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Table 1: Stakeholders

Organization Type	Agency Name	Role
EMS	Pittsburgh Bureau of Emergency Medical Services	Incident and Emergency response
FHWA	FHWA Federal Highway Administration	Design Support
Fire Department	Churchill Volunteer Fire Department	Incident and Emergency response
Fire Department	Edgewood Volunteer Fire Department	Incident and Emergency response
Fire Department	Forest Hills VFD	Incident and Emergency response
Fire Department	Monroeville Fire Department	Incident and Emergency response
Fire Department	Penn Hills No.7 VFC	Incident and Emergency response
Fire Department	Pittsburgh Bureau of Fire	Incident and Emergency response
Fire Department	Swissvale Fire Dept.	Incident and Emergency response
Fire Department	Wilkins Township VFD	Incident and Emergency response
Government	Allegheny County	Local Government
Government	Churchill Borough	Adjacent Traffic Signal/Incident Management Coordination
Government	City of Pittsburgh	Adjacent Traffic Signal/Incident Management Coordination
Government	Edgewood Borough	Adjacent Traffic Signal/Incident Management Coordination
Government	Forest Hills Borough	Adjacent Traffic Signal/Incident Management Coordination
Government	Monroeville	Adjacent Traffic Signal/Incident Management Coordination
Government	Penn Hills Borough	Adjacent Traffic Signal/Incident Management Coordination
Government	Pennsylvania Emergency Management Agency (PEMA)	Incident and Emergency Response
Government	Pennsylvania Office of Homeland Security	Incident and Emergency Response

Organization Type	Agency Name	Role
Government	Southwestern Pennsylvania Commission (SPC)	Regional Planning
Government	Swissvale Borough	Adjacent Traffic Signal/Incident Management Coordination
Government	Wilkins Township Borough	Adjacent Traffic Signal/Incident Mgt Coordination
Government	Wilkinsburg Borough	Adjacent Traffic Signal/Incident Management Coordination
PennDOT	PennDOT Central Offices	Overall System Management
PennDOT	PennDOT District 11-0	Overall System Management
PennDOT	PennDOT District 11-0 Maintenance Office	I-376 Maintenance Operations
PennDOT	PennDOT District 11-0 Tunnels	Squirrel Hill Tunnel Operations
Police	Churchill Borough Police Department	Incident and Emergency Response
Police	Edgewood Police	Incident and Emergency Response
Police	Forest Hills Police	Incident and Emergency Response
Police	Monroeville Police	Incident and Emergency Response
Police	Penn Hills Police	Incident and Emergency Response
Police	Pennsylvania State Police (PSP)	Enforcement and Incident/Emergency Response
Police	Pittsburgh Police	Incident and Emergency Response
Police	Swissvale Police	Incident and Emergency Response
Police	Wilkins Township Police	Incident and Emergency Response
Police	Wilkinsburg Police	Incident and Emergency Response
Transit	Port Authority of Allegheny County	Transit Information
Transit	Westmoreland County Transit Authority	Transit Information
Toll Operator	Pennsylvania Turnpike Commission (PTC)	Tolling Information

Table 2 Parkway East Exit and Entrance Ramps

I-376 Eastbound (outbound)			I-376 Westbound (inbound)		
On Ramps	EXIT	Off Ramps	On Ramps	EXIT	Off Ramps
			Stanwix Street	70D	Stanwix Street
Fort Pitt Blvd. (add lane)	71A	Grant Street (lane drop)	Grant Street	71A	Grant Street (lane drop)
				71B	Second Avenue
Bates Street PA-885	72A	Forbes Avenue Oakland (lane drop)	PA-885 Boulevard of the Allies (add lane)	72B	TO I-579 Boulevard of the Allies Liberty Bridge (lane drop)
				73A	PA-885 SOUTH Glenwood
PA-885 Boulevard of the Allies (add lane)	73			73B	PA-885 NORTH Oakland
Beachwood Boulevard (stop controlled)	74	Squirrel Hill Homestead (lane Drop)	Forward Avenue (add lane)	74	Squirrel Hill Homestead
Edgewood/Swissvale: Monongahela Avenue	77	Edgewood Swissvale	South Braddock Avenue	77	Edgewood Swissvale
Edgewood/Swissvale: South Braddock Avenue					
	79A	US 30 East Forest Hills			
	78B	PA-8 NORTH Wilkinsburg	PA-8 NORTH Ardmore Blvd.	78B	PA-8 NORTH Wilkinsburg (lane drop)
Ardmore Boulevard PA-8, US-30 East	79A	Greensburg Pike	Old Gate Road (add lane)	79B	PA-130 Churchill (lane drop)
Churchill PA-130 (add lane from William Penn Hwy)	79B	PA-130 Churchill			
Rodi Road PA-791	80	US-22 EAST BUSINESS Monroeville	US-22 WEST BUSINESS		
	81	PA-791 NORTH Penn Hills	Rodi Road	81	PA-791 NORTH Penn Hills
	84A	PA-48 SOUTH Monroeville	Haymaker Road		
	84B	Plum	Haymaker Road	84	
	85	I-76 Penna Turnpike	I-76 Penna Turnpike	85	
	-	US-22 EAST Monroeville	US-22 WEST Monroeville	-	

Table 3: User Needs

User Need ID	User	Need
UN001	Public	Real-time incident and congestion data provided mobility options
UN002	Public	Motorist advisory information displayed on DMS about roadway incidents encountered during travel
UN003	Public	Park and Ride available spaces along the PE Corridor
UN004	Public	Individual traffic lane condition in regard to open or closure of lane
UN005	Emergency services	Dynamically closing or opening of individual traffic lanes as warranted and providing advance warning of the closure(s) (through the use of Lane-Use Control Signals), in order to safely merge traffic into adjoining lanes
UN006	Emergency services	Ability to coordinate lane closure with RTMC due to incident
UN007	Squirrel Hill Tunnel Operations Center	Ability to close lane or lanes approaching Squirrel Hill Tunnel for incidents, anti-icing treatments, or maintenance
UN008	Transit Agencies	Real-time park-and-ride lot information to help commuters plan trips
UN009	PennDOT	Automated detection of wrong-way or stopped vehicles, alert/motorist advisory of wrong way drivers, warn right-way drivers of approaching wrong-way vehicle
UN010	PennDOT	(manually/automated) alert/motorist advisory of wrong way drivers, warn right-way drivers of approaching wrong-way vehicle
UN011	PennDOT	Ability to graphically see the ATM system active status on the video wall or operators workstations
UN012	PennDOT	Integrate proposed ATM infrastructure with existing ITS infrastructure
UN013	PennDOT	Regional situational awareness of roadway conditions of the Parkway East corridor
UN014	PennDOT	The ability to dynamically manage lanes throughout the Parkway East corridor
UN015	PennDOT	The ability to automatically detect queued vehicles throughout the corridor
UN016	PennDOT	Adjust speed limits (manually/automated) accordingly to weather conditions, incident conditions, or traffic queueing.
UN017	PennDOT	Ability to coordinate/close lane or lanes for safety service patrol for incident management

UN018	PennDOT	Collect and disseminate real-time incident and congestion data
UN019	PennDOT	Remotely access and control ATM system

Table 4 National ITS Service Package Applicable to Active Traffic Management Strategies

NATIONAL ITS SERVICE PACKAGES APPLICABLE TO ACTIVE TRAFFIC MANAGEMENT STRATEGIES

Service Package	Name	Description	SPC Status
APTS09	Transit Signal Priority	Determines the need for transit priority on routes and at certain intersections and requests transit vehicle priority at these locations.	Future
ATMS03	Traffic Signal Control	Provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package.	Existing
ATMS04	Traffic Metering	Provides central monitoring and control, communications, and field equipment that support metering of traffic and supports the complete range of metering strategies including ramp, interchange, and mainline metering.	Not identified in regional architecture or recommended for this project.
ATMS06	Traffic Information Dissemination	Provides driver information using roadway equipment, such as dynamic message signs.	Existing
ATMS07	Regional Traffic Management	Provides for sharing traffic information and control among traffic management centers to support regional traffic management strategies.	Planned
ATMS09	Transportation Decision Support and Demand Management	Recommends courses of action to traffic operations personnel based on an assessment of current and forecast road network performance	Planned
ATMS18	Reversible Lane Management	Provides for the management of reversible lane facilities; also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.	Existing
ATMS19	Speed Warning and Enforcement	Monitors vehicle speeds and supports warning drivers when their speed is excessive; also, the service includes notifications to an enforcement agency to enforce the speed limit of the roadway.	Existing
ATMS22	Variable Speed Limits	Sets variable speed limits along a roadway to create more uniform speeds, to promote safer driving during adverse conditions (such as fog), and/or to reduce air pollution; also known as speed harmonization.	Not identified in current regional architecture – would be required for ATMS project
ATMS23	Dynamic Lane Management and Shoulder Use	Provides for active management of travel lanes along a roadway, including the associated hardware and control electronics that are used to manage and control specific lanes and/or the shoulders.	Not identified in current regional architecture – would be required for ATMS project
ATMS24	Dynamic Roadway Warning	Includes systems that dynamically warn drivers approaching hazards on a roadway (e.g., roadway weather conditions, road surface conditions, traffic conditions including queues, obstacles or animals in the roadway and any other transient event that can be sensed).	Not identified in current regional architecture – would be required for ATMS project

MC08	Work Zone Management	Manages work zones, controlling traffic in areas of the roadway where maintenance, construction, and utility work activities are underway.	Existing
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Table 5: General ATM System/Functional Requirements

Req. ID	Functional Area	Requirement
1	ATMS	The regional and statewide ATMS shall provide graphical user interface (GUI) for the proposed ATM system
2	ATMS	The regional and statewide ATMS shall provide command, control, status of the ATM system
3	ATMS	The RTMC ATMS operators shall have the ability to manually set condition of the lane use control signal (LUCS), VSLS, DMS, AWWVD individually or gantry entire set
4	ATMS	The ATMS shall have ATM System status/condition recording capabilities
5	LUCS	The LUCS shall be attached to the gantries approximately every 1/2 mile and in accordance with MUTCD section 4M.03.
6	LUCS	The LUCS shall have compliant MUTCD full color displays Off (Blank), GREEN downward arrow, RED X, AMBER X for lane conditions
7	LUCS	The LUCS shall have the ability to have remote/local control for lane conditions
8	LUCS	The LUCS shall operate to inform drivers of downstream lane control conditions in accordance with MUTCD guidelines
9	LUCS	The LUCS shall be fully interlock to prevent conflicting indications.
10	LUCS	Malfunction LUCS or control function shall cause the affected signs to show blank face.
11	LUCS	The LUCS shall comply with all pertinent state guidelines, MUTCD, NEC and NEMA standards and be NTCIP compliant.
12	LUCS	The LUCS controller shall interconnect to the ATM System and be housed in the local ITS cabinet
13	MVDS	The MVDS shall be spaced 1/2 mile apart or where roadway geometry and Queue typically occurs.
14	MVDS	The MVDS shall coincide with LUCS location or where roadway geometry and Queue typically occurs.
15	MVDS	The MVDS shall interconnect to the ATM System network that is housed in the local ITS cabinet
16	MVDS	The MVDS shall be capable of capturing data across all lanes of traffic
17	MVDS	The MVDS shall collect classification, speed and volume

18	MVDS	The MVDS shall transmit its data locally and to the RTMC in real time for dissemination to the ATMS automated Queue detection system
19	CCTV	The CCTV system shall provide 100% coverage of roadway, tunnel and tunnel approaches to monitor traffic and provide visual confirmation of ATM System LUS, DMS and VSLS.
20	DMS	The DMS shall provide roadway situational awareness advisory information to the motorist.
21	AVIDS	The AVIDS shall provide alerts to the ATMS operators for wrong way detection for vehicles, stopped vehicles and automate motorist advisory signs.
22	AVIDS	The AVIDS shall be controlled by the ATMS traffic control system software and provide automated vehicle detection and wrong way detection system notification
23	VSLS	VSLS shall be controlled by the ATMS traffic control system software or locally controlled that is housed in an adjacent ITS field cabinet/enclosure.
24	VSLS	VSLS shall be a combination of a static and electronic sign used to manage and control traffic
25	VSLS	VSLS shall use an active programmable/changeable LED speed limit pixel matrix and surrounding reflective MUTCD complaint static panel
26	VSLS	VSLS design and operation shall comply with all pertinent State guidelines, MUTCD, NEC, NEMA, and NTCIP standards.
27	AWWVD	The Automated Wrong-Way Vehicle Detection System Signs shall be place at mainline and ramp sites for motorist alert of WWD

Table 6: Desired Changes

Change Type	Change
Capability	The ATM System needs to allow for a single data entry source for RTMC operations personnel. Types of data entry may include: traffic modes, events (e.g., incidents, weather events, work zones, and work order requests), field device messages (e.g., DMS, VSLS), and access control information. This allows the ATM System to collect and log actions and provide information to the regional and statewide ATMS application
System Processing	Proposed ATM System shall disseminate real time roadway conditions and status of the Parkway East to system users and stakeholders
Interface	Existing Parkway East ITS infrastructure, ATMS application, Squirrel Hill Tunnel Lane Control System will have the ability coordinate together for full corridor operations
Personnel	Additional personnel may be required due to complexity of ATM System operation and required interaction with the system. Additional training provided for the RTMC and Tunnel Operations Staff
Operation Environment	The operational environment will require development of standard operational procedures, guidelines and functional (i.e., changes in the operational environment)
Support	Due to the additional infrastructure (Hardware and Software) of the ATM System, budget, maintenance and life cycle replacements will be required to keep the system at operational effectiveness.
Data Collection	The ATM The ATM System needs to collect and consume traffic data (e.g., volume, speed, occupancy, vehicle classification, vehicle location, and possible parking information) from ITS field devices, third party data providers, and probe vehicles. This allows the ATM System to report real-time traffic conditions and vehicle location data, and to process traffic data to create congestion alerts, and calculate travel times to the ATMS. System needs to collect and consume traffic data (e.g., volume, speed, occupancy, vehicle)

<p>Data Collection</p>	<p>The ATM System will collect and disseminate planned and unplanned events data from internal/external in-state sources e.g. Tunnel and special events modes This allows the ATM System to report and manage roadway events such as incidents, work zones, and weather events and provide data to the regional ATMS operators</p>
<p>Data Collection</p>	<p>The ATM System needs to receive field device traffic, environmental, and event data from other systems and to provide other TMCs. This allows the regional and statewide ATMS to collect and report traffic data, environmental data, and events from systems collecting data in jurisdictions outside of PennDOT geographic and jurisdictional boundaries</p>

Table 7: Risk Register

Risk #	Risk Owner	Description of Risk and Impact	Likelihood (1-4)	Impact (1-4)	Rating (L + I) (2-8)	Mitigation Strategy
1	PennDOT	System interoperability between the stakeholder agencies	2	2	4	Update Regional ITS Architecture to include all stakeholders and identify their required interactions
2	PennDOT	Compatibility of new systems/technologies with life cycle stage and limits of the existing systems	2	2	4	Perform ITS technology evaluation to identify new technologies. Perform condition assessment and inventory to identify existing limitations and create a plan fund, acquire, and implement to new and compatible technologies.
3	PennDOT	Speed of technology innovation and life cycle	2	2	4	Evaluate then choose technologies that have the longest life cycle and upgrade capability.
4	PennDOT	Need for periodic system maintenance and upgrades	3	1	4	Implement plans for maintenance and upgrades. Prepare for upgrades and maintenance prior to end of system life cycle.
5	PennDOT	Longevity of regional commitment to system due to the dynamic ATM System environment in the region	1	2	3	Determine the realized safety benefits after operation of the ATM system. Ensure regional ITS projects continue to be a priority.

Risk #	Risk Owner	Description of Risk and Impact	Likelihood (1-4)	Impact (1-4)	Rating (L + I) (2-8)	Mitigation Strategy
6	PennDOT	Ability to obtain support and commitment from agencies for the establishment and maintenance of systems/technology	2	3	5	Program system maintenance into budgets to ensure system is maintained.
7	PennDOT	Ability to provide periodic staff training	2	2	4	Budget for and provide staff training, learning and reference recourses.
8	PennDOT	Ability to provide technical staff continuity	2	1	3	Use PennDOT employees as technical staff, or provide longer term staffing contracts with consultants.
9	PennDOT	R/W	3	3	6	Early Survey in areas where right-of-way impacts may occur.
10	PennDOT	Material lead time	4	3	7	Start material procurement early in the project to ensure availability and reduce material sourcing delays.
11	PennDOT	Escalation of project costs due to inaccurate cost estimating	1	2	3	Work with vendors and contractors and historical ECMS price data.
12	PennDOT	Schedule risk: the risk that construction and integration will take longer than expected	2	2	4	Proactively work with designers, contractors and vendors to identify issues early and plan mitigation strategies.

Risk #	Risk Owner	Description of Risk and Impact	Likelihood (1-4)	Impact (1-4)	Rating (L + I) (2-8)	Mitigation Strategy
13	PennDOT	Performance risk, the risk that the project will fail to produce results consistent with project specifications.	1	2	3	Work with vendors and other agencies to help select proven hardware and systems.
14	PennDOT	Risks associated with external hazards, including storms, floods, vandalism, sabotage, and terrorism	1	3	4	Work with vendors and other agencies to help select proven hardware and systems.

Table 8: SPC TIP for Parkway East Allegheny County 2019-2022

TIP Project ID	Category	Title	County	Improvement	Cost	Primary Project
27225	TIP	2048 Wm Penn Hwy/I-376 Ramp to PA 48	Allegheny	Restoration	\$ 125,000.00	Mill and overlay, curb gutter repair, mountable curb, guide rail, drainage on SR 2048 (Business 22) from Interstate 376 in Churchill to SR 48, Churchill and Monroeville Borough and Wilkins Township, Allegheny County.
87767	TIP	I-376, Edgewood to Churchill	Allegheny	Restoration	\$ 40,855,000.00	Mill and overlay and bridge work on I-376 from Edgewood to Churchill in Edgewood, Churchill and Wilkesburg Borough's, Allegheny County.
87778	TIP	I-376, Churchill to Monroeville	Allegheny	Resurface	\$ 90,920,000.00	Mill and overlay, bridge rehabilitation and preservation on I-376 from Churchill to Monroeville in Churchill Borough and Monroeville Borough, Allegheny County.
94651	TIP	I-376/Parkway East ATM (This Project)	Allegheny	Safety Improvement	\$ 14,500,000.00	(This Project) The Parkway East Active Traffic Management System (PE ATMS) is an intelligent transportation system (ITS) improvement intended to improve traffic safety and operations on portions of I-376 in Allegheny County, Pennsylvania.
105438	TIP	I-376, Commercial Street Bridge	Allegheny	Bridge Replacement	\$ 123,100,000.00	Study the replacement of the Commercial Street Bridge and 4 structures at the Braddock Avenue Interchange in the City of Pittsburgh, Allegheny County.
105465	TIP	I-376 Above 2nd Ave Wall Replacement	Allegheny	Safety Improvement	\$ 2,000,000.00	Rehabilitation to two retaining walls along I-376 above 2nd Avenue and the Three Rivers Heritage Trail at segment 0711 and 0720 in the City of Pittsburgh, Allegheny County.
112249	TIP	I-376, Bath Tub Flooding	Allegheny	Drainage Improvement	\$ 3,713,150.00	Study drainage issues on I-376 Westbound, from Fort Pitt Bridge to about 600 feet before 10th Street Bridge overpass in the City of Pittsburgh, Allegheny County

Table 9: ATM System Operational Alternatives by Location

Section	Direction	Segment(s)	Location	Deficiency	ATMS Conceptual Mitigation Strategy	Strategy/Notes	Comments
1	Westbound		Second Ave to the Grant St "bathtub" area	Roadway Obstruction	Dynamic Lane Control	Close Right two lanes and all traffic Exits at Grant St.	By NOAA National Weather Service Flood Stage indication or roadway sensors
1	Intersecting roadways		Blvd of the Allies WB prior to ramp to Parkway (Ramp U)		DMS signs on Arterials prior to onramps	Warn of roadway incidents before traffic enters Parkway East	
2	Eastbound	724 – 744	Bates Street interchange approaching the Squirrel Hill Tunnel	Rear-end crashes	Queue Warning/Dynamic Speed Limits	Time of day research	
2	Westbound	725	Near the Bates Street interchange	Rear-end crashes	Queue Warning/Dynamic Speed Limits		
2	Eastbound		From Boundary Street through the Squirrel Hill Tunnel	Angle Crashes	Dynamic Speed Limits		
2	Intersecting roadways		Bates Street		DMS signs on Arterials prior to onramps	Warn of roadway incidents before traffic enters Parkway East	
3	Eastbound	750 – 764	Near the Edgewood-Swissvale Interchange	Rear-end crashes	Queue Warning/Dynamic Speed Limits		
3	Eastbound	774 – 780	Near the Forest Hills interchange	Rear-end crashes	Queue Warning/Dynamic Speed Limits		
3	Westbound	785 – 745	Churchill to the Beechwood Boulevard Interchange	Rear-end crashes	Queue Warning/Dynamic Speed Limits		
3	Eastbound		Near Edgewood / Swissvale off-ramp	Angle Crashes	Dynamic Speed Limits		
3	Westbound		Edgewood/Swissvale interchange	Angle Crashes	Queue Warning/Dynamic Speed Limits		
3	Intersecting roadways		South Braddock Ave		DMS signs on Arterials prior to onramps	Warn of roadway incidents before traffic enters Parkway East	
1,2	Westbound		Second Avenue off-ramp to the Grant Street off-ramp	Angle Crashes	Dynamic Speed Limits		
1,2,3,4	Eastbound		Corridor wide Grant St to US-22		CCTV Coverage	Incident Management	
1,2,3,4	Westbound		Corridor wide Grant St to US-22		CCTV Coverage	Incident Management	
1,2,3,4	Eastbound		Corridor wide Grant St to US-22		Dynamic Lane Control	Incident Management	
1,2,3,4	Westbound		Corridor wide US-22 to Grant St		Dynamic Lane Control	Incident Management	

Table 10: I-376 Parkway East Active Traffic Management Conceptual Cost Estimate

I-376 Parkway East Active Traffic Management Conceptual Cost Estimate										
Disclaimer: This cost estimate is inconclusive until the ConOPS is approved with PennDOT's direction for ATMS infrastructure along the corridor.										
Item	Quantity	Unit Cost	Component Cost	Utilities Cost (5%)	ROW Cost	30% Contingency	Total Construction Cost	Design Cost (20% of Total Construction Cost)	CM/CI Cost (15% of Total Construction Cost)	Total System Cost
Full Span Sign Structure	23	\$200,000.00	\$4,600,000.00	\$230,000.00	\$0.00	\$1,380,000.00	\$6,210,000.00	\$1,242,000.00	\$931,500.00	\$8,383,500.00
Half Span Sign Structure	15	\$75,000.00	\$1,125,000.00	\$56,250.00	\$0.00	\$337,500.00	\$1,518,750.00	\$303,750.00	\$227,812.50	\$2,050,312.50
Half Span Sign Structure (would be upon Retaining Wall)	2	\$75,000.00	\$150,000.00	\$7,500.00	\$0.00	\$45,000.00	\$202,500.00	\$40,500.00	\$30,375.00	\$273,375.00
Existing Sign Structure Load Analysis/Inspection	22	\$5,000.00	\$110,000.00	\$0.00	\$0.00	\$33,000.00	\$143,000.00	\$28,600.00	\$21,450.00	\$193,050.00
Additional Dynamic Message Signs	11	\$50,000.00	\$550,000.00	\$27,500.00	\$0.00	\$165,000.00	\$742,500.00	\$148,500.00	\$111,375.00	\$1,002,375.00
Additional CCTV Cameras	68	\$5,000.00	\$340,000.00	\$17,000.00	\$0.00	\$102,000.00	\$459,000.00	\$91,800.00	\$68,850.00	\$619,650.00
Overhead LUCS 4'x4'	279	\$15,000.00	\$4,185,000.00	\$209,250.00	\$0.00	\$1,255,500.00	\$5,649,750.00	\$1,129,950.00	\$847,462.50	\$7,627,162.50
Auxiliary DMS sign every 1.5 mile (48"x80")	20	\$25,000.00	\$500,000.00	\$25,000.00	\$0.00	\$150,000.00	\$675,000.00	\$135,000.00	\$101,250.00	\$911,250.00
Mobilization	1	Lump Sum (5% of Total Construction Cost)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$786,525.00
Equipment Package	1	Lump Sum (1% of Total Construction Cost)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$157,305.00
Construction Surveying	1	Lump Sum (0.05% of Total Construction Cost)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$78,652.50
Maintenance and Protection of Traffic During Construction	1	Lump Sum (6% of Total Construction Cost)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$943,830.00
RTMC Back-end software modification/integration	1	\$100,000.00	\$100,000.00	\$0.00	\$0.00	\$30,000.00	\$130,000.00	\$26,000.00	\$19,500.00	\$175,500.00
		Total	\$11,660,000.00	\$572,500.00	\$0.00	\$3,498,000.00	\$15,730,500.00	\$3,146,100.00	\$2,359,575.00	\$23,202,487.50

Table 11: Operational and Safety Measures of Effectiveness

Type	Measure of Effectiveness	Suggested Data Sources
Operational	<u>Average travel time</u>	<u>INRIX</u>
	<u>Travel time reliability</u>	<u>INRIX</u>
	<u>Total delay</u>	<u>INRIX and PennDOT sensors in/on the Parkway East</u>
	<u>Utilization of ATM system</u>	<u>RTMC logs</u>
Safety	<u>Crash frequency, severity and rate</u>	<u>Pennsylvania Crash Information Tool (PCIT) and State Police Crash Reports</u>