NJTPA NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY
Defining the Vision. Shaping the Future.


Regional Performance Measures

Implementation Plan:

Maintenance of the Regional Performance Measures and Recommendations for Further Enhancements

Prepared by

ICF

June 28, 2019

Table of Contents

1. Introduction and Purpose

While this Regional Performance Measures study has laid a foundation for a set of regional performance measures to be used by the NJTPA, the application and use of these performance measures should go well beyond the end of this study effort. Performance management is an ongoing process that involves developing performance measures, tracking progress on an on-going basis, using that information to inform investment and policy decisions, and re-evaluating measures and progress over time.

This implementation plan is designed to support the continued use and updates to the products of this research effort. It includes the following sections:

- **Maintenance Plan for Recommended Performance Measures** – This section discusses the database produced through this study effort, including the summary data and raw data files, as well as the process for reformatting data for the development of the interactive dashboard, and information on the parameters used for the scorecard and fact sheets. This information will be helpful for the on-going maintenance and updating of these data and outreach products.
- **Recommendations for Potential Future Measures** – This section provides recommendations on potential future measures to consider for integration into performance reporting. Recognizing that the set of measures that was selected was limited based on available data, this section identifies measures for consideration that would require either collecting new data or conducting additional analysis. It focuses on measures associated with the topics of community, mobility/access, and resiliency.
- **Recommendations for Processes to Support Use of Regional Measures** – This section provides recommendations regarding processes for further integrating the performance measures into regional decision making, including relation to the Unified Planning Work Program (UPWP), Long Range Transportation Plan (LRTP), and project selection and prioritization.

The implementation plan is designed to support continued use of the performance measures and refinements of the process as the NJTPA proceeds over upcoming cycles of updating the LRTP, Transportation Improvement Program (TIP), and UPWP, and communicating information to the public and stakeholders.

2. Maintenance Plan for Recommended Performance Measures

The ICF team has delivered to the NJTPA the data used for developing the regional performance measures and other regional indicators. The delivered data includes both the summary data and the raw data used to compute the performance measures. The delivered data is organized within appropriate folders and subfolders.

Figure 1 shows the snapshot of the organization of the data within the data directory. The summary data Excel files are in the “Summary” subfolders under each performance area; likewise, the files containing the raw downloaded data from the sources and the processed data are in the “Raw_Data” subfolders. For more details regarding the source of data and calculation methodology refer to the report “Development of Key Regional Transportation Performance Measures: Methodology and Data Summary Report.”

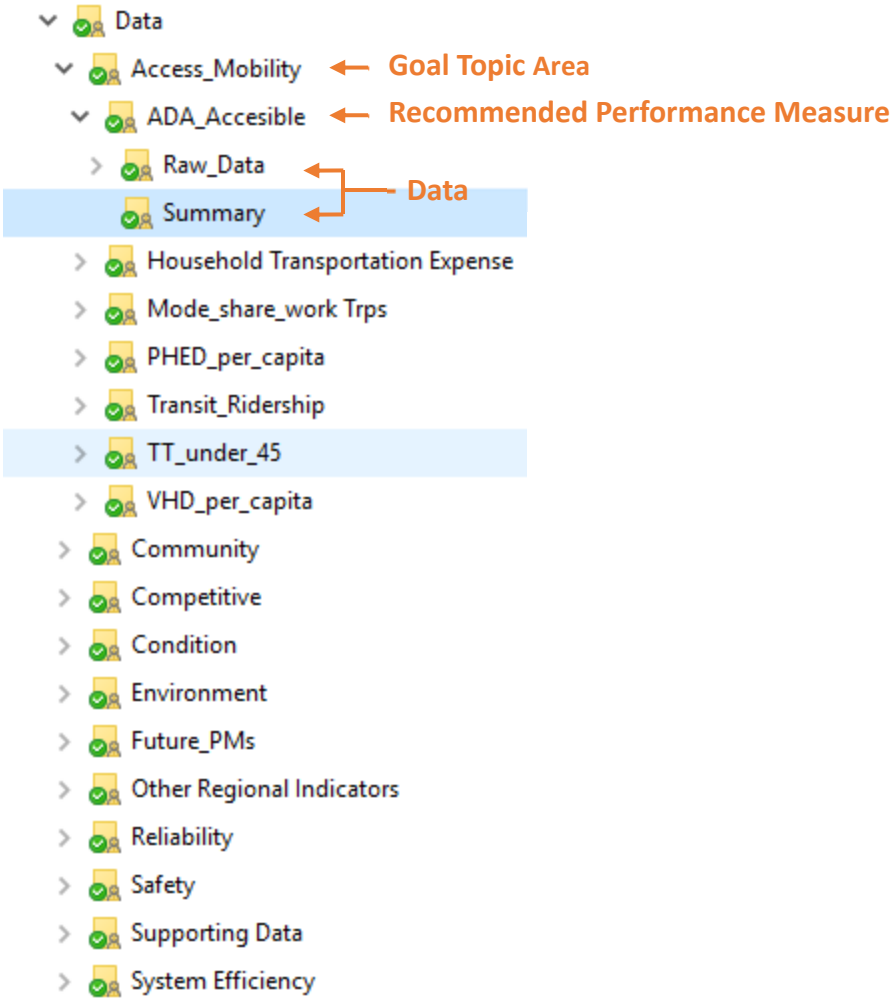


Figure 1: Organization of the Data delivered by the ICF team to the NJTPA

Data Manipulation and Tidying for the Development of Interactive Dashboards in Power BI

Although the summary data is organized in Microsoft Excel files, the data format needed to be pivoted to be best displayed in Power BI. **Figure 2** and **Figure 3** show an example of how the data were manipulated in Power BI for the development of the interactive dashboard for the performance measure "Number of Bad Air Quality Days." The pivoting (reformatting) of the data was necessary to support the multi-level customized filtering in Power BI based on year, geography, etc. The reformatted data are stored in folders under the Goal Topic Areas.

Number of Bad Air Quality Days								
	2010	2011	2012	2013	2014	2015	2016	2017
NJTPA Region Bad	**53**	**51**	**32**	**17**	**22**	**31**	**22**	**14**
Bergen	16	13	8	7	6	12	10	7
Essex	17	14	13	2	5	5	3	1
Hudson	13	13	12	2	6	17	2	3
Hunterdon	24	15	10	4	2	4	7	4
Middlesex	27	16	20	1	4	9	12	6
Monmouth	10	10	15	4	1	6	3	1
Morris	9	10	10	6	1	3	3	3
Ocean	26	15	17	3	4	10	6	4
Passaic	10	7	6	2	0	7	5	1
Somerset	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	0	0
Union	4	7	0	1	5	2	0	1
Warren	5	31	2	6	5	1	3	1
Summer Average	78.7	78.0	76.9	76.3	74.8	76.5	77.2	74.7
Avg Max	87.90	87.00	85.87	84.47	83.73	85.20	86.03	83.17
Avg Min	69.57	68.97	67.97	68.07	65.80	67.90	68.43	66.10

Figure 2: Summary Data for the Performance Measure - Number of Bad Air quality Days in Microsoft Excel

A	B	C	D	E	F	G	H
Year	Bad Air Quality Days	Geography	County	Bad Air Quality Days (2017)			
2010	53	NJTPA Regi	NJTPA R	14			
2011	51	NJTPA Regi	NJTPA R	14			
2012	32	NJTPA Regi	NJTPA R	14			
2013	17	NJTPA Regi	NJTPA R	14			
2014	22	NJTPA Regi	NJTPA R	14			
2015	31	NJTPA Regi	NJTPA R	14			
2016	22	NJTPA Regi	NJTPA R	14			
2017	14	NJTPA Regi	NJTPA R	14			
2010	16	Bergen	Bergen,	7			
2011	13	Bergen	Bergen,	7			
2012	8	Bergen	Bergen,	7			
2013	7	Bergen	Bergen,	7			
2014	6	Bergen	Bergen,	7			
2015	12	Bergen	Bergen,	7			

Figure 3: Reformatted data in Power BI for Data for the Performance Measure - Number of Bad Air quality Days

Importing Reformatted Data into Power BI

Once the data have been orientated correctly for Power BI, the analyst needs to select the "Get Data" button on the top ribbon within Power BI, and select the Microsoft Excel option. **Figure 4** illustrates importing the appropriate Excel file from the "Get Data" button in Power BI.

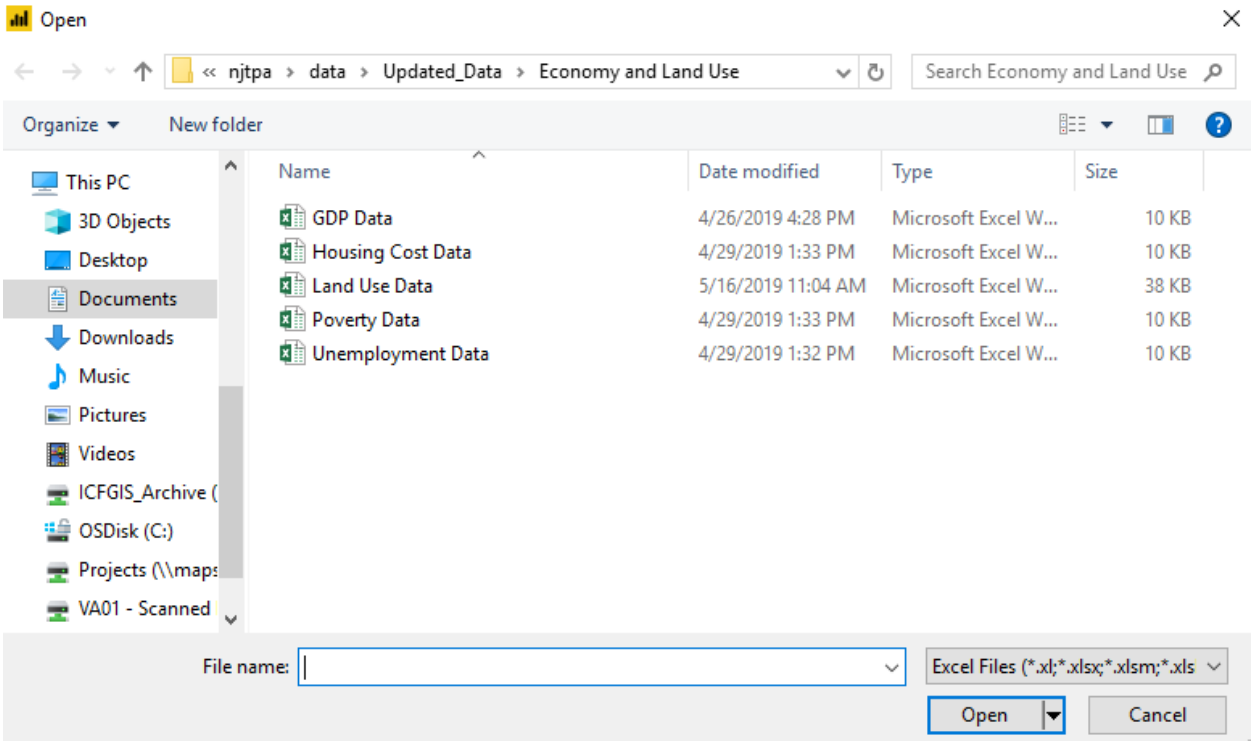
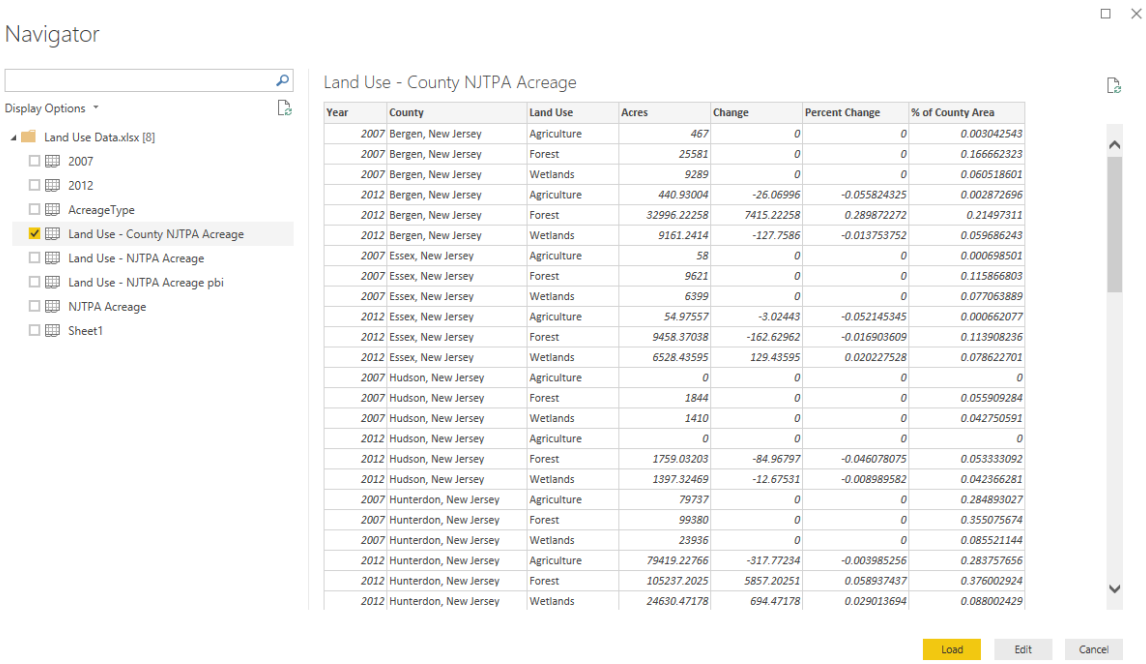


Figure 4: Importing Data into Power BI

After selecting the appropriate Excel file, select the specific table that will be imported. Visually inspect the selected table to ensure it is correct. **Figure 5** below shows the selected table in Power BI.



Year	County	Land Use	Acres	Change	Percent Change	% of County Area
2007	Bergen, New Jersey	Agriculture	467	0	0	0.003042543
2007	Bergen, New Jersey	Forest	25581	0	0	0.166662323
2007	Bergen, New Jersey	Wetlands	9289	0	0	0.060518601
2012	Bergen, New Jersey	Agriculture	440.93004	-26.06996	-0.055824325	0.002872696
2012	Bergen, New Jersey	Forest	32996.22258	7415.22258	0.289872272	0.21497311
2012	Bergen, New Jersey	Wetlands	9161.2414	-127.7586	-0.013753752	0.059686243
2007	Essex, New Jersey	Agriculture	58	0	0	0.000698501
2007	Essex, New Jersey	Forest	9621	0	0	0.115866803
2007	Essex, New Jersey	Wetlands	6399	0	0	0.077063889
2012	Essex, New Jersey	Agriculture	54.97557	-3.02443	-0.052145345	0.000662077
2012	Essex, New Jersey	Forest	9458.37038	-162.62962	-0.016903609	0.113908236
2012	Essex, New Jersey	Wetlands	6528.43595	129.43595	0.020227528	0.078622701
2007	Hudson, New Jersey	Agriculture	0	0	0	0
2007	Hudson, New Jersey	Forest	1844	0	0	0.055909284
2007	Hudson, New Jersey	Wetlands	1410	0	0	0.042750591
2012	Hudson, New Jersey	Agriculture	0	0	0	0
2012	Hudson, New Jersey	Forest	1759.03203	-84.96797	-0.046078075	0.053333092
2012	Hudson, New Jersey	Wetlands	1397.32469	-12.67531	-0.008989582	0.042366281
2007	Hunterdon, New Jersey	Agriculture	79737	0	0	0.284893027
2007	Hunterdon, New Jersey	Forest	99380	0	0	0.355075674
2007	Hunterdon, New Jersey	Wetlands	23936	0	0	0.085521144
2012	Hunterdon, New Jersey	Agriculture	79419.22766	-317.77234	-0.003985256	0.283757656
2012	Hunterdon, New Jersey	Forest	105237.2025	5857.20251	0.058937437	0.376002924
2012	Hunterdon, New Jersey	Wetlands	24630.47178	694.47178	0.029013694	0.088002429

Figure 5: Selected Table to be imported in Power BI

When the data are successfully imported, the corresponding data show up in the "FIELDS" right hand portion of the screen. See **Figure 6** for an example of imported data in Power BI.

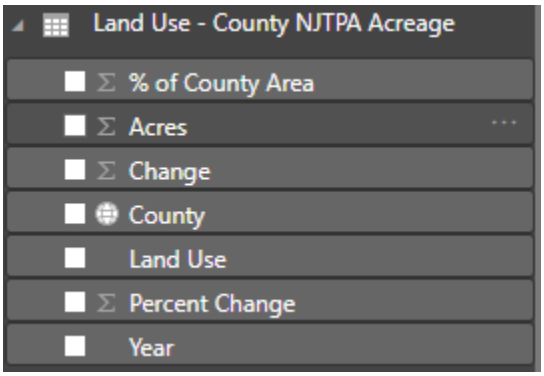


Figure 6: Example of Imported data in Power BI

Refreshing Data in Power BI

Finally, when changes/additions are made to the data, the analyst will need to refresh the data to ensure that any changes made to the Excel tables are reflected in Power BI. In the upper ribbon of Power BI, there is a "Refresh" button (See **Figure 7**). After making a change in the corresponding Excel document, the analyst needs to select this "Refresh" button and the corresponding data will be refreshed in the Power BI document.

When refreshing data, make sure that the titles of fields are not changed. This will cause an error and the data source will need to be re-imported. However, the analyst can add as many new fields as desired without getting this error.

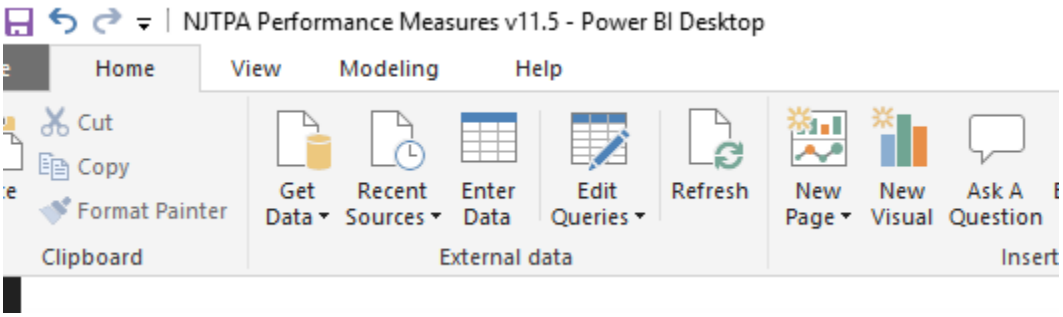


Figure 7:Refresh Data in Power BI

Exporting Power BI Document (pbix) as a Power BI Service

Once data has been refreshed, the Power BI desktop needs to be published as a service. In the upper left corner of the Power BI document, select "File" → "Publish" → "Publish to Power BI."

Updating the Scorecard and Fact Sheets

The regional scorecard and individual fact sheets for each of the performance topic areas, as well as the two modal summaries (roadways and transit) have been developed using the graphics program, InDesign. The ICF team is delivering the graphics files to the NJTPA, and these files can be updated as new data become available on a periodic (e.g., annual or biennial) basis. While the files contain all of the building blocks to manipulate for future products, **Table 1** provides a summary of all of the color codes used within the files (as well as on the interactive dashboard) in order to support development of supplemental products in the future with a consistent look.

Title	Code (CMYK)
Reliability (Yellow)	C:28% M:25% Y:100% K:1%
Environment (NJTPA Blue)	C: 100% M: 84% Y:26% K:11%
Safety (Green)	C: 46% M: 30% Y: 82% K: 14%
Access/Mobility (NJTPA Red)	C: 32% M: 100% Y: 63% K: 31%
Community (Coral)	C: 4% M: 81% Y: 70% K: 1%
Competitiveness (Purple)	C: 65% M: 100% Y: 10% K: 2%
Condition (Orange)	C: 13% M: 38% Y: 86% K: 2%
Resiliency (Grey)	C: 51% M: 51% Y: 51% K: 45%
Healthy Living (Light Blue Green)	C: 40% M: 0% Y: 7% K: 33%
Economy and Land Use (Dark Pink)	C: 0% M: 32% Y: 11% K: 45%
Roadway Fact Sheet (Teal)	C: 82% M: 24% Y: 46% K:3%
Transit Fact Sheet (Light Green)	C: 80% M: 11% Y:66% K:1%

Table 1: Color Codes Used for Each Performance Theme

3. Recommendations for Potential Future Measures

The regional performance measures identified through this study effort were selected based on several key factors, with the following criteria used as a basis for shortlisting measures.

Criteria Use for Selecting Performance Measures—The performance measures selected must:

- Address regional goals.
- Measure what matters to the public and stakeholders.
- Relate to transportation system performance (i.e., they can be influenced to some extent by transportation investments, operational decisions, programs, or policies).

- Have consistent, quality data available for on-going tracking.
- Be understandable to a general audience (to the greatest extent possible).

Within this list, the availability of consistent, quality data was an important factor that limited the selection of some performance measures that otherwise would have been desirable to include. This portion of the implementation plan discusses the gaps within the existing performance measures, and identifies recommendations for possible development of additional performance measures in the future.

Gaps in the Selected Performance Measures

Most of the data used in selecting performance measures came from data sets that are maintained either at the federal or state-levels, and that are updated annually in order to support tracking of performance consistently over time. Examples of data sources include: the American Community Survey (ACS), National Performance Management Research Data Set (NPMRDS), New Jersey DOT's Bridge Inventory, and New Jersey Transit's data to support reporting to the National Transit Database.

While the selected performance measures cover a broad array of important goals for the NJTPA, there were three primary areas that were somewhat limited in coverage due to gaps in available, high quality data:

- **Access/Mobility Measures:** While a wide array of different performance measures were selected to address various aspects of mobility, access, and affordability, there were gaps in data that limited the ability to directly measure the important issues of system connectivity and access to and the quality of bicycling and walking options.
- **Community-related Measures**: The selected measures focus on employment and households in proximity to regional transit stations/stops as a way to measure the connections between transportation and land use (specifically, transit-oriented development). However, they do not cover a full array of issues associated with community quality of life, such as access to greenspace or exposure to transportation-related noise.
- **Resiliency Measures**: Finally, the selected set of performance measures did not include any resiliency measures, due to lack of available data for tracking on-going performance.

These areas lacked existing data sets collected on a regular basis, and would benefit from additional data collection, development, or processing in order to develop trackable performance measures. Below, we identify possible future performance measures for development, along with possible data sources or methodologies for data development, recognizing the possibilities for using new and emerging sources of data (e.g., crowdsourced data, private sector data) or models.

Access / Mobility-related Measures

The basic purpose of the transportation system is to provide access to destinations. Access can be measured as in terms of an outcome such as the number of destinations that can be accessed within a specific travel time, or could be measured in terms of availability of travel options or connectivity across these options. Based on the discussion groups held as part of this study effort and the vetting of performance measures, there is a particular interest in exploring issues related to connectivity across modes, as well as the availability and quality of access afforded by bicycling and walking. This section

provides some options for development, along with possible data sources, and information about agencies that are using similar measures.

Access to Destinations (Travel Time)

One way to measure access is to explore the number of destinations, such as jobs, that are available to residents within a specific travel time threshold, such as 45 minutes. This type of measure goes beyond the measures that address the number of households or jobs within a half-mile of regional transit (which focuses primarily on land use around transit stations) or the share of commutes under 45 minutes by providing a broader measure of access to opportunities for jobs (or other trip purposes). "Destinations" can be interpreted as meaning any destination type for which the NJTPA has data.

Examples of potential measures are:

- **Average number of jobs accessible within a 45-minute transit trip.**
- **Average number of jobs accessible within a 45-minute drive.**

Some regions use these measures to assess long-range plan scenarios or investment strategies. For instance, the National Capital Region Transportation Planning Board (TPB), the metropolitan planning organization (MPO) for the Washington, DC metropolitan area, uses these performance measures (the number of jobs accessible within a 45-minute transit commute and within a 45-minute drive from home) to assess the performance of its long-range transportation plan, considering conditions in the base year (i.e., today) as well as conditions in the end year of the plan both with and without the investments in the plan. For instance, TPB's *Visualize 2045* plan provided an estimate that the region's residents can reach on average 369,000 jobs within a 45-minute transit commute today, and forecasts an increase of 40% to 518,000 jobs in 2045 with the long-range plan investments due to the expansion of higher quality transit service to more areas of the region.[1] The Metropolitan Transportation Commission (MTC), the MPO for the San Francisco Bay Area, used performance measures that identify the share of jobs accessible within 45 minutes by transit and 30 minutes by auto in congested conditions, and set targets for these figures, as part of the *Plan Bay Area 2040* long range transportation plan.[2]

While these measures are often used as part of long-range planning to assess changes in long-term performance in order to support investment decision making, these types of measures can be estimated and tracked using existing geographic information systems (GIS) and models.

Data Needs / Methodology Development

When measuring access using travel times, the NJTPA would use a combination of transportation modeling and GIS mapping. For bicycle and pedestrian measures, GIS-mapping is generally sufficient; select the desired travel time and estimate the trip distance that can be accomplished during that travel time at an average pace. For measures involving vehicular trips and transit, the region's travel demand model is typically used. The resulting figures are modeled, rather than directly collected, but this approach is similar to the measure of on-road greenhouse gas (GHG) emissions, which requires use of

[1] National Capital Region Transportation Planning Board, *Visualize 2045*, Chapter 5: Financially Constrained Element. https://www.mwcog.org/assets/1/6/Final_Visualize_2045_-_Chapter_5.pdf#page=12

[2] Metropolitan Transportation Commission, *Plan Bay Area 2040, Performance Assessment Report,* March 2017. http://2040.planbayarea.org/sites/default/files/2017-07/Performance_Assesment_DPBA2040_Supplemental%20Report_3-2017_0_0_0.pdf

the region's travel demand model (and EPA's MOVES emissions model) in order to calculate the regional measure.

Network Completeness

Network completeness explores the coverage and/or connections of different components of the multimodal transportation network. Network completeness is one of the easiest and most important ways to explore multimodal network connectivity.[3] FHWA's 2018 Guidebook for Measuring Multimodal Network Connectivity provides a step-by-step approach to developing appropriate measures associated with network completeness as well as other aspects of multimodal network connectivity. There you can find additional example measures, a list of the typical data needed, and a fuller discussion of the pros and cons. Network completeness measures address parts of the transportation network that are deemed usable for walking or bicycling, and represents the minimum accommodations needed for a facility to be considered part of the walking or bicycling network. Examples include:

- **Percent of roadway miles with complete sidewalks or bicycle facilities on both sides.**
- **Percent of planned pedestrian or bicycle network that is constructed.**
- **Total miles of greenways, multiuse trails, and other "low-stress" transportation facilities.**[4]

Similar to the NJTPA, the Indianapolis region has a greenways program, and they use several of the performance measures listed above. Traffic stress addresses the sense of danger associated with riding a bike near motor vehicles. Streets with higher vehicle speeds and more cars feel dangerous for people bicycling, and have higher levels of stress. Low-stress streets are those where people feel more comfortable biking because there are fewer vehicles, slower vehicle speeds, or a physical barrier (such as a curb, bollards, or planters) that protects people biking from adjacent traffic.

By measuring how complete the bicycle and/or pedestrian network is, the NJTPA can determine progress toward a regional goal or target of providing complete networks. Moreover, exploring the connectivity of the network can identify critical gaps, which can then lead to activities to fill those gaps. Measuring the extent of the network with a low stress threshold can help to expand beyond specified bicycle lanes or greenways and account for roadways that are conducive to bicycling.

Data Needs / Methodology Development

Developing a regional measure of network completeness for bicycling and for walking will require the NJTPA to develop a regional inventory of sidewalks, bicycling lanes, greenways, or other infrastructure, or to conduct analyses to identify low stress roadways. The NJTPA might want to look for data from completed studies, such as the Assessment of System Connectivity in Northern New Jersey, for data that

[3] Federal Highway Administration, Guidebook for Measuring Multimodal Network Connectivity, 2018. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/. Also, see: Federal Highway Administration, Guidebook for Developing Pedestrian and Bicycle Performance Measures, 2016. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/performance_measures_guidebook/

[4] See Indy Moves Transportation Integration Plan, 2018, at https://www.indy.gov/activity/comprehensive-plan-for-the-city-county for a discussion of how to calculate the percentage of the roadway network that has a low level of traffic stress.

could be used as a starting point. The NJTPA could work with local governments and NJDOT to explore data available as a starting point, and potentially conduct a targeted study to complete the analysis.

Once the initial inventory is complete, then the NJTPA will need to work with partners to continue to update the inventory regularly, or conduct periodic updates.

Pedestrian and Bicycling Activity

Beyond the actual completeness of the bicycle and pedestrian network, another way to measure access and mobility is to estimate the actual level of pedestrian or bicycle activity. This measure goes beyond the work trip commute mode share performance measure, recognizing that a large portion of bicycling and walking trips are for non-work purposes. Examples of this type of measure include:

- **Pedestrian counts (at a set of sidewalk locations) throughout the region.**
- **Bicycle counts (at a set of signalized intersections or destination points) throughout the region.**

A challenge is that these types of pedestrian and bicycling count activities only address a sample of the region. However, by collecting data at even a sample of locations, the NJTPA can gain an indicator of change over time. For instance, Washington State Department of Transportation (WSDOT) as part of its Bicycle and Pedestrian Documentation Project collects bicycle and pedestrian usage data in cities throughout the State. Each year, WSDOT, in coordination with the Cascade Bicycle Club, enlists the support of volunteers and other organizations to benchmark the number of people bicycling and walking on trails, bike lanes, sidewalks, and other facilities at selected locations. They use a combination of permanent count locations (using automated count technology) and manual counts, with counts occurring annually in the early fall. The resulting information is displayed on a bicycle and pedestrian count portal.[5]

The NJTPA could also utilize the National Household Travel Survey (NHTS) Add-on Program to obtain standardized region-specific data on "active" trip-making. While DOTs mostly participate in the add-on program (note that NJDOT did not participate in most recent 2017 survey), regional planning agencies such as Iowa Northland Regional Council of Governments (INRCOG), Des Moines Area MPO and the Indian Nations Council of Governments (INCOG) participated in the survey for the add-on program.[6]

In the past, the NHTS was only conducted approximately every five to seven years, so the data would not enable trends analysis except over very long periods of time (at least over two cycles of participation). The Federal Highway Administration is in the process, however, of developing the next generation of the NHTS through a Next Generation Travel Behavior Data Initiative that will shift from the traditional sampling survey approach to establish a continuous travel monitoring program (building on passive data, such as Global Positioning System [GPS] navigation data). A Transportation Pooled Fund Program solicitation allows states and MPOs to participate by purchasing additional survey samples

[5] Washington State Department of Transportation, Washington State bicycle and pedestrian documentation project. https://www.wsdot.wa.gov/travel/commute-choices/bike/count. Bicycle and Pedestrian Count Portal. https://wsdot.maps.arcgis.com/apps/webappviewer/index.html?id=12b44775815446159c6a240218c2cf5a.
[6] Federal Highway Administration. The NHTS Add-on Program. https://nhts.ornl.gov/addOn.shtml. Accessed June 28, 2019.

and/or more detailed passive data. The NJTPA could choose to participate in the Pooled Fund Program with a minimum commitment of $25,000 per year, with the exact amount to be determined based on the degree of customization and sample size collected.[7]

Data Needs / Methodology Development

The NJTPA could undertake a periodic count project to assess pedestrian and bicycle activity at a series of locations throughout the region. A first step in establishing a network-wide count program would be to identify key locations of interest, and design a count plan that could be replicated annually or biennially. The National Documentation Project provides information on how to go about conducting bicycle and pedestrian counts and surveys. Additional resources are available such as the National Cooperative Highway Research Program (NCHRP) Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection, and study by FHWA on Exploring Pedestrian Counting Procedures: A Review and Compilation of Existing Procedures, Good Practices, and Recommendations (2016).

Moreover, use of "big data" applications can be explored to assess potential for future use in monitoring pedestrian and/or bicycle activity data. For instance, Google Street View, as well as other on-line sources such as Bing Streetside and Everyscape, have been identified as potential sources for counting pedestrians and bicyclists.[8] shows an example from a study in New Orleans using Google Street View to capture the number of people visible in images in 2007 (two years after Hurricane Katrina) and 2016, which showed a substantial increase in the number of pedestrians visible; similar analysis was conducted for bicycles.

[7] Transportation Pooled Fund Program, Moving Forward with the Next Generation Travel Behavior Data Collection and Processing. https://www.pooledfund.org/Details/Solicitation/1466

[8] Campenella, Richard. "People-Mapping through Google Street View: A New Orleans Experiment." November 2017. https://placesjournal.org/article/people-mapping-through-google-street-view.

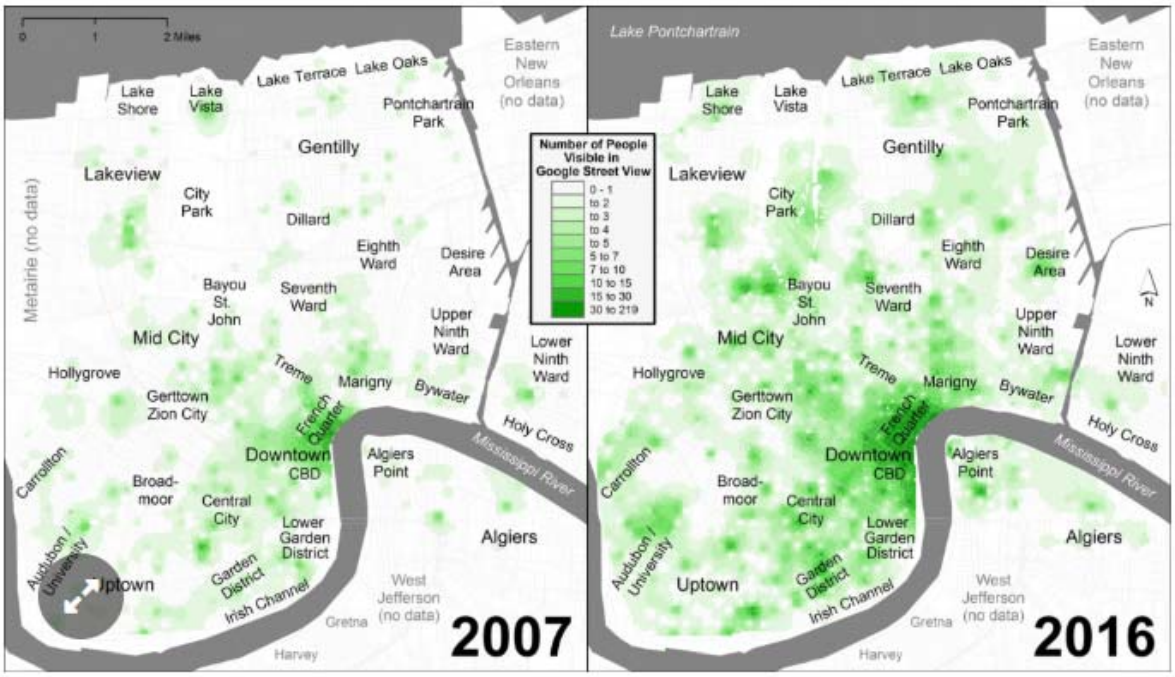


Figure 8: People Visible in Google Street View, New Orleans, 2017 and 2016 [Richard Campanella for Places Journal]

Other sources of big data such as StreetLight Data ingest data from location records from smart phones and navigation devices. StreetLight Data indicates that it is able to differentiate bicycles and pedestrians from vehicle traffic using machine learning in order to measure bicycling and pedestrian activity. In 2018, the California Department of Transportation (Caltrans) initiated a project with StreetLight Data that will result in statewide information on people's active transportation behavior.[9] This type of information can be used not only for overall performance analysis, but for fine grain level analysis to help support investment prioritization by exploring origins and destinations, time of day, and other factors.

Measuring Transportation Access by Traditionally Underserved / Environmental Justice Populations

This measure category helps evaluate the effectiveness of the transportation system in providing access for traditionally underserved or disadvantaged populations. These populations typically include one or more of the following: low-income households, persons with disabilities, persons under 18, persons 65 and over, minority populations, households without access to a vehicle, or single parent households.

[9] StreetLight Data website, https://www.streetlightdata.com/modes/#bicycle-and-pedestrian. Accessed June 20, 2019.

Almost any transportation performance measure can be analyzed to compare how the transportation system performs for underserved populations as compared to other populations. Example measures to evaluate disadvantaged populations served could include:

- **Percent of disadvantaged households within a ½-mile walking distance of regional transit.**
- **Percent of disadvantaged population within a 45-minute or less commute.**
- **Percent of low-income population with transit access to living wage jobs**.[10]

Data Needs / Methodology Development

Building on the NJTPA's existing environmental justice analyses, the NJTPA would identify parts of the region to designate as equity emphasis areas or EJ areas where there are significant concentrations of low-income, minority populations, or both, as well as consider other disadvantaged population groups. The analysis for other performance measures would then be conducted for these specific geographic areas in order to develop indicators for these areas. For instance, data from the American Community Survey (ACS) used to calculate share of workers with travel time under 45 minutes would be explored but with a focus on the specific equity emphasis area or EJ area.

Community-Related Measures

Community-related performance measures are intended to measure the degree of effectiveness of transportation-related activities in enhancing community livability (including local environmental quality) and health. These measures relate to two of the NJTPA's goals:

- *Protect and improve natural ecosystems, the built environment and quality of life.*
- *Create great places through select transportation investments that support the coordination of land use with transportation systems.*

The measures selected as regional measures include the percent of jobs within a ½ mile of regional transit (commuter rail, light rail, express bus); and the percent of households within a ½ mile of regional transit. These measures provide an indication of the connections between transit and jobs and housing locations, and serve as indicators of transit-oriented development. However, they do not capture all aspects of community quality of life.

Access to Destinations (Distance)

Some regions are expanding the use of measures to understand access to community destinations, such as schools, grocery stories, or medical facilities. These measures are often direct distance-based accessibility measures, and so most strongly address land use decisions and provide indications of accessibility by bicycling and walking. Examples include:

- **The percent of households within a 1/2 mile distance of a full service grocery store**
- **Number of jobs accessible within a 1/2 mile walk of the average regional household**

[10] See Indy Moves Transportation Integration Plan at https://www.indy.gov/activity/comprehensive-plan-for-the-city-county.

Data Needs / Methodology Development

Distance-based accessibility measures are often based on GIS-mapping of network or buffer distances around a specified type of destination. The measures are generally framed by an origination point (e.g., a household) and a destination point (e.g., an employment site) with a distance specified in the middle. The NJTPA's GIS infrastructure can be used as a base, including its Open Data Portal, as long as household locations and destination point data are updated regularly.

Density of Destinations / Scores for Walkability, Bikeability, and Transit Friendliness

The density of destinations focuses on the number of desirable destinations (e.g., jobs, homes, recreation, shopping, etc.) within a specific area. Density of destinations measures focus primarily on land use patterns, rewarding development with greater intensity and mix of uses. Building on land use data and transportation data, several scoring systems have been developed to assess how walkable, bikeable, or transit-friendly a community is. These scores are usually presented at a neighborhood scale for sub-regional analysis, but could potentially be aggregated for region-level analysis. These measures developed by Walk Score include:

- **Walk Score** – Walk Score is a popular tool used to estimate a location's walk-friendliness, based heavily on density of destinations, on a scale of 0 to 100. Walk Score analyzes hundreds of walking routes to nearby amenities with points awarded based on the distance to amenities in each category. Amenities within a 5-minute walk (0.25 miles) are given maximum points, and a decay function is used to give increasingly fewer points to more distant amenities, with no points given after a 30 minute walk.[11]
- **Transit Score** – Transit Score is a patented measure of how well a location is served by public transit on a scale of 0 to 100. The Transit Score algorithm calculates a score for a specific point by summing the relative "usefulness" of nearby routes based on the distance to the nearest stop, the frequency of the route, and type of route, based on data published by transit agencies in General Transit Feed Specification (GTFS) format.[12]
- **Bike Score** – Bike Score measures whether a location is good for biking on a scale from 0 to 100, based on four equally weighted components: bike lanes, hills, destinations and road connectivity, and bike commuting mode share.[13]

Regional indicators using such scores might include:

- **Regional Average Walk Score (or Share of Households Located in Neighborhoods with a Walk Score above X).**
- **Regional Average Bike Score (or Share of Households Located in Neighborhoods with a Bike Score above X).**
- **Regional Average Transit Score (or Share of Households Located in Neighborhoods with a Transit Score above X).**

[11] Walk Score. https://www.walkscore.com/. Accessed 28 June 2019.

[12] Transit Score® Methodology. https://www.walkscore.com/transit-score-methodology.shtml. Accessed 28 June 2019.

[13] Bike Score. https://www.walkscore.com/bike-score-methodology.shtml. Accessed 28 June 2019.

Data Needs / Methodology Development

Given that the Walk Score and Transit Score are patented systems that are widely recognized, the NJTPA could obtain a subscription service in order to use and report the data on a regular cycle.[14] Individual neighborhood scores could be obtained and then weighted by population within each neighborhood in order to develop an overall average weighted figure for the region, or to identify the share of households or population that are in neighborhoods that meet a certain threshold score such as 50 for an individual indicator.

Alternatively, the NJTPA could conduct a similar analysis focused primarily on access to destinations. First, the NJTPA would need to define "destinations" of interest that will be included in the analysis. Destinations may include schools, parks, retail sites, grocery stores, medical centers, businesses with a certain number of employees, or even high-density residential locations. Once destinations are defined, the NJTPA could determine the density of destinations in a given land area, showing areas where pedestrian and bicycle travel demand may be occurring or may occur if infrastructure is available. It could then develop its own estimate of the overall density of destinations as a proxy for potential pedestrian and bicycle demand. Density of destinations is being used by Washington State DOT to inform evaluation and prioritization of investments for the Pedestrian and Bicycle Program. Specifically, the evaluation process for proposed projects to be funded by the Pedestrian and Bicycle Program includes the following criterion: “the cost of the project compared to the potential number of people who would be served, or population density within one mile of the project location.”[15]

Access to Public Green Space

Public green spaces are important to maintaining the health of New Jersey residents and of their natural environment. Green spaces are man-made (e.g., parks, gardens, sports fields) or natural environments (e.g., forests, wetlands, meadows) in which the land is primarily covered with vegetation (e.g., trees, bushes, flowers, grass) rather than with man-made objects.

Public green spaces benefit the physical and mental health of New Jersey residents. Physical health benefits include reductions in air pollution (because vegetation filters air), increases in physical activity achievable through the provision of recreational space, and reductions in the urban heat island effect. Mental health benefits include reductions in mood disorders (e.g., depression) and providing a refuge from noise. Access to green space is a measure of the social determinants of health and can reduce health disparities. [16]

Public green spaces also help maintain a healthy environment by providing wildlife habitat, filtering air pollution, and storing stormwater. Many of these environmental benefits can also be achieved using green infrastructure, such as bioswales and rain gardens; see the section on resiliency-related measures for more info.

[14] See: Walk Score Professional, available at: https://www.walkscore.com/professional/research.php.
[15] Washington State Department of Transportation. Pedestrian and Bicycle & Safe Routes to School Programs, 2019-2021 Prioritized Project List and Program Update. December 2018. https://www.wsdot.wa.gov/sites/default/files/2019/01/03/ATD-Bike-Ped-Safe-Routes-Priortized-List-19-21.pdf.
[16] Jennings, V., Baptiste, A., Jelks, O. and Skeete, R. Urban green space and the pursuit of health equity in parts of the United States. International journal of environmental research and public health, 14(11), p.1432. 2017.

Potential measures of green space include:

- **Percent of households within walking distance of a park (or other green space).** The USGS Protected Areas Database of the U.S. can provide the GIS data on the official national inventory of areas that are "dedicated to the preservation of biological diversity and to other natural, recreation and cultural uses, managed for these purposes through legal or other effective means."
- **Percent of households within a green space deficit zone.** The NJ MAP Conservation Blueprint defines green space deficit zones as zones in which residential units with less than 5 acres of open space within a ½ mile and further away than ½ mile from preserved open space and recreational lands.

Data Needs / Methodology Development

The data for these measures are generally available. For instance, the NJ MAP Conservation Blueprint provides geographic information on "green space deficit zones" and this geographic data can be overlaid with population in order to develop a regional estimate of the share of population in these zones. These data, however, do not appear to be updated on a regular basis. The NJTPA could work with Geospatial Research Lab at Rowan University's Department of Geography, Planning and Sustainability to provide periodic updates to the mapping and analysis in order to track changes in the measures. These data are not expected to change significantly year to year, so a study or reassessment every 5 years may be appropriate.

Combined Transportation-Housing Affordability

One of the measures that the NJTPA is moving forward with is the percent of households that spend more than 30% of their income on housing. As demographic changes lead to the increasing suburbanization of poverty, housing-burdened households may also face increased transportation costs. The Center for Neighborhood Technology (CNT) recommends a 45% threshold for combined cost for a household's transportation and housing as burdened. A potential measure would be:

- **Percent of households with combined transportation-housing burden (over 45% of household income for transportation and housing).**

Data Needs / Methodology Development

The U.S. Department of Housing and Urban Development (HUD) maintains a Location Affordability Index that provides geographic information on combined housing and transportation costs as a percent of various income groups, such as for very low-income households or for the region's typical household. These geographic data could be used to support calculation of a regional indicator. Alternatively, NJTPA could use Housing and Transportation (H+T) Affordability Index, an index developed by Center for Neighborhood Technology (CNT). CNT's H+T Affordability Index provides a perspective on affordability that includes both the cost of housing and the cost of transportation at the neighborhood level. The H+T Index presents an option to separate out the cost of transportation, and transportation costs as a share of income at various scales, including neighborhood, county, and MPO level.[17] Useful tools on affordability include the CNT calculator: https://htaindex.cnt.org/ and the CNT location-efficiency tools

[17] Center for Neighborhood Technology. H+T Index. https://htaindex.cnt.org/map/index.php?mapR=109,-74.1723667,40.735657,9,mpo,389. Accessed June 28, 2019.

hub: http://locationefficiency.cnt.org/. In addition, NJTPA could also use Transportation and Housing Alliance (THA) toolkit that provides planners guidance on how to assess regional transportation + housing issues and develop strategies, along with additional tools to analyze data numerically and through mapping.[18]

Exposure to Transportation-Related Noise Pollution

Exposure to transportation noise can adversely affect human health and other living beings. The adverse effects of noise range from general nuisance to auditory and non-auditory health issues such as hypertension, cardiovascular and psychological diseases. Measures of noise exposure often rely on looking at major roadways and can also rely on modeling. The regional performance measure would be:

- **Percent of population residing in high-noise locations.**

Data Needs / Methodology Development

There are several data sources and methodologies that the NJTPA could consider for assessing high levels of transportation noise exposure. These are noted below:

1. The simplest approach would use a GIS buffer around major sources of noise pollution. Rhode Island DOT drew a 250' buffer around interstate highways and freeways. They then ran a count of residents that live within those buffer areas to understand the number of people residing in these high-exposure areas. As Rhode Island was doing this as part of their EJ analysis, they then developed a ratio to determine whether EJ populations were disproportionately burdened by this exposure. See their long-range plan for more info. Such an analysis could account for noise barriers or other investments as well.
2. EPA's EJScreen maps exposure to traffic, defined as "count of vehicles per day at major roads within 500 meters." EJ Screen calculates this using data from U.S. DOT's National Transportation Atlas Database, Highway Performance Monitoring System. The NJTPA could draw a map of the region in EJScreen and then run the "traffic proximity" report to see which areas score in which percentiles relative to the nation or state.[19]
3. National-level modeling of transportation noise levels from the Bureau of Transportation Statistics (BTS)[20] could be utilized. BTS has started a national, multi-modal transportation noise mapping initiative to facilitate the tracking of trends in transportation-related noise as changes occur at an unprecedented rate. The noise mapping tool takes into account noise from road and aviation sources. **Figure** below is a snapshot of the analysis shown geographically. It should be noted that BTS has indicated that the modeling is designed for tracking of general trends, and is not intended to evaluate local noise levels. The model predicts average noise levels over all times of the day and seasons of the year. As with GIS buffer and EPA's EJScreen options listed

[18] Transportation and Housing Alliance (THA) Toolkit. http://tjpdc.org/transportation/tha-toolkit/. Accessed June 28, 2019.

[19] EJScreen can do the same for a variety of environmental indicators such as PM 2.5, Ozone, and Diesel PM. It also can run an EJ Index to help understand how EJ populations may be facing disparate exposure.

[20] As with any model, a number of conservative assumptions were made for the model. If any one of those assumptions were to change, the noise exposure numbers could also change. Noise attenuation or shielding due to barriers and terrain are not considered in the current model. Additionally, sounds from non-transportation sources are not considered. Also, sounds from things such as construction sites, rock quarries, power plants, etc., could actually mask some of the transportation noise.

above, one of the weaknesses of the analysis using national-level modeling approach is that it does not account for noise barriers. However, future enhancements may help to refine the modeling.

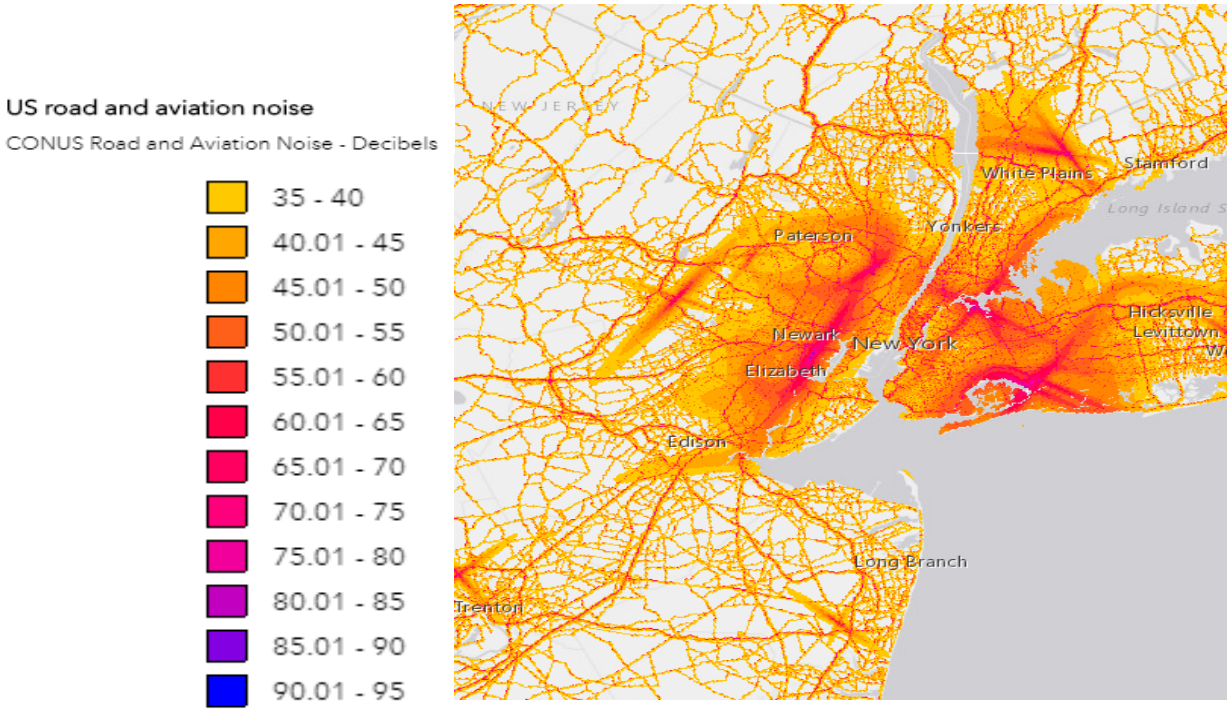


Figure 9: National Transportation Noise Map for Road and Aviation Noise

Resiliency-related Measures

Resilience is a key theme in the NJTPA's plans but for this round of planning, a resilience-related performance measure was not developed. In the future, the NJTPA may wish to adopt one or more resilience performance measure(s) and to develop the appropriate data sets to inform evaluation of the measure(s).

The following sections provide information on three potential types of resiliency-related measures: impact-based measures, design-based measures, and maintenance-based measures. The NJTPA might also want to look at the resiliency-related plans put into place post-Sandy, such as the Post Hurricane Sandy Transportation Resilience Study in NY, NJ, and CT.[21] One potential measure could be a count of how many of the various suggestions have been implemented in the NJTPA region.

Impact-based Measures

An impact-based measure would provide information on the changing frequency, duration, or magnitude of flooding impacts over time. Some examples of potential measures include:

[21] Available at https://www.njtpa.org/planning/regional-studies/completed-studies/post-hurricane-sandy-transportation-resilience/ny-nj-ct-hurricane-sandy-follow-up.

- **Hours of roadway lane miles closed due to flooding or other weather conditions.**
- **Number of roadway closures due to flooding or other weather conditions.**

The benefit of an impact-based measure is that it provides a direct and observable measure of the resilience of the system to flooding. More than any other type of measure, it can be used to identify where interventions are needed to improve performance over time. The primary drawback of these types of measures is that they are focused on current day issues with no advanced consideration of how environmental conditions may change over time.

One potential issue with impact-based measures is the year-to-year variability in weather events. This variability may obscure the true changes in resilience. The NJTPA could use any of the following approaches to smooth over the year-to-year variability and identify more specific trends in resiliency:

- Use a four-year rolling average of closures to better identify trends in closures.
- Normalize the closure data by the number of heavy precipitation/storm surge events. However, this metric would still be skewed when there are extremely heavy precipitation events like Hurricane Irene and Lee.
- Segment the measure into two – one for flood events below the design storm (e.g., 50-year, 25-year, 15-year. See Section 10 – Drainage of the NJDOT Roadway Design Manual), and one for events that exceed the design storm.
    - *Storms at or below the design standard:* By removing the large, outlier precipitation events, this segmentation would allow the NJTPA to better set expectations for performance by focusing on resilience to storms that are at or below the region's design storm.
    - *Storms exceeding the design standard*: Creating a parallel measure for large storm events would provide useful insight into the region's response and preparedness for large storm events, which are projected to become more frequent in the future.

Data Needs

TRANSCOM's historical event search data and NJDOT's Drainage Management System (DMS) may be useful for evaluating an impact-based measure; however, the quality and level of detail of those systems on flooding-related closures and damages may be insufficient. For example, NJDOT recently attempted to use the DMS as part of an extreme weather and asset management pilot funded by FHWA. They found that the recording of flood impacts varies depending on the person reporting it and the person recording the incident. If revisions are made to those systems, the following data fields should be standardized and information on how to record specific flood events should be shared with a broader audience:

- Route number, milepost begin and end
- Direction of closure
- Specific lanes affected
- Partial or full closure
- Duration of closure
- Specific cause of closure
- Specific clogged drainage structures

Additionally, NJDOTs 23 CFR Part 667 analysis of facilities repeatedly requiring repair and reconstruction due to emergency events may provide useful information on vulnerable locations. However, ICF does not recommend it as the only data set on resilience since it provides a narrow perspective on impacts (e.g., it only covers the NHS, it focuses exclusively on emergency events rather than all flooding events).

Another option to explore is the use of third party smart phone application data to track weather-related incidents on the road network. For example, Waze allows users to report fog, hail, flood, and "ice on road" conditions (see Figure 10). Through Waze Connected Citizens Program, public agencies can partner with Waze to access this information. Individual cities, such as Norfolk[22], have found the flood data from Waze to be accurate, but it is not known if this data source is reliable in more rural locations.

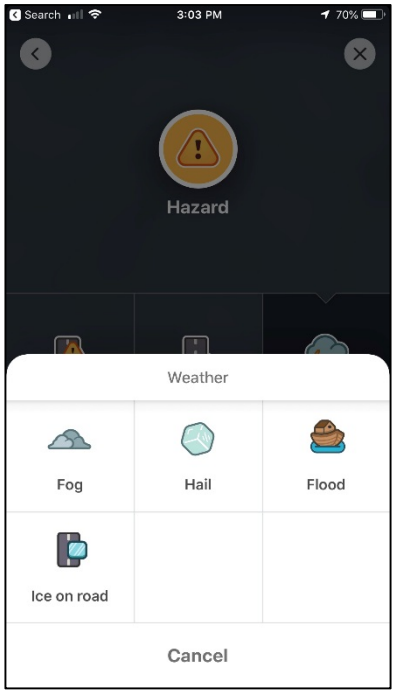


Figure 10 : Waze screenshot of weather-related hazard reporting capabilities

Resilient Design Measures

A design-based measure would provide information on the percent of facilities designed to withstand current storms and/or future changes in sea level rise and precipitation, either based on their location, vulnerability, or design. Some examples of potential measures include:

- **Location**
  - Percent of [businesses/residents/roadways/bridges] within the 100-year flood plain.
- **Vulnerability**
  - Percent of facilities that are highly vulnerable to climate change.
  - Percent of passenger miles traveled on facilities that are highly vulnerable to climate change.
- **Design**
  - Percentage of facilities that can accommodate XX inches of sea level rise.
  - Percentage of culverts that are hydraulically adequate for current and future precipitation events.
  - If new design guidelines are developed to make infrastructure more resilient: percentage of facilities in compliance with the new guidelines.

One of the benefits of resilient design measures is that after an initial assessment of performance, it should be relatively easy to update and track over time. Additionally, the vulnerability and design measures provide a direct measurement of resilience to current and future extreme weather events.

While the percent of people and infrastructure within the flood plain, is arguably the easiest measure to calculate and track, it does not provide meaningful information on the resilience of the system. It is a measure that other MPOs are using, but ICF does not recommend it as a measure for the NJTPA. A

[22] Murphy, Ryan. "Waze helps track flooding, and could predict the future." AP News. 8 August 2018. Accessed at: https://www.apnews.com/d5e9d30a98ca4d63ac14c855590cc12a

roadway or business could be within the flood plain but be sufficiently elevated to withstand flood events without damage. Additionally, the NJTPA and local communities should not immediately aim to abandon existing infrastructure investments within the flood plain. The NJTPA could, however, modify the measure to distinguish between facilities that have a resilient design and those that still need to be updated.

Another type of measure that could also be considered, and is related to one of the "other regional indicators" that has already been selected (related to land cover) includes:

- **Regional Stormwater Absorption Ability**
  - Percent of tree canopy in the region. For example, Washington, DC, has a tree canopy goal of 40% by 2032.[23] Tree canopy data are available via the National Land Cover Database.
  - Percent of the region covered by impervious surface. Imperviousness data is available from the National Land Cover Database.
  - Number of gallons of stormwater retainable by newly installed green infrastructure (e.g., bioswales or raingardens).
  - Acres of wetlands restored.

Data Needs

The following table provides a proposed approach and data needs for each of the potential resilient design measures.

Measure Type	Proposed Measure	Assessment Approach
Location	Percent of [businesses/residents/road ways/bridges] within the 100-year flood plain.	Overlay of assets/businesses/residences with FEMA 100-year flood plain maps.
Vulnerability	Percent of facilities that are highly vulnerable to climate change.	The NJTPA could use or modify their existing vulnerability assessments with data-driven indicators for sensitivity and adaptive capacity. The data sets used in the analysis should be updated on a routine basis so the vulnerability scores can be re-run to determine if the number of highly vulnerable assets is changing over time. Examples of data-driven sensitivity and adaptive capacity indicators are available in Table 2 of the FHWA *2013-2015 Climate Resilience Pilot Program: Outcomes, Lessons Learned, and Recommendations* report.
	Percent of passenger miles traveled on facilities that are highly vulnerable to climate change.	Overlay information on the passenger miles traveled annually on facilities within the information above in order to calculate the percentage on facilities that are highly vulnerable. Passenger miles traveled would be collected for transit and calculated for highways based on vehicle miles traveled and average vehicle occupancies.

[23]DC Department of Energy & Environment. Trees in the District. https://doee.dc.gov/node/1118761

Design	Percentage of facilities that can accommodate XX inches of sea level rise.	The NJTPA could use an elevation-based asset data set to determine which assets are sufficiently elevated or otherwise protected from future sea level rise. As opposed to a simple analysis of whether an asset is in or out of a floodplain, this accommodation-based assessment would take into account more detailed information on exposure based on asset attributes. A LiDAR data set that has not stripped out transportation assets (i.e., not a "bare earth" dataset) can help with this assessment.
	Percentage of culverts that are hydraulically adequate for current and future precipitation events.	Using the approach taken in the CTDOT *Climate Change and Extreme Weather Vulnerability Pilot Project*, NJDOT could model the hydraulic adequacy of their culverts and their capacity for larger future precipitation events. As culverts are replaced at the end of their useful life and designed to current standards and precipitation values, the number of inadequate culverts should decrease.
	Percentage of facilities in compliance with the new guidelines	This would require including compliance with new guidelines as a field in existing transportation asset management systems. This could build upon the NJTPA's project prioritization criteria resilience element: "incorporate flood proofing retrofit for areas within FEMA flood risk zone."

Table 2: Potential Resilient Design Measures

Maintenance-based Measures

A maintenance-based measure would track maintenance activities undertaken to reduce the impact of flooding events. Examples of potential measures are:

- **Number of drainage systems and/or culverts proactively cleaned prior to storm events.**
- **Frequency of sweeping of roads and rail tracks at frequently flooded locations.**
- **Frequency of monitoring of assets following extreme heat events.**

Additional maintenance-based measures could be developed to reflect the region's approach to addressing and managing flooding.

Data Needs

The NJTPA would need access to state and local maintenance logs to track these measures. Over time, the maintenance efforts can be correlated with frequency of flooding and extreme heat events to determine the effectiveness of these maintenance-based approaches to resilience.

4. Recommendations for Processes to Support Use of Regional Measures

Beyond the development and tracking of measures, the NJTPA should integrate use of these performance measures into its various planning products.

Unified Planning Work Program

Many of these new measures would require additional research and preparation before the NJTPA would be able to fully implement them. For example, many of the measures assume some kind of inventory, which the NJTPA could develop as part of a future project within the UPWP. Some of the measures already recommended for on-going tracking, such as on-road mobile source greenhouse gas emissions, also would need to be incorporated into on-going analysis that is conducted as part of the biennial conformity analysis and would need to be accounted for in the UPWP.

Transportation Improvement Program

For the region to make progress toward goals, the regional agencies need to fund projects that will address these performance areas. Therefore, these selected measures should be used to help support evaluation of projects as part of project prioritization for the TIP during each update cycle. The NJTPA already has a robust project prioritization process, with prioritization criteria that are the foundation of a system that scores proposed projects according to how well they satisfy LRTP goals, considered along with other factors, such as feasibility of project delivery, funding availability and project timing. The NJTPA can consider to what extent the project prioritization criteria could be updated or enhanced to more specifically address the contribution of projects toward the region's goals, using the performance measures or variants that would be appropriate for project-level analysis.

Long Range Transportation Plan

The regional performance measures should be documented in relation to regional goals as part of the update of the NJTPA LRTP, and information on performance should be included within the system performance report component of the Plan. Moreover, the performance measures could be integrated into project prioritization procedures to support project selection for the plan. Also, the LRTP update process could be used to set long-range targets in relation to the performance measures and assess forecast progress toward the targets in order to further strengthen the performance-focus of the plan.

Coordination with Other Agencies

Many of these measures overlap with the interests of other agencies in the region or state, such as environmental resource agencies, housing and urban development agencies, transit agencies, or land use planning agencies. Moreover, the NJTPA can use its convening authority among all of the local governments in the region to build a consensus to work together to achieve common goals through policies and priorities that would be integrated into local comprehensive plans and local programs. For instance, the region could consider designating priority investment areas that support increasing density around regional transit stations and stops (similar to how the Metropolitan Washington Council of Governments has designated regional Activity Centers, and works with local governments to support land use planning that targets growth to these locations that are aligned with the region's transit

network).[24] Such an effort would build directly on the Together North Jersey initiative and its recommendations for promoting transit-oriented development by encouraging local development codes to support compact, mixed-use development near transit stations and stops; working with New Jersey's economic incentive programs to encourage development easily accessible to public transit; and refining the Grow NJ program to foster job growth near transit. By putting a focus on measuring progress toward regional goals using performance measures, such as the share of households and jobs within a ½ mile of regional transit, the NJTPA can potentially encourage new collaborative initiatives.

Beyond local land use planning, the NJTPA could also work with NJDOT and local transportation agencies to consider updates to design standards, such as by requiring that all non-freeway roadway improvements provide safe pedestrian accommodations, and that any investments in climate vulnerable areas be built to withstand a higher level of water intrusion and force. While these types of efforts are not contingent on the performance measures, use of regional performance measures could help to support more visibility and attention to critical issues within the region in order to encourage greater cross-agency collaboration.

[24] For more information on the Metropolitan Washington Council of Government's designated Activity Centers, see: https://www.mwcog.org/community/planning-areas/land-use-and-activity-centers/activity-centers/