,000,000	961,682,162
3	Electricity	0	0	307,060,109	n/a		
4	Gasoline	1,405,601	30,159,194,660	30,159,194,660	21.5		
5	Natural Gas	9,697	48,084,154	48,084,154	5.0		
6	Plug-in Hybrid	6,259	169,290,955	313,839,169	50.1		
7	**Grand Total**	**1,592,643**	**31,872,303,116**	**32,323,911,440**	20.3		
8	Total Gasoline Fueled Consumption (1000s of Gallons) and VMT Row 4 + Row 6	1,411,860	30,328,485,614	31,968,767,177	22.6	1,325,000,000	30,001,999,125
9						**TOTAL ANNUAL VMT**	**30,963,681,287**

Since plug-in hybrids also burn gasoline a new row (row number 8) was put in the spreadsheet that adds hybrid and conventional gasoline powered vehicle CVMT and fuel consumed.

The first column to the right of the pivot table in column “E” is used to calculate fuel economies in miles per gallon, which are total CVMT divided by annual fuel consumption divided by 1000 to convert to gallons. The CEC-A15 annual gallons multiplied by 1,000,000 to convert to the correct units sold can be directly entered into column “F” in the table in the appropriate row. The estimate VMT is the gallons sold multiplied by the fuel economy.

In this example for year 2019, the estimated VMT is 30.96 million. As can be seen in the exhibit, this is around 4% below the CARB annual total VMT estimate of 32 million in 2019. A review of the Caltrans Highway Performance Monitoring System (HPMS) VMT for San Diego County indicates that this method produces an estimate that is 2.7% higher than the HPMS VMT estimate.

This method is relatively easy to apply. With minimal training and a working knowledge of Microsoft Excel and its features, relatively junior level staff can apply this method.

eVMT Estimation

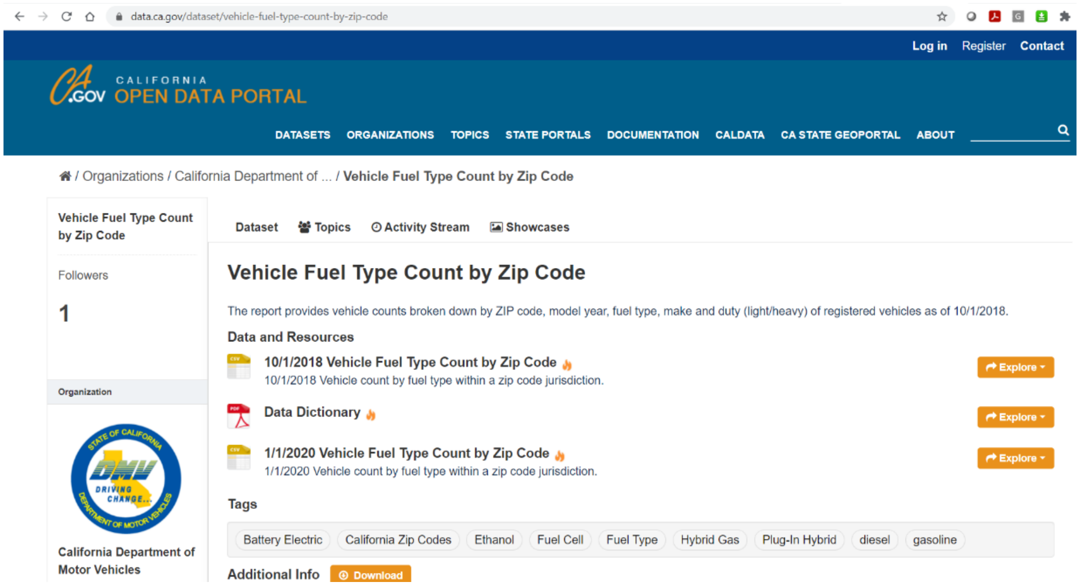
The latest CARB EMFAC emissions inventory described in the previous section reports county, MPO, and sub-area eVMT as illustrated above in Exhibit 6-13 However, if SANDAG wants to perform on-going monitoring of eVMT between updates of EMFAC, California vehicle registration data is available online from the California Open Data Portal.[8] This data produces results that are comparable with the CARB estimates. The California Department of Motor Vehicles (DMV) zip code level vehicle registrations are available by fuel type. Exhibit 6-14 shows the DMV data set landing page.

SANDAG uses a California Department of Motor Vehicles (DMV)/ California Energy Commission (CEC) data portal for EV vehicle numbers including total registrations by county and new Zero Emission Vehicle (ZEV) sales by county (one can also sort by MSA and zip code). This portal provides numbers on vehicles and infrastructure but not on eVMT--so it could be considered complementary information.

One approach to estimate eVMT is by aggregating VMT from the SANDAG ABM2+ travel demand model to the zip code level. Then calculate the percentage of ZEVs in that zip code to total vehicle registrations in that zip code. The total zip code VMT is then multiplied by the percentage of battery electric vehicles in the zip code to get the eVMT at the zip code level. The zip code eVMT can then be summed to get the county-level eVMT estimate. ZEVs include battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs) and plug-in hybrid vehicles (PHEVs). Though FCEVs are minimal in percentage currently, those numbers could scale up significantly in coming years.

[8] https://data.ca.gov/

Exhibit 6-14: California Open Data Portal Vehicle Registrations by Fuel Type by Zip Code

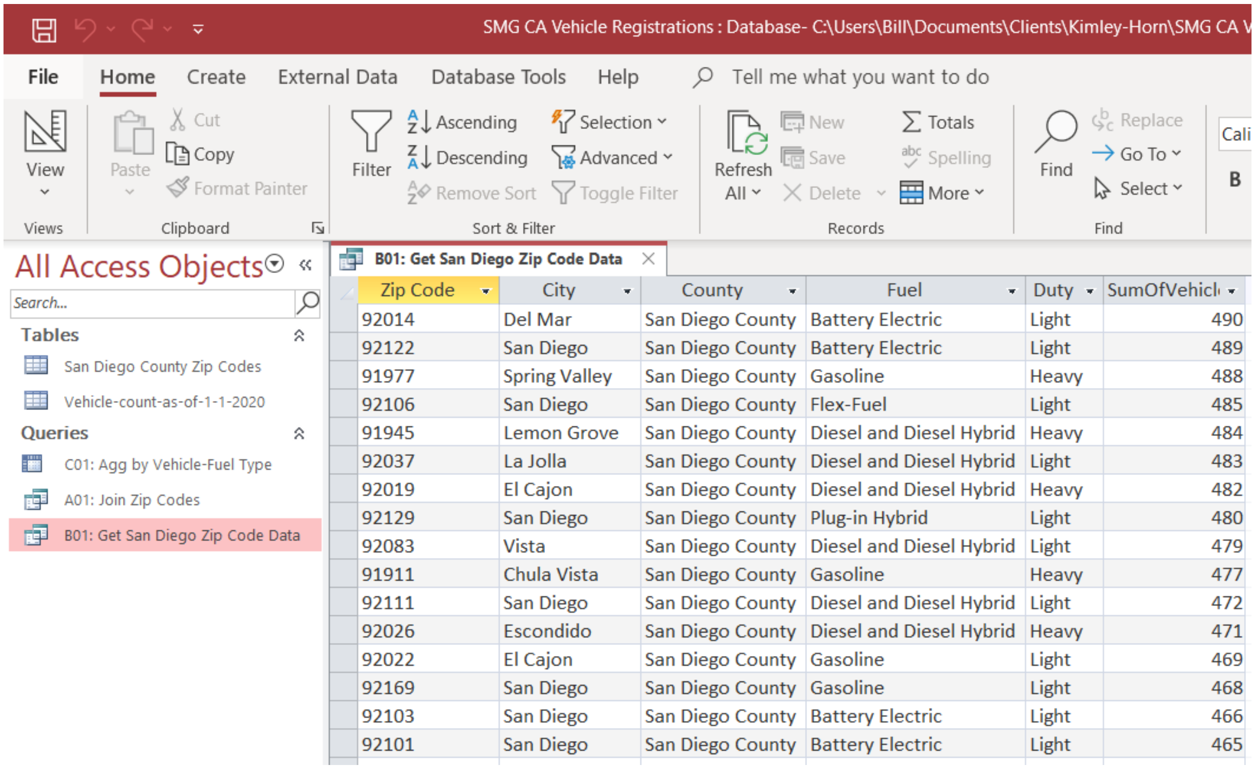


Source: California Open Data Portal-https://data.ca.gov/dataset/vehicle-fuel-type-count-by-zip-code

The statewide dataset has over 600,000 records, so it may be best manipulated using a database tool. Exhibit 6-15 illustrates how this can be done using Microsoft Access. Exhibit 6-16 summarizes countywide total vehicle registrations by vehicle category and fuel type. This table shows that in 2019 countywide, ZEVs represented around 1% of all vehicle registrations with gasoline powered vehicles representing over 86%.

However, some zip codes have higher percentages of e-vehicles registered relative to other zip codes, and if these zip codes also generate higher total VMT than other zip codes, then the percentage of eVMT may be higher than the 1% represented by vehicle registration data (for reference EMFAC estimated that 2019 eVMT was 1.4%).

Exhibit 6-15: Illustrative San Diego Vehicle Registrations by Fuel Type Database



Zip Code	City	County	Fuel	Duty	SumOfVehicl
92014	Del Mar	San Diego County	Battery Electric	Light	490
92122	San Diego	San Diego County	Battery Electric	Light	489
91977	Spring Valley	San Diego County	Gasoline	Heavy	488
92106	San Diego	San Diego County	Flex-Fuel	Light	485
91945	Lemon Grove	San Diego County	Diesel and Diesel Hybrid	Heavy	484
92037	La Jolla	San Diego County	Diesel and Diesel Hybrid	Light	483
92019	El Cajon	San Diego County	Diesel and Diesel Hybrid	Heavy	482
92129	San Diego	San Diego County	Plug-in Hybrid	Light	480
92083	Vista	San Diego County	Diesel and Diesel Hybrid	Light	479
91911	Chula Vista	San Diego County	Gasoline	Heavy	477
92111	San Diego	San Diego County	Diesel and Diesel Hybrid	Light	472
92026	Escondido	San Diego County	Diesel and Diesel Hybrid	Heavy	471
92022	El Cajon	San Diego County	Gasoline	Light	469
92169	San Diego	San Diego County	Gasoline	Light	468
92103	San Diego	San Diego County	Battery Electric	Light	466
92101	San Diego	San Diego County	Battery Electric	Light	465

Source: SMG Analysis of DMV Vehicle Registration Data

Exhibit 6-16: San Diego County Total Vehicle Registrations by Fuel Type and Vehicle Type (2019)

Fuel	Heavy	Light	Total by Fuel Type	% of Total by Fuel Type
Battery Electric	1,531	305,272	306,803	1.0%
Diesel and Diesel Hybrid	693,441	577,045	1,270,486	4.1%
Flex-Fuel	30,495	1,226,797	1,257,292	4.0%
Gasoline	295,136	26,690,183	26,985,319	86.4%
Hybrid Gasoline		1,123,090	1,123,090	3.6%
Hydrogen Fuel Cell		6,648	6,648	0.0%
Natural Gas	17,211	11,885	29,096	0.1%
Other	2,746	3,121	5,867	0.0%
Plug-in Hybrid		248,388	248,388	0.8%
Total by Vehicle Type	1,040,560	30,192,429	31,232,989	100.0%

Source: SMG Analysis of DMV Vehicle Registration Data

6.1.3 Workflow Assignments

Within SANDAG, effort related to VMT and eVMT monitoring is most likely to involve one of, or a combination of, the following current organizational units:

- Data and Modeling
- Research and Program Management

As with the other conceptual scenarios, since SANDAG does not currently consistently monitor VMT or eVMT, the agency first needs to make the policy decision about developing this function. The responsibility for taking on the new VMT/eVMT monitoring and reporting could theoretically be assigned to a new resource within any of these departments. Perhaps the most logical approach however is to establish a new coordinator (most likely a senior planner) with Research and Program Management to drive the new process. This would not be a full-time position, but this person would be expected to produce annual monitoring reports. Support from the Data and Modeling team would be expected.

Another key input in the decision making for this new process is the decision on how which and how many arterials to conduct the VMT/eVMT monitoring efforts.

6.1.4 Other Implementation Factors

Depending on the approach used to estimate VMT and eVMT there may be few initial costs other than staff training (if needed for database applications) and staff resources to set up the tools (e.g., spreadsheets, databases, downloading data). Most of the data described above is free and publicly available. For estimating arterial VMT, SANDAG may need to fund traffic counts at select locations on primary arterial corridors. Some count data may be available from local jurisdictions that contribute data to the SANDAG regional traffic count database.

The arterial VMT approach would also involve developing a spreadsheet or database tool to store the count data and calculate VMT.

Should SANDAG decide to conduct field counts, the cost for a 72-hour continuous traffic count (i.e., 3 days for 24 hours per day) cost approximately $150-$200 per location. If counts are conducted every one or two miles along a corridor, then the data collection cost for a 10-mile arterial corridor could range between $600 and $2,000 (for between 4 and 9 count locations).

The recurring costs would involve replicating the same steps and procedures developed as part of the initial costs. In addition, if SANDAG were to update the arterial count data, cost $600-$2,000 per 10-miles of arterial centerline mile.

6.2 SAFETY

6.2.1 Scenario Context and Description

This scenario corresponds to Option 2.4 in the Implementation Plan (Safety and Trends Reporting).

Capturing performance outcome data related to safety metrics was a key recommendation from the 2018 *TransNet* Triennial Performance Audit. The report highlights considering using heatmaps to identify where the majority or significant severity accidents occur and work with Caltrans and local jurisdictions to inform solutions and future projects. The Transportation Performance Management (TPM) Framework Implementation Plan also identifies Safety and Trends Reporting as a recommended set of actions. The intent is to report trends in collisions as compared to adopted Safety targets.

This safety scenario provides SANDAG with examples to evaluate safety on corridors through crash data analysis and serves as an implementation guide to regularly report regional safety statistics. The two approaches discussed in this scenario are examples of how existing accessible safety data can be used to influence decision making and establish goals and metrics for future safety improvements. Following consultation with SANDAG staff, this safety scenario is focused on two categories:

- **Active transportation.** This includes pedestrians and bicyclists.
- **Complete streets.** Caltrans defines complete streets as “a transportation facility that is planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit vehicles, truckers, and motorists, appropriate to the function and context of the facility. Every complete street looks different, according to its context, community preferences, the types of road users, and their needs.”

Additional safety statistics can be evaluated using the tools and data processes outlined below.

6.2.2 Methodology / Approach

Using the Caltrans SHSP Crash Data Dashboard

The Caltrans Strategic Highway Safety Plan (SHSP) Crash Data Dashboard provides traffic safety professionals and partners with direct access to statewide crash data to support the data-driven implementation of the SHSP and coordinated safety programs. SANDAG will gather collision data from the Caltrans SHSP Crash Data Dashboard (https://shsp.dot.ca.gov/dashboard) in November or at the time when the next full year of collision data (FARS[9]/SWITRS[10]) is considered final. Fatal and serious injury collision data for pedestrians and bicyclists within the SANDAG region will be filtered using this

[9] FARS – Fatality Analysis Reporting System *FARS is a nationwide census providing NHTSA, Congress and the American public yearly data regarding fatal injuries suffered in motor vehicle traffic crashes.*
[10] SWITRS – Statewide Integrated Traffic Records System (CA) *The Statewide Integrated Traffic Records System (SWITRS) is a database that serves as a means to collect and process data gathered from a collision scene.*

dashboard and include information related to type of collision, cause of collision, and other key factors which can be used to understood corridor safety needs.

As detailed in **Attachment A,** using the Data Dashboard to access relevant crash data within the jurisdiction of the MPO can produce useful visuals and build the foundation for evaluating transportation improvements to further enhance pedestrian and bicycle safety. The data accessed on the SHSP Crash Data Dashboard is provided as a direct representation of SWITRS data. Although Caltrans strives for the most accurate geocoded locations, they cannot guarantee all coordinates are correct. Agencies accessing data should always review downloaded data based on specific analysis needs.

Using the Data Dashboard has the following key benefits:

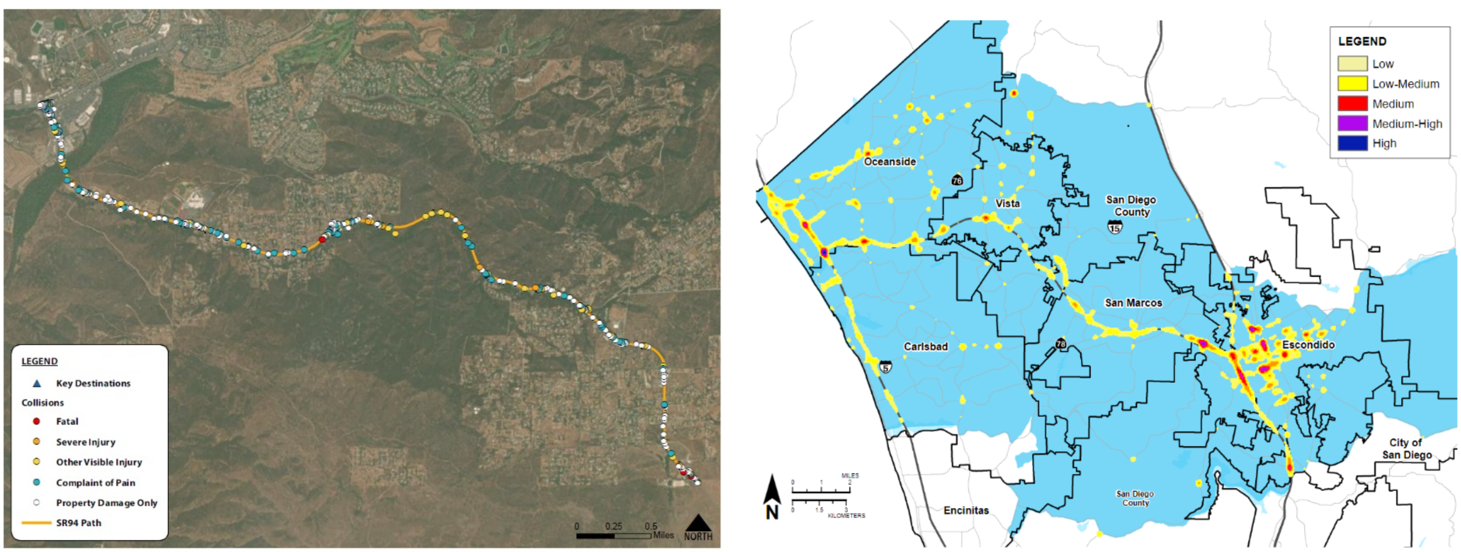
Quality Control
- Quickly access updated crash data statistics, organized and quality-controlled by Caltrans

Data Consolidation
- The dashboard provides a unified data set, consolidating data from statewide and federal collision databases

SHSP Alignment
- Using the Data Dashboard provides alignment with SHSP efforts and data consistency

In addition, the Data Dashboard provides intuitive and useful filtering options to efficiently answer safety-related questions with data. As an example, data downloaded from the SHSP Crash Data Dashboard could be used to make useful collision visuals and heatmaps similar to the examples below, created for a study along the SR 94 corridor in the SANDAG region.

Exhibit 6-17: Collision Data Mapped by Collision Severity and Heatmap Example

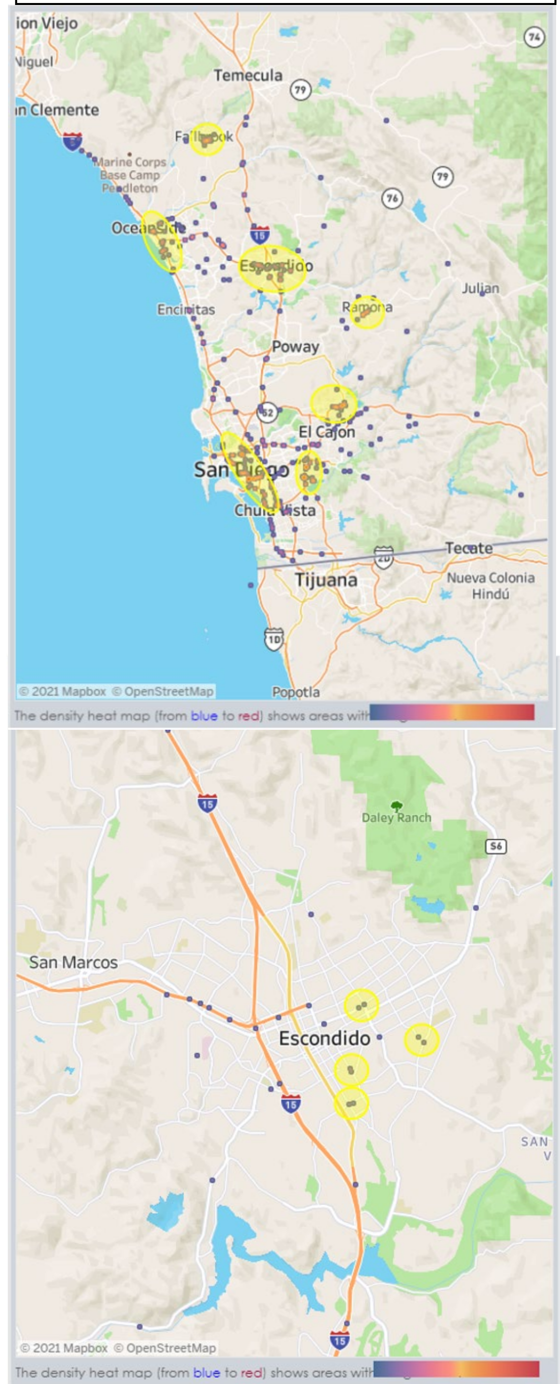


Active Transportation

This is a high-level approach to evaluating safety of active transportation users including pedestrians and bicyclists. This approach will begin with developing a methodology to gather data inputs, followed by a process of when and how to monitor and measure changes annually. The metrics against which this data will be compared will come from SANDAG goals related to the 2021 Regional Plan for pedestrian and bicyclist safety. This approach will ensure that SANDAG is consistently monitoring the performance of regional safety metrics against the goals set within SD Forward. This approach prioritizes evaluating total, fatal, and serious injury collisions with pedestrians and bicyclists on the SANDAG transportation network.

An example process of using the Data Dashboard to analyze regional collision data to inform regional planning decisions is outlined below.

Exhibit 6-18: Data Dashboard Example



Process Overview

1. **Downloading Data:**
    a. As detailed in "Workflow Assignments", SANDAG should annually download and review regional collision data
2. **Determining Regional Hotspots:**
    a. Understanding collisions at a Regional Level, SANDAG can identify hotspots for collisions
        i. *Shown at right are regional collisions involving pedestrians*
        ii. *The highlighted areas represent the informal identification of regional pedestrian collision hotspot*
        iii. *Data shown are collisions classified in the "Pedestrians" Challenge Area, years 2014 – 2018, in the SANDAG jurisdiction*
3. **Determining Local Hotspots:**
    a. Using the tool to limit collisions to specific jurisdictions, SANDAG can then work with member cities to address collision hot spots related to pedestrians
        i. Shown at right are pedestrian collisions in Escondido
        ii. The highlighted areas represent the informal identification of local pedestrian collision hotspots
4. **Additional Analysis:**
    a. Once a focus area is determined, SANDAG can download the filtered data and produce additional analysis, graphics, and heatmaps to determine potential improvements
5. **Planning for Improvements:**
    a. Whether through long term regional planning, local planning efforts, or quick build "tactical urbanism" type of improvements, site-specific enhancements can then be designed, piloted, and implemented to enhance pedestrian safety.

Complete Streets

According to SANDAG, "complete streets are streets designed and operated to enable safe access for all users… traveling by all modes, including walking, biking, using public transit, and driving cars or commercial vehicles". For safety analysis based on historical crash data, it is important to note that the evaluation of safety for complete streets cannot be conducted by comparing collision statistics for collision types or causes of collisions. Complete Streets safety should be analyzed by evaluating the rate and severity of collisions for multimodal users on corridors with and without infrastructure to identify if the dedicated space for these modes provides higher levels of safety.

In the future, this concept could evolve to Complete Corridors to align with the 2021 Regional Plan.

Process Overview

Utilizing SANDAG's GIS data from SANGIS, SANDAG should create a base map of infrastructure data for alternative modes of transportation including bicycle facilities (by type), pedestrian facilities (i.e. sidewalks, trails, crossings), and transit stops (i.e., bus stops, BRT stops, transit centers). With these layers and the existing roadway network, the entire existing transportation network will be visible. This map will also highlight complete streets and multimodal corridors. All collision data for the study period will be collected, making sure the fields for type of collision, those involved in the collision, and the cause of collision are included. SANDAG should geospatially map this data as well.

For the first two categories (pedestrian and bicycle), compare the rate at which those collisions happen on corridors/at intersections with dedicated facilities compared to those without. Proceed with further analysis to compare the rate of collision for the type of dedicated facility to see if, in addition to recommending new dedicated facilities, recommending a higher level of separation would be prudent.

For the transit category, identify the total number of collisions (all types) that occur near transit stations and transit infrastructure. Analyzing the causes of these collisions will help SANDAG understand how transit infrastructure influences safety on multimodal corridors. Detailed step-by-step analysis guidance for the steps outlined above is provided in **Attachment B.**

The ideas above represent a baseline for Complete Streets safety analysis. Should SANDAG develop and maintain the multimodal infrastructure base map, additional analysis opportunities are available and can be efficiently completed.

6.2.3 Workflow Assignments

With the current SANDAG staff organization, effort related to safety data collection, analysis, and responsive regional planning is conducted by four main departments:

- Regional Planning
- Integrated Transportation Planning
- Research and Program Management
- Data and Modeling

The responsibility for taking on the new safety monitoring and reporting could be deputized to a new resource within any of these departments, but most logically with Research and Program Management (this would be an incremental position, additional to current staffing levels). This department now includes the State of the Commute, Passenger Counting, performance monitoring, and original data collection (e.g., surveys).

Alternatively, as part of the 2021 *TransNet* Triennial Performance Audit, SANDAG is considering designating a Safety Coordinator to "synchronize safety efforts of the region and develop a regional safety plan with regular communication on safety progress."

If this new position of a Safety Coordinator is established, this role will have the primary responsibility of ensuring that the findings of regularly updated safety data analysis are incorporated into short and long-term regional planning efforts. The Safety Coordinator would coordinate with SANDAG departments and external agencies to collect data and anecdotal evidence as necessary and monitor changes. It is assumed the role of the Safety Coordinator would be a full-time position in the Research and Program Management department, reporting to the director. Additional coordination will be needed to facilitate data exchanges.

The Safety Coordinator should have the following key responsibilities:

- Coordination with:
  - Data and Modeling team to produce maps and visuals
  - Regional Planning team to ensure the Regional Plan is responsive to safety needs and trends identified in data analysis
  - Contracts and Grants team for grant application efforts related to safety
  - Member jurisdictions and local tribes to support safety-related grant efforts, local improvements, and data analysis
- Develop and publish annual progress reports
- Report relevant findings to and receive feedback from member jurisdictions via committees and working groups including, but not limited to, the following:
  - San Diego Regional Traffic Engineers Council
  - Cities/County Transportation Advisory Committee
  - Transnet Independent Taxpayer Oversight Committee
  - Regional Planning Technical Working Group
  - Active Transportation Working group
  - Regional Planning Committee
  - Transportation Committee
  - Board of Directors

6.2.4 Other Implementation Factors

In addition to staff considerations outlined in **Workflow Assignments**, SANDAG should consider the following implementation factors.

Utilization of the Caltrans SHSP Data Dashboard

Caltrans is prioritizing the publication of clean, consolidated collision data for statewide use. This product is expected to be continuously maintained, improved, and available free of charge to Caltrans partners, including SANDAG, for the foreseeable future. There are not expected to be any licensing/use fees.

Initial GIS and Analysis Costs

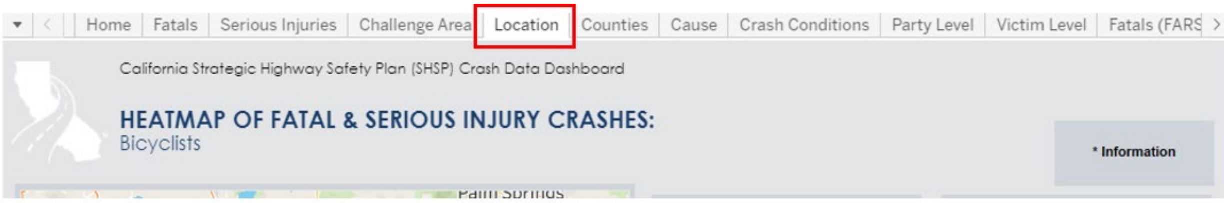
In addition to the annual time commitments outlined previously, there will be an initial cost and time factor to develop the base map that will include the necessary data for evaluation. Although collision data should be evaluated for a time-range of a three-year period minimum, with a five-year range recommended, updates to this evaluation process should occur annually.

Maintaining existing licenses to GIS software like ArcGIS Pro/additional Esri-based GIS tools will be critical for continued analysis. SANDAG should also consider the costs and time required for the continued maintenance and regular updating of a transportation infrastructure database (SANGIS). To further improve safety analysis capabilities and keep pace with increased performance monitoring and infrastructure inventory capabilities, SANDAG should also allocate time and costs, annually, to adding data to existing databases.

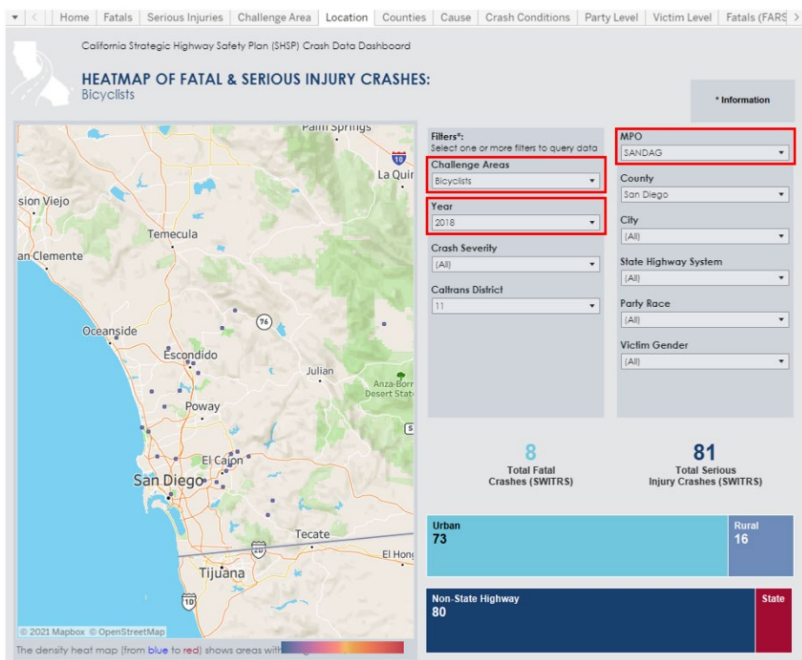
Attachment A: Data Dashboard Downloads

Data Dashboard Download Steps:

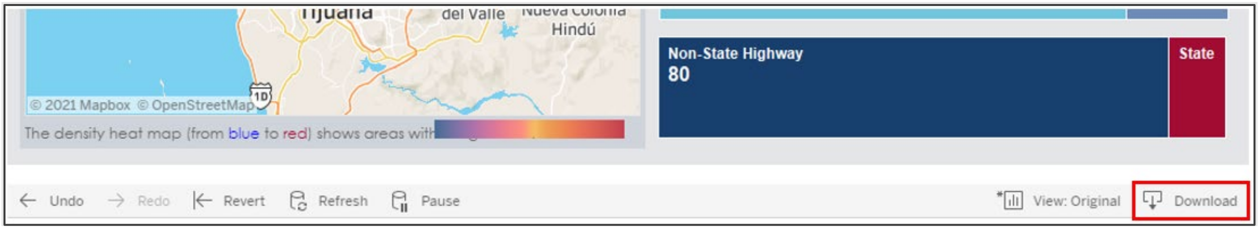
1. Firstly, register and create a login for the Data Dashboard
2. Select the “Location” tab in the menu of tabs running along the top of the window.

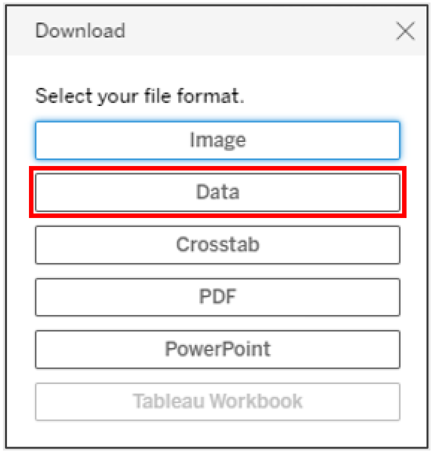


3. Select the following filters within the “Location” tab:
   a. Desired Challenge Area (Pedestrians or Bicyclists).
   b. Select the most recent complete year.
      i. *At the time this implementation guide was drafted, the most recent available data was 2018.*
   c. Select “SANDAG” as the MPO
   d. Select additional filters as needed for analysis.
      i. *Crash Severity, City, State Highway System, Party Race, Victim Gender.*



4. Download the location data for internal use and analysis.
   a. At the bottom of the window, select the “Download” button, then select the “Data” option.





5. Data can then be downloaded in CSV format. Each row represents one collision and has the columns “Latitude” and “Longitude” allowing each collision to be mapped and analyzed using GIS software.

Attachment B: Complete Streets Data Download

Expanding on the **Complete Streets** section, this appendix outlines steps needed to compile the base map of complete streets infrastructure and ideas of initial analysis. The following data will need to be collected to continue the analysis.

From SANGIS:

- Bike Routes (BIKE_ROUTES.zip)
- All Roads (Roads_All.zip)
- Intersections (Roads_Intersection.zip)
- Transit Routes and Stops (Transit_Routes_GTFS.zip & Transit_Stops_GTFS.zip)

From Local Jurisdictions/Additional Databases:

- Pedestrian Infrastructure
  - *Sidewalks, crosswalks, trails, multi-use pathways.*

Bicycle:

1. Identify the number of bicycle accidents that occur on corridors without bicycle facilities.
   a. Data Process:
      i. *Create a 50' buffer on Bike Routes (filter by classification to remove "Other Suggested Route" – roadways must have a Class I – IV bikeway).*
      ii. *Join the crash data to the buffered bike routes and continue analysis with rows (collisions) that are not captured within the join.*
2. Identify the number of bicycle accidents that occur on corridors with bicycle facilities.
   a. Additional Step: Breakdown by facility type to understand the level of separation from other modes of transportation.
   b. Data Process:
      i. *Join the crash data to the buffered bike routes and continue analysis with rows (collisions) that are captured within the join.*
3. Identify the number of bicycle accidents that occur at intersections.
   a. Additional Step: Breakdown by the presence/lack of signage or markings through the intersection to designate bicycle movements.
   b. Data Process:
      i. *Create a 50' buffer on Intersections*
      ii. *Join the crash data to the buffered bike routes and continue analysis with rows (collisions) that are captured within the join.*

Pedestrian:

4. Identify the number of pedestrian accidents that occur on corridors without pedestrian facilities.
   a. Data Process:
      i. *Create a 50' buffer on existing pedestrian facilities*
      ii. *Join the crash data to the buffered pedestrian facilities and continue analysis with rows (collisions) that are not captured within the join.*
5. Identify the number of pedestrian accidents that occur on corridors with pedestrian facilities.
   a. Data Process:
      i. *Create a 50' buffer on existing pedestrian facilities*
      ii. *Join the crash data to the buffered pedestrian facilities and continue analysis with rows (collisions) that are captured within the join.*

Transit:

6. Identify the number of all accident types that occur with a 250' radius of a transit facility.
    a. Data Process:
        i. *Create a 250' buffer on existing transit stops/stations*
        ii. *Join the crash data to the buffered transit facilities and continue analysis with rows (collisions) that are captured within the join.*

6.3 PAVEMENT PRESERVATION

6.3.1 Scenario Context and Description

This scenario corresponds to Option 2.2 in the Implementation Plan (Integrated Pavement Reporting).

The FY2018 *TransNet* Triennial Performance Audit recommended capturing performance outcome data related to pavement condition for highways and local roadways. This conceptual scenario addresses pavement preservation with an emphasis on local roads, since roadway preservation is already managed by the California Department of Transportation (Caltrans).

Roadway preservation can be divided into State Highway System (SHS) facilities (owned and operated largely by Caltrans) and local roads (owned and operated by cities and the county of San Diego). For the SHS, Caltrans maintains a pavement management system and reports roadway conditions biannually as required by Senate Bill 1 (SB-1). Hence, SANDAG can retrieve the county-specific information from Caltrans as a means of monitoring the SHS.

For the county and cities, it is more complicated. The agencies often use different pavement management systems to store their roadway information and optimize future expenditures. As a result, it may be resource intensive for SANDAG to collect information from different agencies in different formats and use the information for monitoring purposes. Although the California Transportation Commission (CTC) reports on local roadway conditions, it does not provide specific roadway conditions. For instance, if SANDAG wants to develop a map of conditions of individual local roadways, the CTC report will not be useful. Moreover, SANDAG cannot perform a regional analysis of needs versus available funding, since it currently does not maintain a regional pavement management system.

This may be important since SB-1 provides flexibility in using funding for local roadways once its stated performance target is achieved. The performance measure used is the Pavement Management Index (PCI). If the target of 80 PCI is achieved, the funding can be used for other purposes.

Specifically, SB-1 states that: "*A city or county may spend its apportionment of funds under the program on transportation priorities other than those allowable pursuant to this chapter if the city's or county's average Pavement Condition Index meets or exceeds 80."*[11]

The rest of this section discusses the proposed methodology for SANDAG to start monitoring and eventually conduct scenario planning for local roadway conditions using a regional pavement management system.

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[11] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1

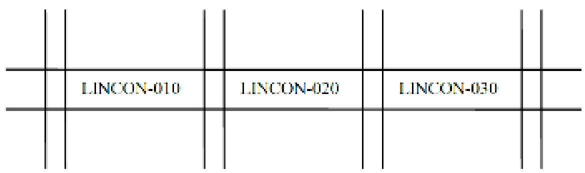
6.3.2 Methodology / Approach

Pavement Management System Features

At a high level, roadways are divided in sections as shown in Exhibit 6-19. For each section, conditions are recorded based on visual inspection or cameras on vehicles traversing the roadways. This is done periodically (e.g., every two years) depending on available resources and other priorities. The database of conditions can then report on average PCI, and in many cases, report PCIs on a section by section basis.

Pavement Management Systems can then project the conditions under different expenditure scenarios through simulation. They can also provide the optimal expenditures (i.e., where to invest to improve roadway conditions to get the best return on investments). Some agencies choose to follow some of these optimal expenditures and others, due to other considerations) change the profile for investing to address other needs (e.g., political or other factors). Regardless, at the beginning of funding cycles, cities and the county have a preservation plan for their roadways. In fact, many of the organizations that are eligible for SB-1 funding use these outputs to submit funding requests to the CTC.

Exhibit 6-19: Roadway Segmentation Example



Street ID	Section ID
LINCON	010
LINCON	020
LINCON	030
etc.	

PCI conditions for each section are recorded in the pavement management system. For reference purposes, the photos below shows what roadways look like for different PCI conditions.

Pavement management systems then allow visualization and analysis. Exhibit 6-20 depicts these functions for the StreetSaver software utilized by many cities. These include:

- Viewing roadway conditions using a geogrpahic information system (GIS)
- Budgeting
- Asset Management (optimizing expenditures)
- Viewing projected deterioration curves that would occur without improvements
- Other reporting capabilities

Exhibit 6-20: Street Saver Functionality

6.3.3 Workflow Assignments

With the current SANDAG staff organization no one currently collect or analyze local roads and streets pavement conditions. To do so, SANDAG needs to answer several questions:

- Is SANDAG willing to invest in developing a pavement preservation function?
- Does SANDAG want to just monitor the conditions of roadways or does it also want to conduct scenario analysis to understand the long-term investment needs and the average regional PCI and roadway-specific PCI? Such analysis could be used in its planning processes (e.g., during the development of the RTP/SCS)?
- Does SANDAG want to encourage its cities and the county to use the same pavement management software to facilitate data collection and analysis?
- How would SANDAG start this effort?

The proposed methodology is similar to the approach of the Metropolitan Transportation Commission (MTC) has adopted several years ago and that SANDAG used before. It can be described as follows:

1. Identify the most common pavement management software used by its cities and the county and evaluate its capabilities.

2. Select a software used by many, if not most of these agencies, and adopt it as a regional system. In the case of MTC, they selected the aforementioned StreetSaver.[12] Note that StreetSaver has also added functionality related to pavement conditions in parking lots if needed. The capabilities of the software package were briefly described above.

3. Encourage stakeholders to adopt the selected software. These packages are not expensive. A license for StreetSaver only costs $500. MTC pays for the licenses for its cities and counties. The total cost for SANDAG would be less than $25,000 annually. Note that a similar approach to SANDAG's approach to encouraging cities to adopt a uniform signal timing software QuicNet control software from McCain.[13] This approach is likely to help with implementing Smart Intersections around mobility hubs and other active transportation-heavy intersections in San Diego.

4. Establish a roadway preservation function at SANDAG. This should include at least two professionals (not full time) so that the intellectual capital is not lost if one of them leaves. These professionals could be under Data and Modeling or Regional Planning departments.

5. Train selected staff on the use of the selected software, including importing city and county roadway condition data and potentially budgeting data, projecting future conditions, and scenario analysis for different funding levels.

6. Once everyone adopts and migrates to the selected software, periodically update the regional system by asking cities and the counties to submit their data and importing them. Benefits include a true regional system and more consistent and comprehensive reporting, leading to highest priority projects.

7. At that point, SANDAG can report on regional local roads and street conditions, project future conditions under different scenarios, and select the scenario to include in the RTP/SCS. It is likely that such update would occur biannually given that local jurisdictions do not update their data more frequently.

6.3.4 Other Implementation Factors

The initial costs include stakeholder outreach to decide on the software, purchasing licenses, training SANDAG staff, and possibly supporting agencies if the software requires efforts to migrate to the new system. The total initial cost is estimated to be $50,000 ($25,000 for outreach and agreement and $25,000 for training). The recurring costs will include staff and annual licenses fees. The recurring costs are estimated to be $100,000 (two part time analyst positions and 10,000 in licensing fees). Note that the licensing fee estimates are based on 20 licenses and cost estimates from three years ago. Also, if SANDAG wishes to supplement the pavement condition data that the cities collect in order to get more updated information, this could cost up to $100,000 per cycle of reporting.

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[12] https://www.streetsaver.com/

[13] https://www.mccain-inc.com/products/software

SANDAG can reap significant benefits of this approach. As a first step, SANDAG should consider contacting MTC to verify the benefits and the costs and perhaps identify some lessons learned.

If SANDAG decides to just collect existing data and reporting it, it should try and ask for a GIS-based output from the cities and the county and aggregate them and reporting them. The output should include section, section location geo-coded, and the associated PCI. This would address the pure monitoring of roadway conditions. However, it would not allow for further analysis or standardize systems across San Diego. The cost for this alternative approach is estimated to be $55,000 bi-annually or per reporting cycle.

6.4 CONGESTION

6.4.1 Scenario Context and Description

This scenario corresponds to multiple options in the Implementation Plan: Option 2.1 (Local Streets Speed Reporting); option 2.5 (Various RTP Measures) as well as option 3 (Before and After Studies).

In addition to the need to estimate VMT on arterials that was detailed in Scenario 1, the ability to monitor arterial performance is lacking. For example, there is no current approach to evaluating the impact of projects on arterial performance such as for signal synchronization projects or for active transportation projects. The FY2018 *TransNet* Triennial Performance Audit recommends conducting more robust analysis of cause and effect for all performance metrics, as well as enhancing/expanding regular performance monitoring reports.

This scenario will also provide illustrative examples of how PeMS has been used to evaluate before and after impacts on freeway projects (and how this can be adapted to arterials).

6.4.2 Methodology / Approach

There will be two sections for the methodology. The first will discuss how to estimate arterial congestion. The second will provide illustrative examples of how PeMS can be used to perform before and after causality analyses for freeways.

Arterial Congestion Monitoring Methodology

For this scenario we provide an illustrative example of a tool that uses a big data application such as INRIX along with arterial traffic volume data to calculate a congestion-related performance measures that include:

- Average Speed
- Average Travel Time
- Vehicle-Hours Traveled (VHT)
- Vehicle-Hours of Delay (VHD).

There are two primary data sources that will be used for this analysis:

- Arterial Traffic Volumes – either automatically collected from arterial sensors or obtained from field data collection
- Third Party “Big Data” – used to calculate speeds and travel times along arterial corridors.

Scenario 1, presented above, described a method for calculating VMT along arterial corridors using traffic volume data. The results from this VMT estimation method can be combined with travel time estimates from “big data” to calculate vehicle-hours of delay (VHD). This delay measure can be calculated along a corridor for any time period (e.g., 15-minute, hourly, peak period) using the formula:

VHD = [Traffic Volume] x (Average Travel Time – Travel Time at Reference Speed)
or alternatively

VHD = VMT x (1/[Average Speed] – 1/[Reference Speed])
where the reference speed is equal to a pre-defined "free-flow" speed.

Data vendors such as INRIX typically provide a "reference speed" as part of their datasets. This speed may not be equal to the legal speed limit. Some data vendors estimate this reference speed by measuring travel times along corridors during off-peak periods typically late at night or early morning hours.

Big Data Speed and Travel Time Processing

Private data providers often can provide segment and even corridor average speed and travel time data for the level of aggregation needed for the project (i.e., 15-minute or hourly intervals). If the dataset is very detailed such as one-minute level data will have to be aggregated to an interval appropriate for the analysis. If third-party data has to be aggregated, then an experienced staff member with extensive expertise in working with databases will be required since the use of a sophisticated application will have to be used.

For this example, we will assume that the data will require minimal processing to aggregate to the 15-minute or hourly level. The processing typically follows three general steps:

(1) Mapping big data provider GIS shapefiles and segmentation to the appropriate GIS datasets used by the agency. This will usually quiring select-by matching techniques by a skilled GIS person. Now there is a data linkage between the agency GIS and the provider GIS
(2) Get private vendor data for the same segments that have been linked to arterial segments. If aggregation of data is needed, then it should be performed at this point.
(3) Big data can be used to develop corridor travel times and speeds from the big data segments that are linked to the corridor. This is simply summing the travel times for each segment along the corridor to get the travel time. The average speed is the corridor distance divided by the travel time, then converted from miles per minute to miles per hour.

The following sections describe these steps in more detail.

Link Big Data Segments to APMT Arterial Corridors

Given the very large size of any big data solution, the big data GIS segmentation should be linked to the SANDAG GIS arterial coverage. Typically, agency GIS segmentation is smaller than the big data segments (though this is not always the case), so one big data segment can often correspond to multiple agency GIS segments. In these cases, the same big data segment unique identifying code will apply to multiple GIS segments. If the big data segments are shorter than a SANDAG GIS segment, then the GIS analyst will need to identify the appropriate big data segment to use. Often, it is easiest simply to using GIS to match the agency GIS segment to the nearest big data segment.

Pull and Aggregate Big Data

Once the appropriate segmentation is identified, then the data for the big data segments needs to be downloaded. If the big data needs to be aggregated to a higher-level time interval (say 30-seconds to 1-hour), then it is easiest to apply a straight average of the speeds (i.e., for each data segment for each weekday of the year for each hour there will be 120 30-second intervals). This can be done using any combination of the open-source programming languages (e.g., Python, PostgresSQL object-relational database system).

Calculate Average Travel Times, 95th Percentile Travel Times, and Average Speeds

Once the segments are linked, big data extracted, and the data aggregated to hourly intervals, the data can be processed to calculate travel times, 95th percentile travel times, and average speeds.

It is very important to conduct a detailed QA/QC on the data at this point. For example, data providers often provide confidence scores or ratings to the data (e.g., to identify if the data was observed or estimated).

The big data produced speeds that were assigned to GIS segments were then used to calculate the travel time along that GIS segment, where travel time is equal to the GIS segment distance divided by the big data speed assigned to the segment.

Since an arterial corridor in a jurisdiction is comprised of many smaller GIS segments, the travel times along the segments are summed to obtain the travel time along a directional corridor for the jurisdiction for a single hour of a single day (e.g., northbound Cuyamaca Street through the City of Santee at 8:00 AM on April 14, 2021).

Once the hourly travel times have been calculated for each jurisdictional directional corridor, the average travel time are then calculated for all non-holiday weekdays. Another data quality check is performed at this stage that compares the distance covered by segments with available big data to the total directional arterial corridor distance for that jurisdiction for a given date and hour. This ensures that the available data is close to the real-world corridor distance. The average speed is then calculated for the corridor by taking the average travel time and dividing that by the jurisdictional arterial corridor distance to get the average travel time for that segment.

The 95th percentile travel time is called the planning time and is used to estimate the reliability of a corridor's travel times from one day to the next. The 95th percentile is the travel time on the 95th day out of 100 days of data when sorted in ascending order from the fastest travel time to the longest travel time. Many database applications have functions that can be used to calculate this statistic.

Integrate Into Monitoring Tool

Once the average speed and travel time data has been processed along with the planning time, the data can be integrated into a spreadsheet-based tool and combined with traffic volume data (See Scenario 1 for more discussion on how to incorporate VMT into the tool.) Exhibit 6-21 shows an example of that tool. Using big data in combination with traffic volume data allows for a range of performance measures to be calculated and presented. This analysis can be used to evaluate the impacts of signal synchronization projects as well as the impacts of active transportation improvements on congestion.

Exhibit 6-21: Illustrative Arterial Performance Measurement Tool

Source: Los Angeles Metropolitan Transportation Authority (Metro) MeasureUp! Program

PeMS Before/After Methodology

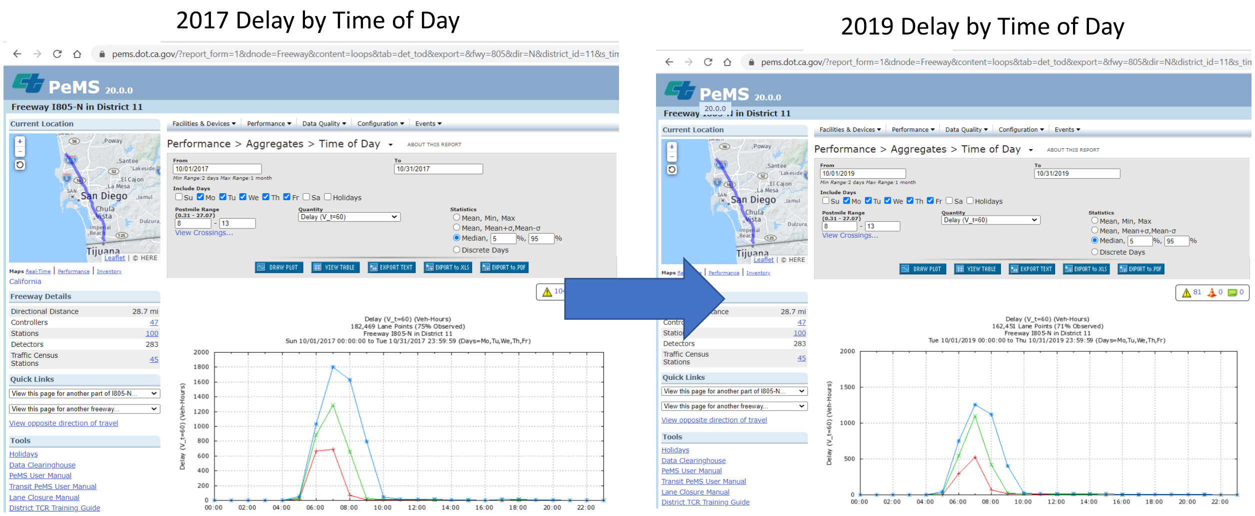
This section will provide an example of how to use PeMS to perform a freeway before/after analysis. PeMS has a range of tools that can be used to compare before and after project conditions. The PeMS "Routes" feature allows the user to pre-define a route, which can be used to compare travel times and other performance measures along the corridor.

Other features of PeMS allow the user to perform more ad hoc analyses of corridor performance. For example, Exhibit 6-22 shows a comparison for a five-mile segment of I-805 northbound weekday vehicle-hours of delay for the month of October in 2017 and 2019, respectively. This comparison shows that during between the two years, delay during the 7:00 AM peak hour declined by 15% along this corridor.

Other time of day results can readily be produced for VMT, speeds, and the travel time index among other measures. Other features in PeMS allow for aggregations and spatial analyses by time series, day of week and other measures.

This type of analysis can be used to evaluate the impacts of a wide range of projects. For example, did the implementation of ramp metering along a corridor produce a measurable impact on speeds and travel times. Exhibit 6-23 is an illustrative example to evaluate the impact of the conversion of HOV lanes to express lanes impacted travel speeds on a freeway corridor. This data was downloaded from PeMS and presented as a bar chart.

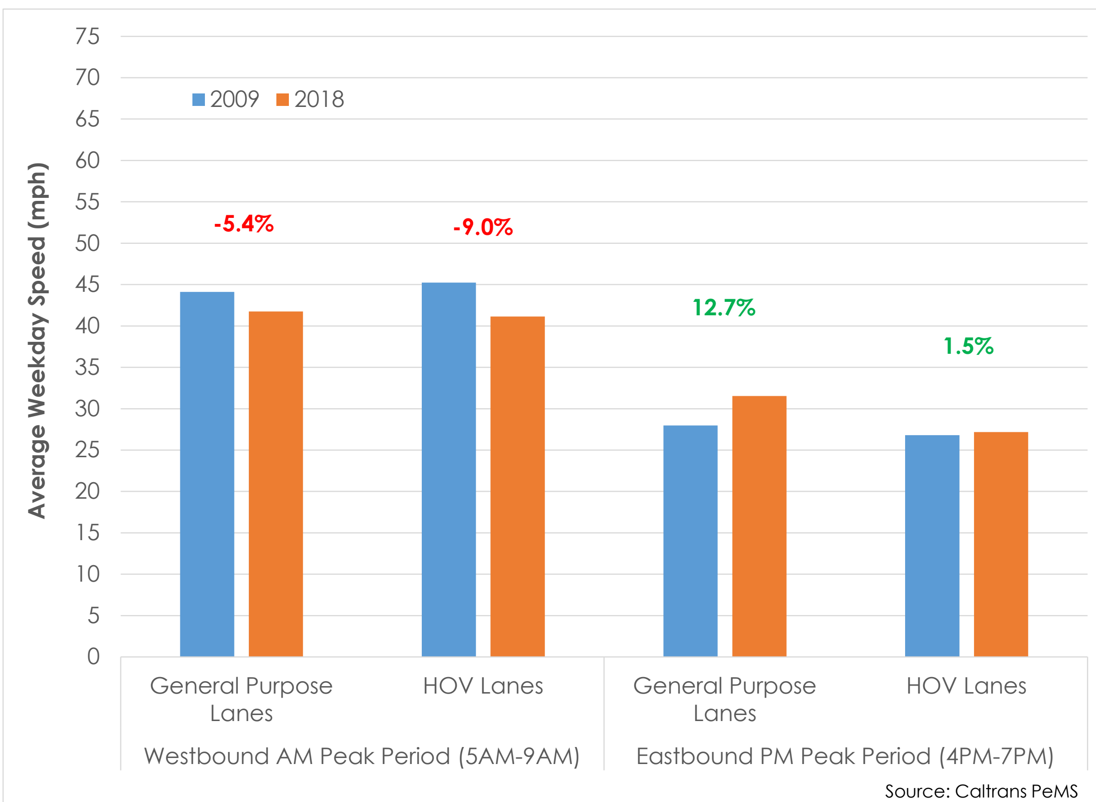
Exhibit 6-22: Illustrative PeMS Before After Example Approach



Source: Caltrans PeMS

https://pems.dot.ca.gov/?report_form=1&dnode=Freeway&content=loops&tab=det_tod&export=&fwy=805&dir=N&district_id=11&s_time_id=1569888000&s_time_id_f=10%2F01%2F2019&e_time_id=1572566340&e_time_id_f=10%2F31%2F2019&dow_1=on&dow_2=on&dow_3=on&dow_4=on&dow_5=on&start_pm=8&end_pm=13&q=del_60&fn=3&pct1=5&pct2=95&chart.x=56&chart.y=2

Exhibit 23: Illustrative PeMS Before After Results Presentation



Source: SMG Analysis of PeMS data

6.4.3 Workflow Assignments

Within SANDAG, effort related to congestion monitoring of arterials throughout the region is most likely to involve one of, or a combination of, the following current organizational units:

- Data and Modeling
- Mobility and Innovation
- Research and Program Management

As with the other conceptual scenarios, since SANDAG does not currently consistently monitor congestion for arterials in the region, the agency first needs to make the policy decision about developing this function in the first place.

The responsibility for taking on the new congestion monitoring and reporting arterials could theoretically be assigned to a new resource within any of these departments. There is an opportunity to train up two individuals (e.g., one primary and one secondary) to use a third party big data provider (e.g., INRIX, Streetlight, etc.) so there is some skill redundancy in-house.

Perhaps the most logical approach however is to establish a new coordinator (most likely a senior planner) with Research and Program Management to drive the new process. This coordinator could be the same person as for Scenario 1 (VMT and eVMT). This would not be a full-time position necessarily, but this person would be expected to produce annual monitoring reports. Support from the Data and Modeling team would be expected.

If desired, this person could be a regional resource and present to the regional traffic engineers council (SANTEC), the Cities and Counties advisory committee (CTAC) and provide congestion data to local cities and agencies as appropriate. If this were to be case, depending on the demand, this could potentially be a full-time position.

6.4.4 Other Implementation Factors

To calculate congestion using INRIX or other third-party crowdsourced data would require a subscription to that service, which can cost between $200,000 and $300,000 per year depending on the license procured.

As described above in the discussion in Scenario 1 for arterial VMT estimations, a tool would have to be developed to incorporate the traffic count data. The processing of INRIX or other third-party data to develop hourly travel time and speed estimates also requires expertise in downloading and processing that data.

Should SANDAG decide to conduct field counts, the cost for a 72-hour continuous traffic count (i.e., 3 days for 24 hours per day) cost approximately $150-$200 per location. If counts are conducted every one or two miles along a corridor, then the data collection cost for a 10-mile arterial corridor could range between $600 and $2,000 (for between 4 and 9 count locations).

The recurring costs would involve replicating the same steps and procedures developed as part of the initial costs. In addition, if SANDAG were to update the arterial count data, cost $600-$2000 per 10-miles of arterial centerline mile.

To cost to perform Before/After studies can vary widely depending on the type of project being evaluated. For example, evaluating the effectiveness of an on-ramp metering implementation may be as straightforward as examining travel times and reliability (i.e., the variability of travel times) along the corridor. Some third-party crowdsourced data such as INRIX provide that capability as part of their license. PeMS allows for the creation of user-defined “routes” that can be used to evaluate a range of freeway performance measures along a corridor. However, more complex evaluations such as evaluating the effectiveness of express lanes or Integrated Corridor Management (ICM) deployments that require multiple modes, route options will cost significantly more. The range of expected costs for these types of evaluations can range from $50,000 to $200,000 depending on the type of evaluation.

7. IMPLEMENTATION PLAN

This section moves beyond the options for implementation laid out in the TPM Framework discussion and sets out a course for actual TPM implementation and phasing. In formulating the TPM implementation plan, the consultant team considered the following three issues:

- Most options relate to the monitoring of performance. The planning processes, data, and tools to forecast performance for different improvements and scenarios were found to be reasonable by the consultant team. They also undergo peer reviews and quality assurance and control. SANDAG's use of an Activity Based Model (ABM) is viewed as the state of art and is used by other MPOs. However, monitoring of performance to identify deficiencies, inform project selection, and develop improvement scenarios require improvements. Therefore, the implementation plan focuses on improving monitoring processes and tools. Some of these improvements were also recommended by the FY 2018 *TransNet* Triennial Performance Audit.

- Some options, but not all, are assumed to require a policy decision (i.e., Board action). These are flagged in Exhibit 10 below. Policy options may require additional time to implement due to this fact and because they require Board approval.

- Some options present SANDAG with a range for possible implementation. For example, there could be an interim option to adopt an option for implementation partially in the short term, followed by a final option to adopt later. The second option might require additional changes in procedures, additional resources and/or new tools. Where the options contain a potential spectrum of options for implementation, this is noted in the text as in Exhibit 10 below.

- The change type is shown in Exhibit 10 as well, and sorted by process change, regional methodology or organization. A regional methodology assumes changing methodology at SANDAG to align with a regulatory body (e.g., CARB), or aligning SANDAG and local jurisdiction methods.

The options for implementation can be mapped by type of decision and type of change as shown below in Exhibit 7-1.

Exhibit 7-1: Options for Implementation by Decision and Change Type

Option		Decision Type			Change Type		
		Policy Decision	Multiple Options	Phased Approach	Process Change	Regional Methodology	Organization
1	**Additional Board Reported Targets**	✔	✔	✔	✔		
2	**Additional Monitoring Reporting**	✔	✔	✔	✔		✔
2.1	*Local Streets Speed Reporting*	✔			✔		
2.2	*Integrated Pavement Reporting*	✔			✔	✔	
2.3	*Integrated VMT Reporting (and possibly GHG)*	✔			✔	✔	
2.4	*Safety and Trends Reporting*	✔			✔		✔
2.5	*Various RTP Performance Measures*	✔	✔	*Depends*	✔		
3	**Before and After Studies**				✔		
4	**Simulation Tools for Operational Improvements**				✔		
5	**Private Data**				✔		
6	**Data Collection Consolidation**				✔		✔

7.1 OPTIONS AND RESOURCES

Implementing the options depends on policy and management decisions. Exhibit 11 provides resource estimates for each option (e.g., labor estimates, licensing, training). As mentioned before, the options relate mostly to new monitoring activities not currently undertaken by SANDAG.

As SANDAG contemplates which options to implement first, its policy bodies (e.g., Transportation Committee, Board, ITOC) and management need to decide which performance outcomes they want to monitor, the frequency of that monitoring, and whether they want to set additional targets for some measures.

Note that the most resource intensive options that were identified relate to measuring mobility, pavement conditions of local streets, and roads and using simulation models for estimating benefits of operational improvements. The remainder of the options are relatively less resource intensive and can be implemented with some training and fewer resources. The general framework, regardless of which options SANDAG decides to implement, can be summarized in the following steps:

- Management and policy bodies agree on which performance measures to track on a regular basis and whether they will need to set targets for each one. The recently adopted 2019 Federal

RTP has many performance measures[14] not currently monitored and reported. These are the starting point to discuss, develop agreement on, and assign resources to monitor performance.

Some of the measures (such as work travel time by mode) are partially reported in the State of the Commute report. Some are not reported even though they are critical measures for performance monitoring, especially GHG and possibly VMT (note VMT monitoring is more difficult and expensive). These should be included in any option selected. At the same time, some measures are slow to change on an annual or bi-annual basis such as "Percentage of homes within 1/2 mile of a transit stop." Therefore, management and policy bodies should consider the usefulness of monitoring measures that may not change often and potentially monitor them only when updating the RTP/SCS. [Options 1 and 2]

- Establish an enhanced performance monitoring function and/or organizational unit. In addition to the State of the Commute, candidates for performance monitoring could include functions related to VMT reporting, active transportation, vanpool and transit. The same organizational unit would also be responsible for "cause and effect" and "before and after" studies for trends and major projects. [Options 2, 2.1, 2.2, 2.3, 2.4, 2.5]

- Performance monitoring ought to include both reporting on some additional measures (e.g., MAP 21 measures, pavement monitoring) and include multi-year, trend reporting. Trends are important to understand whether the region's transportation performance is moving in the right direction, and if not, potentially revise/update investment decisions. Present performance measurement results and trends to policy committees regularly on a pre-established schedule. [Options 2, 2.1, 2.2, 2.3, 2.4, 2.5, 3]

- On a case by case basis, consider using simulation tools (e.g., building on the capabilities of the Aimsun dynamic traffic assignment model similar to what has been used for the I-15 express lanes integrated corridor management) to estimate the benefits of operational improvement projects. [Option 4]

- Adjust methodologies for performance measurement as better data and/or tools are identified and proven to be better quality than current ones used. Make organizational refinements to support this strategy. [Options 5 and 6]

When reading the Implementation Plan table in Exhibit 7-2, note that:

- Some of the costs identified are one-time only costs, some are recurring (annual). This is flagged in the table. All costs are incremental from current levels. Ranges are provided where known.

- The "Approximate Labor Cost" column is the consultant team's own educated best guess of what it would take a trained SANDAG staff member or a specialized consultant to carry out the work,

[14] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1

factoring in some overhead for management, coordination with different SANDAG work units as appropriate such as QA/QC and coordination with local jurisdictions if applicable.

- The “Licensing and Tools” column contains any licensing costs (where known) and specialized tools or applications required for implementation.

- The “Training/Other” column identifies suggested training needs, where known, and the approximate duration of the training.

- The “Benefits” column identifies the primary reasons to implement the options for implementation. The genesis of this body of work was the FY2018 *TransNet* Audit recommendations, but other benefits beyond *TransNet* are identified as well.

- Finally, recommended timeframe for implementation is not presented in this table but in the later table on the Preliminary Phasing Plan.

Exhibit 7-2: Implementation Plan

		Approximate Labor Cost[15]	Licensing and Tools	Training / Other	Benefits
1	Adopt New Board Reported Targets. Consider identifying and setting new targets to better track RTP performance in the areas of arterial mobility, reliability, safety, environmental and pavement conditions.	$100,000 to $150,000 (one-time cost, through adoption)	None	None	• Address *TransNet* Audit recommendations • Improved RTP performance tracking
2	Reporting on Additional Monitoring Information. SANDAG should consider including arterial mobility, reliability, safety, environmental and pavement conditions. This is a policy decision with cost and process change repercussions depending on what is selected. This option assumes establishing a performance monitoring function and/or organizational unit.	No additional cost beyond the other costs in the table.	Depending on measures selected by policy bodies and management, a portion or all the packages identified in other options.	Training will be required for new data and tools.	• Address *TransNet* Audit recommendations • Improved RTP performance tracking and future investment decision making
2.1	Local Streets Speed Reporting. Consider using a big data solution such as INRIX for speed reporting. Will require some training to facilitate skill development. SANDAG may also consider adding arterial vehicle delay measures.	As mentioned in private data options for implementation, estimated to be $250,000 per year.	Big data product license	Requires training on how to the big data product, but resources required are limited (less than a week of training).	• Address *TransNet* Audit recommendations • Use the information for project formulation and for safety in coordination with local agencies.

[15] Fully loaded, including salaries, fringe and benefits

		Approximate Labor Cost[15]	Licensing and Tools	Training / Other	Benefits
2.2	Integrated Pavement Reporting. Consider, over time, using a common platform such as StreetSaver with all jurisdictions under SANDAG (as MTC does it in the Bay Area). This approach would be facilitated by SANDAG paying for the licenses. The resulting data could be used for future condition forecasting during the next RTP/SCS and informing future funding needs.	$50,000 initial cost ($25,000 for outreach and agreement and $25,000 for training). Recurring annual cost of $100,000 (two part time analysts) and up to $100,000 additional if SANDAG supplements the pavement condition data the cities collect.	StreetSaver license (about $10,000, assumes 20 licenses)	SANDAG can choose to just monitor local roads and street pavement conditions, or also use StreetSaver for planning by forecasting the future conditions under different scenarios. Some training is needed for monitoring. More training is needed is used for planning.	• Address *TransNet* Audit recommendations • Identify deficient roadways and engage with jurisdictions on best application of limited pavement dollars (especially in *TransNet*)
2.3	Integrated VMT Reporting (and possibility GHG). VMT monitoring is complicated, and it is not feasible to calibrate the SANDAG ABM model every year. The ABM model is used for forecasting VMT, but not on-going monitoring VMT. There are two general approaches that could be used to monitor VMT for the entire system (highways and arterials): a ***Proxy Approach*** using publicly available traffic volume and VMT data, and a ***Fuel Consumption Approach*** based on fuel consumption data. For performance monitoring of GHG, SANDAG can consider adopting the	$50,000 to $100,000 (highways) $250,000+ (arterials)	None	SANDAG will need expert knowledge with PeMS and working with and processing traffic volume data.	• Executive management priority • Improved RTP performance tracking and trend towards achieving SB-375 targets.

		Approximate Labor Cost[15]	Licensing and Tools	Training / Other	Benefits
	same GHG estimation methodologies as California Air Resources Board. Even though CARB's methodology will most likely evolve over time to take advantage of emerging data sets (e.g., Replica), adopting CARB's methodology of relying on fuel consumption data for GHG would result in better alignment and benefit SANDAG.				
2.4	Safety and Trends Reporting. Consider reporting on safety results and trends compared to adopted Safety targets. Consider using the Caltrans Strategic Highway Safety Plan (SHSP) Crash Data Dashboard to access and filter regional crash data, compute safety performance measures for which targets were adopted and show heatmaps for collisions by type to identify "hot spots". Using the Crash Data Dashboard is much easier than using SWITRS. The Crash Data Dashboard is built using SWITRS data and available filters align with State safety goals and focus areas.	$100,000 to $150,000 per year	Free	Some Training	• Address *TransNet* Audit recommendations • Use the information for project formulation in coordination with Caltrans and/or local partners.
2.5	Various other RTP measures. Consider reporting on additional RTP measures for example, on congested VMT on the State Highway System and congestion on arterial corridors.	Cost ranges vary significantly and depend on which measures are selected for monitoring	Depends on which ones are selected for monitoring	Requires training on new tools and methodologies.	Improved RTP performance impacts and future decision making

		Approximate Labor Cost[15]	Licensing and Tools	Training / Other	Benefits
3	Before and After Studies. SANDAG has conducted before and after studies for some projects (I-15 managed lanes, active transportation) and not for others (I-5 managed lanes). SANDAG ought to stablish a threshold for capital projects for which it will commit to doing before and after studies (e.g., exceeding $100 million, legislative requirements). SANDAG should conclude the Mid-Coast after study once COVID subsides.	Depending on the level of field data collection needed, each study could range from $50,000 to $200,000.	Third party big data sources (e.g., INRIX, StreetLight) may be needed to evaluate impacts of certain types of projects (e.g., integrated corridor management) along corridors (e.g., arterial corridors)	May require skill training to use private data sources.	Address *TransNet* Audit recommendations
4	Simulation Models for Operational Improvements. On a case by case basis, consider using simulation models to estimate benefits arising from operational improvements (e.g., building on the capabilities of the Aimsun dynamic traffic assignment model).	Cost varies from $50,000 for localized simulation to $1 million for an entire multi-modal corridor	If conducted internally, simulation modeling license (e.g., VISSIM) will be required	Significant training will be needed.	Quantifying benefits of operational improvements
5	Private Data. Continue the exploration and expanded use of multiple private data sources such as INRIX, StreetLight and Replica, but make this part of a broader TPM strategy. Private data providers Replica and StreetLight can potentially provide accurate VMT estimates that can be used for VMT monitoring and GHG calculations.	A big data product such as INRIX is currently used most often by MPOs such as SCAG and MTC. For example, an INRIX Analytics package is estimated to cost $250,000 per year. However, costs are coming down and other private data are emerging. Replica subscription costs range between $300,000-$500,000	SANDAG licensing will be required (SANDAG recently agreed to procure a one-year license from StreetLight and previously held an INRIX license. Potentially other packages as associated data is shown to be reasonably accurate and made	Requires training on how to use the chosen solution, but resources required would be limited (i.e., less than one week of training).	Address *TransNet* Audit recommendations

		Approximate Labor Cost[15]	Licensing and Tools	Training / Other	Benefits
		per year, depending on the application needed.	available to SANDAG.		
6	Data Collection and Reporting Consolidation. Consider consolidating data collection and reporting functions in view of achieving better planning the workload and cost efficiencies through economies of scale. This should be accomplished in context of the larger organizational structure and minimize disruptions within individual departments (e.g., Data Science and Big Data). This could be accomplished either with one large group, or if spans of control become challenging, then two groups. Delineation between the groups could be field data collection (e.g., bike/ped, vanpool) versus large data set acquisition (e.g., Survey, SWITRS, INRIX). At the minimum activities need to be coordinated through a single department.	No cost on its own. Costs depend on which options are adopted and the frequency of reporting required.	No licensing except for those mentioned in other options for implementation.	Training will be needed depending on the options adopted.	TPM Alignment

7.2 PHASING

Implementing the options requires agreement by management and the appropriate decision-making and policy bodies. The assumptions contained in this phasing plan are based on the consultant team's best judgment and SANDAG input; but may be updated as conditions change. Exhibit 7-3 below summarizes the different types of decisions required, rough cost impact, and timeframe estimates. If SANDAG were to implement all the options, the cost impact would be approximately $200,000 in one-time costs, and from $800,000 to $1.3 million in recurring yearly, incremental costs.

Exhibit 7-3: Preliminary Phasing Plan

		DECISION TYPE			COST IMPACT	TIMEFRAME	
		Policy Decision	Multiple Options	Phased Approach		Decision	Imple-mentation
1	Additional Board Reported Targets	✓	✓	✓	$50,000 - $100,000 (one-time)	9/2021	6 months
2	Additional Monitoring Reporting	✓	✓	✓	Included below	9/2021	12 months
2.1	*Local Streets Speed Reporting*	✓			$250,000 / year	9/2021	12 months
2.2	*Integrated Pavement Reporting*	✓			$50,000 one-time $200,000 / year	9/2021	12 months
2.3	*Integrated VMT Reporting (and possibly GHG)*	✓			$50,000-$100,000 (highways) $250,000+ (arterials)	9/2021	12 months
2.4	*Safety and Trends Reporting*	✓			$100,000 - $150,000 / year	9/2021	12 months
2.5	*Various RTP Performance Measures*	✓	✓	Depends	Depends	Ongoing	N/A
3	Before and After Studies				$50,000 - $200,000 / study	9/2021	12 months
4	Simulation Models				Depends	Ongoing	Study specific
5	Private Data		✓	✓	$250,000 (e.g., INRIX) and TBD	Ongoing	Ongoing
6	Data Collection and Reporting Consolidation				None	1/2022	12 months

For the majority of the options, the recommended timeframe for implementation is a policy decision by Q3 or Q4 of 2021, with a roughly 12-month implementation period. Some of the activities like private data are constantly evolving so those can be evaluated on an ongoing basis.

APPENDIX A – FY2018 *TRANSNET* TRIENNIAL PERFORMANCE AUDIT MATRIX

The matrix below contains the TPM-related *TransNet* audit recommendations from FY2018 together with a TPM consultant assessment and conclusions. More detail on implementation of these different options is presented in the main body of this report.

***TransNet* Audit Recommendation**		**TPM Consultant Assessment and Conclusions**
5.	Establish a comprehensive performance framework by implementing the following: a. Setting targets to measure *TransNet* performance against the *TransNet* Extension Ordinance goals in-line with federally mandated deadlines or at a faster pace. At a minimum, some narrative could accompany performance reporting to help others understand whether data and results were favorable or unfavorable.	SANDAG already complies with a variety of Federal (e.g., FAST, MAP-21) and other external targets (e.g., California's SB1). There are no recommendations from the consultant team on SANDAG's current approach to these types of targets. However, most of the 2019 Federal RTP goals do not have related performance targets. SANDAG has the option to proactively identify new targets for areas where no targets exist today yet are identified as important RTP and/or *TransNet* goals. These include arterial mobility, reliability, safety, environmental and pavement conditions. The decision to add targets is a major policy decision that comes with ramifications (i.e., additional cost, potential changes to business processes, and the reporting to Board/ITOC). This change would be a policy change and would require process changes, as well as additional resources.
	b. Capturing performance outcome data related to safety metrics, pavement condition, and bridge condition for highways, local roadways, and bicycle (bike) and pedestrian modes. 1. Use the California Highway Patrols' Statewide Integrated Traffic Records System (SWITRS) to measure and monitor safety statistics—both for motorized and non-motorized fatalities and serious injuries—especially against the new	Currently, safety and asset management data are not monitored regularly and reported to ITOC. Although SWITRS has been used at SANDAG, especially for active transportation, these have not previously been included in the State of the Commute and other updates to ITOC. SANDAG does not have regular reports that show heat maps for accidents (by type), which are resource intensive when using SWITRS (because coordinates are not included in the SWITRS database). Off-shoots of SWITRS like the UC Berkeley Transportation Injury Mapping System (TIMS) would be more efficient as a source. https://tims.berkeley.edu/ In January 2021 SANDAG staff presented 2021 statewide targets for PM 1, which includes 5 metrics for fatalities and serious injuries on all public roads. Staff also presented 2020 regional targets and methodology for public transportation safety plans.

TransNet Audit Recommendation			TPM Consultant Assessment and Conclusions
		safety targets developed by Caltrans and adopted by SANDAG. 2. Track and report highway pavement and bridge condition available from Caltrans on the SANDAG website or provide a hyperlink to where that information is available for taxpayers. Additionally, work with Caltrans to determine if bridge and pavement data can be isolated for San Diego County from the Imperial County data contained within the Caltrans District 11 reported data. 3. Track and report on local jurisdiction pavement condition by requiring local jurisdictions to provide pavement condition index data as soon as pavement condition surveys are performed and results become available. 4. Obtain and use private sector data to analyze congestion and delay on local streets and roads or evaluate status of Caltrans' Performance Measurement System (PeMS) to capture road performance including level of coverage of detection.	Tracking SHS and local agency pavement condition is very resource extensive. SANDAG would need to either collect pavement condition data or request pavement condition data from each local agency. Larger local agencies generally use pavement management system to store pavement data and forecast conditions in the future under different funding scenarios. However, unless they all use the same system, extracting the information is very difficult. SANDAG ought to consider, over time, using a common platform such as StreetSaver with all jurisdictions under SANDAG (as MTC does it in the Bay Area). This approach would be facilitated by SANDAG paying for the licenses. The resulting data could be used for future condition forecasting during the next RTP and informing future funding needs. For the SHS, Caltrans maintains both a pavement condition and a bridge condition database. This should be relatively easy to collect and report to ITOC or the Board. SANDAG is already using PeMS and reports on SHS performance. Where detection in sparse, big data solutions can fill the "holes" with speed and travel time data. However, big data providers such as INRIX do not currently provide SHS delays since they do not typically include traffic volumes. For local streets, SANDAG can use big data such as INRIX for speed reporting. This requires staff to get trained on using the selected application. Private data providers typically provide training and user support services as part of the package..
	c. Conducting more robust analysis of		By cause and effect, the auditor refers for what some term "before and after" studies for projects and strategies. SANDAG

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		cause and effect for all performance metrics to provide meaning to results or help determine if different strategies or projects should be employed to get a better result. For instance, consider using heat maps to identify where the majority or significant severity accidents occur and work with Caltrans and local jurisdictions to inform solutions and future projects.	has conducted a before and after study for the I-15 Managed Lanes. In addition, the Rideshare program reports on users and VMT reduction impacts of the program. Also, SANDAG has conducted a before study for Mid Coast and is planning to conduct the after study after the COVID impacts have subsided. However, SANDAG has not always conducted before and after studies. For example, a before and after study was not conducted for the I-5 Managed Lanes. By cause and effect is also asking for identifying problem areas (e.g., using heat maps for accidents). This may be happening, but it is not evident that this is done with Caltrans, which has a specific methodology to identify safety projects. SANDAG should consider identifying a threshold for before and after studies and ensure adequate funding for these studies.

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	d. Providing regular performance monitoring reports that consider past performance in relation to *TransNet* goals through quarterly updates to the SANDAG Board and committees, annual public reports on the status of *TransNet*, and website postings.	The one regular performance monitoring report is the State of the Commute, which focuses on highway and transit performance. Staff continues to assess viable consistent funding sources for third-party data such as INRIX. Funding commitment is necessary to establish new datasets in on-going monitoring and reporting. Staff continues to work with MTS/NCTD on initial annual reporting of transit travel times in the State of the Commute Report and also continues working on integration of additional roadway and transit data into quarterly reports However, for regular reporting, and consistent with the Executive Director direction to the consulting team, SANDAG does not regularly report on VMT or GHG measures (and several others). Currently, VMT and GHG are estimated by using the Caltrans HPMS and the ABM model (and the EMFAC model for CO2 emissions). This is different from the methodology used by the oversight agency, the California Air Resources Board (CARB). For monitoring (not forecasting) GHG it is advisable to use a consistent methodology as CARB, which relies on fuel consumption data for GHG and to reverse engineer VMT based on average fuel efficiency numbers. Note that CARB itself is not fully satisfied with this methodology since it does not take into account inter-regional trips (e.g., a car fuels up in OC and drives to Los Angeles). CARB is looking at private data sources to improve its methodology. Until it does, it would benefit SANDAG to use the same methodology as CARB. For other performance measures included in the RTP, SANDAG can devote resources after the RTP is adopted to develop a robust monitoring program. For instance, reliability, asset conditions, and safety can be monitored and reported regularly to ITOC and/or the Board.
	e. Considering allocating funding for additional performance monitoring activities given that SANDAG will likely require more data sources, tools, and resources to track, validate, analyze, ensure quality, and report performance.	Many SANDAG staff interviewed mentioned resource limitations as an obstacle to “mine” all the data they collect. This is especially true when staff is focused on developing the RTP. This usually happens for at approximately 2 years before plan adoption. Therefore, some resources after that may be used for monitoring activities. However, if monitoring activities need to occur every year, additional resources will be needed.

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6.	Explore and study public-private partnerships with entities such as Google, Waze, Scoop, TomTom, or others to integrate and summarize performance results as well as provide information on a real-time basis to travelers identifying different commute times and options.	SANDAG is currently exploring multiple private data sources and recently agreed to procure a one-year license with StreetLight. SANDAG has held subscriptions with INRIX Analytics in the past. However, it is not clear whether this is part of a broader strategy or an ad-hoc review.
7.	Enhance the Story Map tool, *TransNet* project status listing (shown in Appendix A), or develop a different tool to capture project output details and track *TransNet* accomplishments over time.	This does not relate specifically to transportation performance, it is more of an execution performance recommendation.
17.	Continue efforts to establish baseline data for bike and pedestrian volume to identify trends and set targets.	In February 2020, the SANDAG Board approved regional Transit Asset Management targets in accordance with MAP-21/FAST Act requirements. In Q1 and Q2 of 2021, the active transportation group also conducted safety analysis to identify active transportation trends.
8.	Improve project management practices and project delivery for the Bike Early Action Program projects by implementing the following: a. Finalizing and implementing the in-progress Regional Bikeway Program Management Plan. b. Using Dashboard data that currently tracks frequent causes of delays during the design and environmental phases of bike projects, to summarize lessons learned, identify and mitigate future preventable occurrences, and improve scheduled delivery of the remaining projects.	SANDAG staff provides quarterly and annual updates on the *TransNet* Major Corridors and Regional Bikeway Programs. The Bike Early Action Program projects continue to be implemented. In the Fall of 2020, there were 25 active projects. SANDAG has a limited number of permanent counters that can also do pedestrian counts, but there is a high demand for data and it is both time and labor intensive to produce good information. Historic data is pretty thin and inconsistent, for example with bicycle data. SANDAG is laying the foundation for building a good data set and did recently receive a grant to add more counters to be operated by San Diego State University. In September 2020, SANDAG published infobits “It’s Just Like Riding a Bike”, Bike Riding in the San Diego Region since COVID-19. The focus of this dashboard is not on safety but focuses instead on volumes and usage of bike facilities compared to pre-COVID levels.