Alexandria Parking Technology Evaluation and Implementation Plan

Contents

Executive Summary

To the end of maximizing the utility of parking operations in its densest activity centers, the City of Alexandria (The City, COA) has evaluated a variety of technology options in order to maximize the existing parking facilities in the City. This report summarizes the parking technology evaluation process recently completed by the City, which included a background conditions review, an evaluation of a set of candidate technology applications, and the development of an implementation framework and timeline. Notably, the existing conditions assessment was conducted prior to the ongoing COVID-19 pandemic, and reflects conditions prior to that time.

Technology Evaluations

Through a process of stakeholder interviews and evaluations of existing conditions, the study team highlighted a set of twenty-eight technology applications to be evaluated. Each of these was to be examined independently, identifying individual technology products and vendors available in the public marketplace, and assessing them according to a set of criteria related to the City's goals and objectives for its parking program, resulting in a set of 16 strategies to me included in an overall parking technology strategy (see Table 1.

Table 1: Revised Set of Technology Applications

1. User Experience/Payment & Pricing	
A. Remote System Access	
1	Enable **advance reservation of spaces** in garages.
2	Enable real-time occupancy rates for garages to be incorporated into parking apps and website through data feeds from U-Street.
B. Off-Street Parking Facilities	
1	Dynamic signage indicating space availability at garage entrances.
3	Conversion to contactless operation in garages, with a focus on payment via mobile devices or pay-by-plate paystations.
C. On-Street Parking Facilities	
1	Incorporate rate variability by time of day into IT systems governing meters.
3	Transition of existing pay & display stations to pay-by-plate stations.
2. Data Collection/Management	
1	Payment-based data collection (continuous collection of data from app payment streams and integration with data from meters and garages/lots)
2	Conduct pilot program to collect **occupancy rates** for on-street parking to be used for planning purposes. Equipment would be a mobile, camera-based system and/or use of LPR system by planning staff.
3	Integration of existing data sources (meters, Parkmobile, others?)
4	Develop a purposeful IT architecture for parking management, possibly through a contractor-developed parking data cloud hub.
3. Permitting	
2	Complete disconnect of RPP program from tax payment. Establish virtual permitting via license plate numbers. Would require full rollout of License Plate Readers (LPR). Expansion of program to allow paid parking in residential zones citywide (mobile app payment only).
3	"Virtual" freight loading zones integrated into parking apps, including ability to reserve a loading zone in advance. Would include discounts up to free for deliveries during low-demand times.
4. Enforcement	
1	Unify systems used for enforcement (moving violations vs. parking infractions), multiple LPR systems.
2	Full deployment of LPRs and integration into ticketing systems to eliminate manual entry of citations.
5. Alternative Vehicles	
2	Develop EV charging station business model.
3	Install % of EV stations in garages (need to determine appropriate percentage).

Implementation Timeline

Having trimmed the list of applications, the study team proceeded to develop a structured implementation framework for an overall technology strategy. Each application was further examined to determine their necessary implementation steps, and realistic start dates and task durations were estimated. Further focus was placed on whether certain steps would be prerequisites for steps that are a part of other technology applications.

The team also examined whether existing contracts could be used to advance certain applications. Applications which entail the acquisition of significant physical infrastructure were considered to be the most applicable uses for grant

funding. Those applications were identified, and a master matrix of hardware and services vendors was prepared (Table 4) to guide the sourcing of technology and services in the future.

The applications most amenable to the use of grant funds have been listed below, and prioritized based on two factors: a) the certainty of whether physical technology assets would be acquired, and b) how soon the application has been placed into the timeline, based on the logic that applications set to be implemented sooner are more reliable uses of available grant funds.

Table 2: Prioritized candidate applications for grant funding

Rank	Application #:	Description	Notes
1	1.B.3	Contactless Garage Payment and Access	Definite acquisition of physical infrastructure
2	1.B.1	Dynamic Occupancy Signage at Garages	
3	2.2	Data collection infrastructure for on-street occupancy rates	
4	2.3	Acquire a purposeful IT architecture/business intelligence system for parking management	
5	1.C.1, 1.C.3	Accelerate acquisition and deployment of pay-by-plate parking meters incorporating meter rate variability by time of day	
6	2.1	Payment-Based Data Collection	New physical infrastructure may be unnecessary depending on assessed capabilities of existing systems.
7	1.A.2	Real Time Occupancy Rates in Garages	

Introduction

The City of Alexandria (The City, COA) embraces a multimodal approach to transportation planning and complete streets principles. In that context, it is important to recognize that automobiles have as much impact on the transportation landscape when they are parked in a parking space as when they are being driven from point A to point B. Parking accounts for a large proportion of usable land in any city, and as such, should receive the same amount of planning attention applied to its management as the roadways themselves.

The ongoing evolution of the role of technology in transportation, embodied in Intelligent Transportation Systems integrated mobile apps and micromobility, is generating a variety of new tools for the management of parking resources. The City's parking infrastructure and pricing policies influence travel behavior as people make decisions based on the best balance of access, cost and availability.

Alexandria is proactively seeking technology applications to enable data-driven decision-making in support of the City's policies. This report summarizes provides a review of existing conditions, an evaluation of a set of candidate technology applications, and the development of an implementation frame-work and timeline.

The City's team generated an outline of available parking technologies and best practices and provided an implementation timeline and suggested phasing plan for the City for the next five (5) years. The City evaluated 28 technological applications that could advance the cause of integrating parking resources and the City's transportation goals through management of parking assets. They include applications to improve the user experience through remote access to payment and reservation processes, improved wayfinding and permitting, streamlined rate-setting processes, and integration of software systems. These candidate technologies were evaluated based on a set of criteria that reflect the City's goals for its parking resources. The list was refined to 16 applications that were determined to be the most applicable and achievable for the City.

The implementation framework identifies the key applications and relationships for each set of technologies and how they help address the City's goals for parking infrastructure, listed below.

A. Maximize the utilization of existing off-street parking resources.
B. Improve parking availability by creating turnover of on-street paid parking.
C. Improve management of residential parking and related programs.
D. Prepare for new and emerging transportation options (e.g. Transportation Network Companies (TNC's), connected and autonomous vehicles, electric vehicles, etc.).
E. Improve the perceptions of parking and access to the City.
F. Educate the public about parking and transportation policies and programs.

A list of potential uses of grant funding are identified, and a set of potential vendors is matched up to those technologies that are candidates for grant funding application.

Existing Conditions

An understanding of the City's context is critical when evaluating technological solutions to address parking needs and transportation priorities. This section summarizes the parking inventory and utilization patterns in key areas of the City, as well as parking-related findings from previous planning efforts. Notably, the existing conditions assessment was conducted prior to the ongoing COVID-19 pandemic, and reflects conditions prior to that time.

City of Alexandria Parking Resources

Off-Street Parking Resources

The City owns four parking garages and five surface parking lots, which are operated under contract. In addition, the densely developed areas in Old Town, Old Town North, and Del-Ray feature over 75 private lots and garages which include approximately 5,000 parking spaces.

Metered Parking

Approximately 100 blocks within the City are metered, with prices varying across the City. Most blocks use pay-and-display multi-space meters, while meters in the Eisenhower East and Potomac Yard areas operate on a pay-by-plate basis. ParkMobile's pay by phone system can be used at all metered parking spaces, as well as select blocks participating in the Residential Pay-by-Phone program. Interviews with stakeholders revealed that the pay-by-plate pay stations have been readily accepted by the driving public in the City, and that the transition of phone payment apps from PanGo to ParkMobile has increased the use of pay-by-phone as an option, likely due to that system's coverage throughout the Washington, DC region.

Residential Permit Programs

The City contains fourteen residential permit zones, restricting non-resident parking by varying durations and at different times of day. On select blocks near King Street, the City uses pay-by-phone payments for non-residents to manage non-resident parking. The Old Town Area Parking Study recommends increasing the incidence of pay-by phone in residential blocks and increased residential permit fees for additional vehicles beyond the first two in a household.

Existing Parking Technologies

The City already employs a variety of technologies to manage its parking inventory, as listed in Table 3

Table 3: Existing Parking Technologies in Alexandria

System	Category	Utilization
Apex system	Software	Management system for permitting transactions
Cale meters	Parking Meters	Parking paystations in two categories: • Pay and Display Stations • Pay-by-Plate Stations
ParkMobile	Service	Processes payments by phone for all metered on-street parking and city-owned surface parking lots throughout Alexandria.
gtechna	Software	Management system for processing parking and traffic enforcement transactions (i.e. ticket processing)
Brazos LPRs	License Plate Readers (LPRs)	LPRs utilized by Alexandria Police Department (APD)
Duncan LPRs	License Plate Readers (LPRs)	LPRs utilized by Parking Enforcement Officers (PEOs)

Amano	Parking Access and Revenue Control System (PARCS)	PARCS system for garages
Parkeon	Parking Meters	Multi-space meters for surface parking lots and ungated garages

Parking Utilization

There is a widely-held perception that parking is in very short supply in Old Town, or that it is "difficult to park" in Old Town on weekdays and during busy shopping times on weekends. The reality reflected in documented utilization rates is that the period when parking availability is low is limited to weekends and the weekday midday period. Other portions of the City generally do not experience short parking supply at any times.

Additional details regarding parking supply and utilization can be seen in this study's Electronic Appendix (Appendix V).

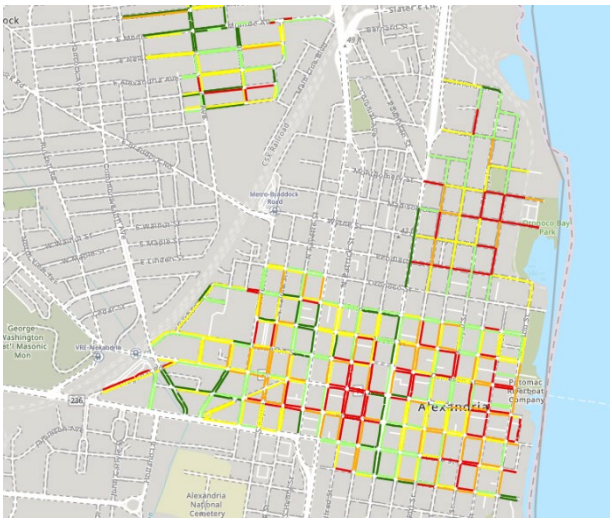

Figure 1: On-street parking utilization in Old Town and surrounding areas during the weekday evening period (6:00PM-7:00PM)

Stakeholder Input Summary

Interviews with stakeholders provided essential context to understand the issues facing the City that may be addressed through technology applications. The set of stakeholders who were interviewed included various COA departments as well as Visit Alexandria, an organization of businesses which works to support hospitality and tourism in Alexandria:

- Alexandria Police Department
- COA – Department of General Services
- COA – Finance Department
- COA – Information Technology and Geographic Information Services
- COA – Planning and Zoning
- COA – Transportation & Environmental Services
- Visit Alexandria

The needs identified by the stakeholders interviewed, summarized in Table 3 and detailed in Appendix II, formed the primary basis for the set of technology applications analyzed in the course of this study.

Table 4: Needs Identified through Stakeholder Interviews

Category	Need identified
Off-Street Parking (garage and lot) Management	• Improve signage standards at garages and lots. • Improve wayfinding signage. • Improve coordination of on- and off-street parking rates. • Integrate parking payment and reservation apps into garages and lots.
On-Street Parking/ Curbside Management	• Better address delivery vehicles blocking lanes in Old Town. • Dedicate curbspace to bicycles and scooters to keep sidewalks clear for pedestrians. • Address improper use of handicap hang-tags. • Increase flexibility in setting parking rates. • Phase-out parking meters and pay stations in favor of mobile payment systems.
Residential Permit Programs	• Complete separation of residential permitting from tax system. • Address three-hour limit, which makes enforcement difficult.

The stakeholder interview process identified several shortcomings of the City's suite of systems that are used to manage parking resources. As mentioned above, real-time information is a desired goal in order to inform parking customers, and in order to achieve the goal of providing real-time information to customers, an open data policy for the City would be a prerequisite. In an overarching sense, the greatest administrative need seems to be for greater integration of systems, something which is hindered by the multiple systems currently utilized. For example, the Alexandria Police Department (APD) uses different systems for moving violations and parking infractions, and APD officers and PEOs use separate systems for license plate readers (LPRs). The variety of contracts maintained for various systems, with different client offices within City government as clients for contractors, is emblematic of the complex current process to manage the City's parking resources (see Figure 2).

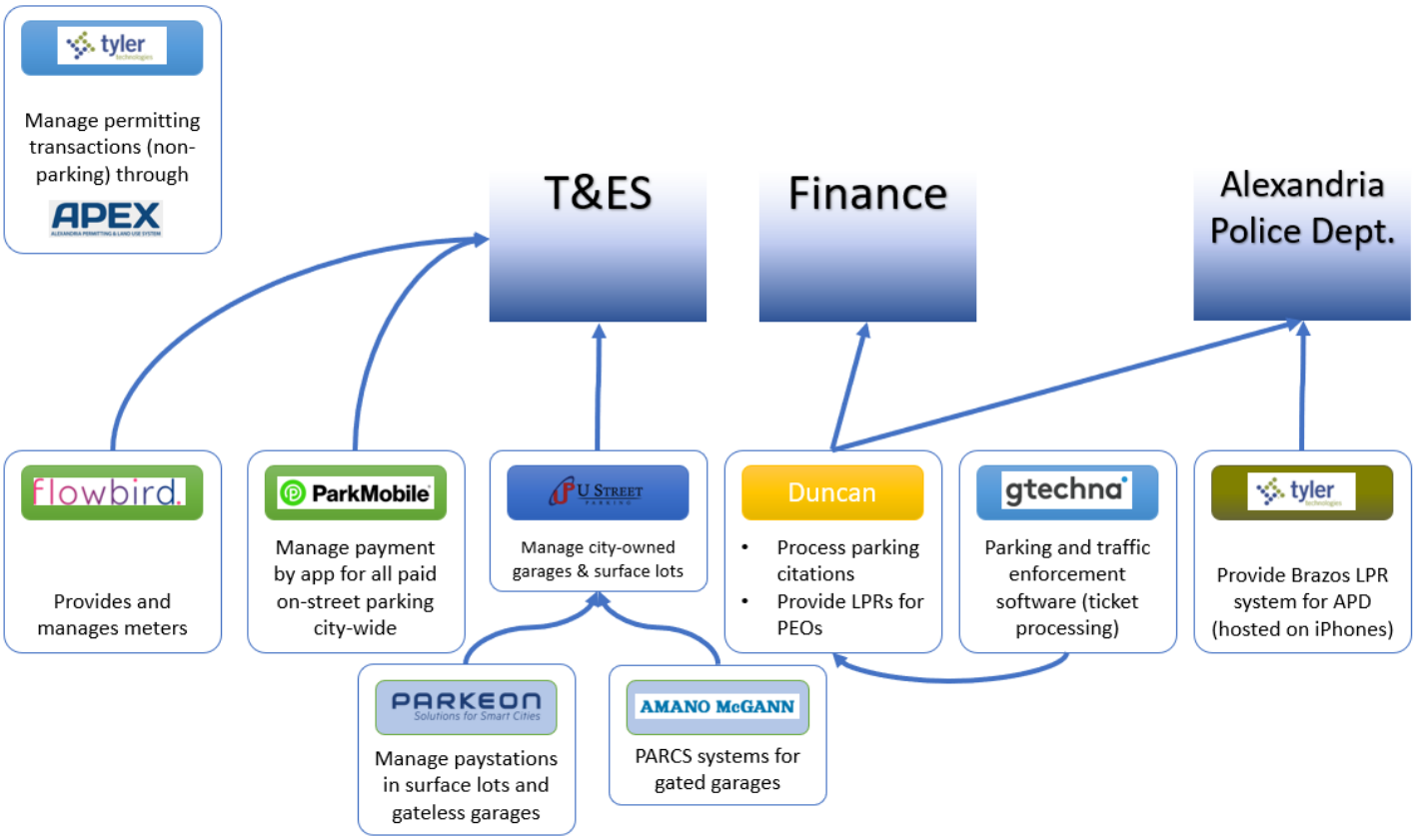

Figure 2: Reporting Relationships of the City's Existing Parking Infrastructure Contractors

Administrative and systems improvements identified thus far include the need to be able to run reports directly from contractors' collected data rather than requesting them from the contractor, the need to better integrate the ITS office in future procurements, and the need for an overarching comprehensive parking strategy developed and supported by all City departments.

Recommendations from Prior Studies

In addition to needs identified through the stakeholder interview process, the study team evaluated the collective set of recommendations captured in prior parking studies conducted by the City. Those recommendations are summarized in Table 4. A detailed listing of recommendations from all prior studies can be found in Appendix I, as well as in the Electronic Appendix (Appendix V).

Table 5: Recommendations from Prior Studies

Study	Year	Recommendations
Old Town Area Parking Study	2015	• Set hourly rates for City-owned off-street facilities during evening and weekend time periods below on-street rates. • Improve wayfinding signage. • Deploy a city-maintained online parking map that includes digital wayfinding and real-time garage/lot occupancy information. • Integrate digital wayfinding and real-time garage/lot occupancy information into parking apps. • Make City-owned surface lots available for long-term parking.
Old Town North Parking Study	2016	• Implement shared parking agreements with owners of private lots to offer overnight parking opportunities for residential permit holders. • Reduce the number of spaces developers are required to provide. • implement in-lieu fees in place of parking provision.
Del-Ray Parking Study	2016	• Improve wayfinding signage. • Implement shared parking agreements with owners of private lots to offer overnight parking opportunities for residential permit holders.
North Potomac Yard Small Area Plan	2017	• Implement shared parking agreements with owners of private lots to offer overnight parking opportunities for residential permit holders. • Mandate that garage parking in new development be either underground or above-ground in parking interiors.
City of Alexandria Smart Mobility Framework Document	2018	• Implement real-time variable rate parking meters. • Implement electric vehicle charging station management. • Install parking garage guidance systems, including occupancy sensors. • Implement near real-time parking information systems.

Technology Evaluations

Technology Review Process

The stakeholder interviews and evaluations of existing conditions highlighted a set of twenty-eight technology applications to be evaluated. Each of the technology applications were each reviewed individually against a set of criteria designed to capture the City's goals for its parking infrastructure (see below). Each evaluation resulted in a short, written assessment that captured the feasibility of the application for the City as well as the degree to which it can be expected to advance those goals.

Each parking technology was evaluated by a series of criteria, reflecting the trade-offs of each option (see Table 5). The goal was for the combined benefits of each implemented technology to compensate for the combined shortcomings. Technologies were evaluated both by their impact on the COA and on the public.

The evaluation process, including the initial full set of 28 applications, detailed explanation of the criteria, and results of the evaluation process, is detailed further in Appendix III.

Table 6: Summary of Evaluation Criteria Applied to Technology Applications

Criteria			Rating	Notes
Cost	Up-Front (Implementation)	Cost to COA	Low/Medium/High	
		Cost to Public		
	Ongoing	Cost to COA		
		Cost to Public		
Implementation Complexity		Complexity for COA	Low/Medium/High	
		Complexity for Public		
Population Served			Small/Medium/Large	
			Equitable Application	Are certain groups disproportionately affected?
Challenges Met		Challenges met for COA	Low/Medium/High	Does the application address previously documented challenges faced by COA and the public?
		Challenges met for Public		
Sustainable and Upgradable Platform			Yes/No	Will the application accommodate further enhancements?
Third Party Platform			Yes/No	
Implementation Timeframe			Short/Medium/Long	
Traffic Impact			Small/Medium/Large	

Refined Set of Technologies

The evaluation process resulted in a set of sixteen technology applications that both address the City's as well as additional factors such as the political landscape in the City, how well each technology application matched to the sources of available grant funds, and related ongoing efforts that may advance certain items on the list, such as the effort to promote electric-powered vehicles. Table 7 lists the technology applications to be included in the City's strategy for parking technology implementation.

Table 7: Revised Set of Technology Applications

1. User Experience/Payment & Pricing	
A. Remote System Access	
1	Enable **advance reservation of spaces** in garages.
2	Enable real-time occupancy rates for garages to be incorporated into parking apps and website through data feeds from U-Street.
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1	Dynamic signage indicating space availability at garage entrances.
3	Conversion to contactless operation in garages, with a focus on payment via mobile devices or pay-by-plate paystations.
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1	Incorporate rate variability by time of day into IT systems governing meters.
3	Transition of existing pay & display stations to pay-by-plate stations.
2. Data Collection/Management	
1	Payment-based data collection (continuous collection of data from app payment streams and integration with data from meters and garages/lots)
2	Conduct pilot program to collect **occupancy rates** for on-street parking to be used for planning purposes. Equipment would be a mobile, camera-based system and/or use of LPR system by planning staff.
3	Integration of existing data sources (meters, Parkmobile, others?)
4	Develop a purposeful IT architecture for parking management, possibly through a contractor-developed parking data cloud hub.
3. Permitting	
2	Complete disconnect of RPP program from tax payment. Establish virtual permitting via license plate numbers. Would require full rollout of License Plate Readers (LPR). Expansion of program to allow paid parking in residential zones citywide (mobile app payment only).
3	"Virtual" freight loading zones integrated into parking apps, including ability to reserve a loading zone in advance. Would include discounts up to free for deliveries during low-demand times.
4. Enforcement	
1	Unify systems used for enforcement (moving violations vs. parking infractions), multiple LPR systems.
2	Full deployment of LPRs and integration into ticketing systems to eliminate manual entry of citations.
5. Alternative Vehicles	
2	Develop EV charging station business model.
3	Install % of EV stations in garages (need to determine appropriate percentage).

Implementation Timeline

Each application has been further examined to determine their necessary implementation steps, realistic start dates and estimated task durations. Further focus is placed on whether certain steps would be prerequisites for steps that are a part of other technology applications, and whether existing contracts could be used to advance certain applications. Applications which entail the acquisition of significant physical infrastructure were considered to be the most applicable uses for grant funding. The implementation Notes section below elaborates these details for each of the sixteen technology applications selected for inclusion in an overall technology strategy, and Figure 3 demonstrates the detailed implementation timeline and dependency relationships.

The applications most amenable to the use of grant funds have been listed below, and prioritized based on two factors: a) the certainty of whether physical technology assets would be acquired, and b) how soon the application has been placed into the timeline, based on the logic that applications set to be implemented sooner are more reliable uses of available grant funds.

Table 8: Prioritized candidate applications for grant funding

Rank	Application #:	Description	Notes
1	1.B.3	Contactless Garage Payment and Access	Definite acquisition of physical infrastructure
2	1.B.1	Dynamic Occupancy Signage at Garages	
3	2.2	Data collection infrastructure for on-street occupancy rates	
4	2.3	Acquire a purposeful IT architecture/business intelligence system for parking management	
5	1.C.1, 1.C.3	Accelerate acquisition and deployment of pay-by-plate parking meters incorporating meter rate variability by time of day	
6	2.1	Payment-Based Data Collection	New physical infrastructure may be unnecessary depending on assessed capabilities of existing systems.
7	1.A.2	Real Time Occupancy Rates in Garages	

Implementation Notes by Technology Application

1.A.1 Advance Registration of Spaces in Garages

Implementation Steps

- Confer with U-Street Parking about capability of existing PARCS infrastructure and any hardware updates/ installation costs for implementing occupancy detection technologies.
- Building on existing vendor relationships, implement coordination strategies between parking app developers and U-Street Parking to monitor real-time demand.

Relevant Existing Contracts

Incumbent and future parking garage management contracts.

Potential Uses of Grant Funding

N/A (Potential investments in upgraded PARCS systems would be made as part of technology application 1.A.2)

Potential Vendors

- Parker (Streetline)
- Parkhub
- ParkWhiz (Arrive)
- SpotHero

Dependencies

Real-time occupancy data for off-street facilities would be a prerequisite for advance space reservation, so the application is dependent on 1.A.2, Real Time Occupancy Rates in Garages.

Related On-going Processes

N/A

1.A.2 Real-Time Occupancy Rates in Garages

Implementation Steps

- Connect API Data feeds gathered through PARCS systems. (Equipment in different garages are from various manufacturers. U-Street has the responsibility to manage all data.) Determine if any current PARCS systems are candidates for early replacement.
- Establish agreements with U-Street Parking on type of information and reporting frequency needed to streamline occupancy information to the City and to users through an open-source map via an app.
- Develop a plan for the most beneficial use of real-time occupancy data (e.g. to adjust parking prices). Verify that PARCS systems can provide data that supports desired uses.

Relevant Existing Contracts

- Incumbent and future parking garage management contracts.
- Maintenance contracts with suppliers of existing PARCS systems.

Potential Uses of Grant Funding

Potential investments in upgraded PARCS systems (including acceleration of replacement schedule) if any of the existing systems are not capable of efficiently transferring occupancy data to parking garage management contractor in real time.

Potential Vendors

- AimsParking
- Conduent
- Designa
- Flowbird
- Metric Parking
- Parkhub
- Parkmobile
- ParkPow
- Quercus
- Quest HTS
- SKIDATA
- Smarking

Dependencies

Application 1.A.1 would be dependent on successful implementation of this strategy.

Related On-going Processes

N/A

1.B.1 Dynamic Signage

Implementation Steps

- Coordinate methodology with U-Street Parking for gated facilities to transfer occupancy (count) data from entrances to signs through the use of induction loops, video equipment, etc.
- Develop a Marketing Plan with U-Street Parking for branding off-street locations. Select locations for new signs and parking information message (payment method, pricing, enforcement, etc.).
- Design dynamic signage installations that comply with architectural review standards for Old Town.
- Architectural Review process and other relevant approvals.
- Procurement lead time for dynamic signage.

Relevant Existing Contracts

Incumbent and future parking garage management contracts.

Potential Uses of Grant Funding

- Data Aggregation Products
- Customized Signage Systems

Potential Vendors

- Carolina Time Equipment
- Conduent
- Indect
- Parkhelp
- SKIDATA

Dependencies

Real-time occupancy data for off-street facilities would be a prerequisite of displaying space availability information for users, so the application is dependent on 1.A.2, Real Time Occupancy Rates in Garages.

Related On-going Processes

N/A

1.B.3 Contactless Garage Payment and Access

Implementation Steps

- Coordinate methodology with U-Street Parking for transition to contactless operation. Determine whether gated or gateless operation model is preferred.
- If gated model is preferred:
    - Acquire PARCS infrastructure that incorporates contactless payment verification readers capable of reading tickets produced by walk-up payment machines and QR codes on mobile devices.
    - Acquire walk-up payment machines that produce printed payment verification tickets.

- If gateless model is preferred:
  - Acquire walk-up pay-by-plate payment machines.
  - Develop a plan for regular enforcement of garages by PEOs. Integrate PEO hand-held devices with garage PARCs system.
- Determine which garages will be prioritized as test-bed locations.

Relevant Existing Contracts

- Incumbent and future parking garage management contracts.

Potential Uses of Grant Funding

- New or upgraded entrance gate systems
- Barcode/QR code readers
- Walk-up payment machines

Potential Vendors

- ParkMe (INRIX)
- Metric Parking
- Parkhub
- ParkMobile
- ParkPow
- SKIDATA

Dependencies

Advance registration of spaces would not be a prerequisite, but would greatly increase the effectiveness of the program if implemented concurrently.

Related On-going Processes

N/A

1.C.1 Implement Meter Rate Variability by Time of Day

Implementation Steps

- Assessment of existing meter infrastructure to determine which meters should be included in time-of-day rate variability program. Oldest meters may not support and are slated for replacement soon.
- Establish price adjustment rules and frequency of rate adjustments changes that provide enough time for the user to adapt to new rates.
- Coordinate with Cale regarding the information to be communicated to ParkMobile and the public (transaction validation, parking duration, time extension) and method of timely transmissions.
- Determine whether and how rate information will be made available for other app developers.

Relevant Existing Contracts

- Maintenance contracts with Cale and IPS for upkeep of and updates to existing meters and pay stations.
- Existing contract with ParkMobile to facilitate pay-by-mobile transactions for on-street parking.

Potential Uses of Grant Funding

Potential need for accelerated acquisition of and transition to pay-by-plate pay stations, if some existing meters/stations are found to be incompatible with desired rate variability plans.

Potential Vendors

- CALE
- Metric Parking

Dependencies

Reliable transmission and aggregation of transaction data would be a pre-requisite for this application, so it is dependent on 2.1 - Payment-Based Data Collection

Related On-going Processes

N/A

1.C.3 Transition to Pay-by-Plate Stations

Implementation Steps

- Identify specific locations for replacement of pay & display stations with pay-by-plate stations based on equipment lifecycle and funding availability.
- Coordinate with VDOT on necessary infrastructure replacements using VDOT funds.
- Update CIP to include accelerated replacement of existing pay-and-display pay stations.

Relevant Existing Contracts

Maintenance contracts with Cale and IPS for upkeep of and updates to existing meters and pay stations.

Potential Uses of Grant Funding

Would likely funded through regular, internal revenue sources.

Potential Vendors

- CALE
- Metric Parking

Dependencies

N/A

Related On-going Processes

N/A

2.1 Payment-Based Data Collection

Implementation Steps

- Coordination with U-Street Parking to determine appropriate timelines, data standards, frequency, and format of transfer when transmitting data to City, and to confirm that U-Street Parking receives data from reservations made through apps.
- Coordination with ParkMobile: Determine appropriate timelines, data standards, frequency, and format of transfer when transmitting data to City.
- Coordination with Cale: Determine appropriate timelines, data standards, frequency, and format of transfer when transmitting data to City.

Relevant Existing Contracts

Incumbent and future parking garage management contracts.

Potential Uses of Grant Funding

Data aggregation products

Potential Vendors

- AimsParking
- Conduent
- Designa
- Flowbird
- Metric Parking
- Parkhub
- Parkmobile
- ParkPow
- Quercus
- Quest HTS
- SKIDATA
- Smarking

Dependencies

N/A

Related On-going Processes

N/A

2.2 Procure Equipment to Collect Occupancy Rates of On-Street Spaces

Implementation Steps

- Investigate portable camera systems to record vehicle occupancy rates. Must be portable, secure, and effective at recording data on a single-block basis.
- Procurement lead time

Relevant Existing Contracts

N/A

Potential Uses of Grant Funding

Portable camera systems

Potential Vendors

- Parkhelp
- Survision

Dependencies

N/A

Related On-going Processes

N/A

2.3 *Develop a Purposeful IT Architecture for Parking Management*

Implementation Steps

Select vendor that provides software services with interoperability capabilities helpful to other departments (Parking Enforcement in Alexandria Police Department).

Relevant Existing Contracts

- Incumbent and future parking garage management contracts.
- Maintenance contracts with suppliers of existing PARCS systems.
- Maintenance contracts with Cale and IPS for upkeep of and updates to existing meters and pay stations.
- Existing contract with ParkMobile to facilitate pay-by-mobile transactions for on-street parking.

Potential Uses of Grant Funding

Data aggregation products

Potential Vendors

- Aimsparking
- All Traffic Solutions
- Conduent
- Designa
- EasyPark
- Parkhelp
- Parkmobile
- Parkpow
- SKIDATA
- Smarking

Dependencies

N/A

Related On-going Processes

N/A

2.4 *Curbside Management Framework*

Implementation Steps

Coordinate with other internal stakeholders to develop policies for a city-wide micromobility management program plan.

Relevant Existing Contracts

N/A

Potential Uses of Grant Funding

N/A

Potential Vendors

N/A – to be identified through ongoing Alexandria Mobility Plan process

Dependencies

N/A

Related On-going Processes

Alexandria Mobility Plan – Curbside Management Chapter

3.2 Virtual Permitting via License Plate Numbers

Implementation Steps

Identify data needs for developing a central system by coordinating with Fairfax County (Permit and Enforcement)

Relevant Existing Contracts

Exploring contract with United Public Safety for parking adjudication in coordination with neighboring jurisdiction.

Potential Uses of Grant Funding

N/A

Potential Vendors

N/A

Dependencies

N/A

Related On-going Processes

Finance – Parking Adjudication Contracting

3.3 Virtual Freight Loading Zones Integrated into Parking Apps.

Implementation Steps

- Map existing loading zones?
- Initiate a conversation with business owners about loading zones needs and solutions.
- Contact app developers such as Curbflow that offer loading zone reservations in the area.

Relevant Existing Contracts

Exploring contract with United Public Safety for parking adjudication in coordination with neighboring jurisdiction.

Potential Uses of Grant Funding

N/A

Potential Vendors

- Curbflow

Dependencies

N/A

Related On-going Processes

N/A

4.1 *Unified Enforcement Systems*

Implementation Steps

- Determine viability of joint UPS contract.
- Assess termination, modification and expansion of current contracts.

Relevant Existing Contracts

Exploring contract with United Public Safety for parking adjudication in coordination with neighboring jurisdiction.

Potential Uses of Grant Funding

N/A

Potential Vendors

- AimsParking
- EasyPark
- IPS Permit Management
- OmniPark
- Quest HTS

Dependencies

N/A

Related On-going Processes

Finance – Parking Adjudication Contracting

4.2 *Deployment of License Plate Readers and Integration into Ticketing Systems*

Implementation Steps

- Discuss data sharing agreements with Alexandria Police Department, VDOT for allowing a central system to archive data on crime, citation, violation, etc. Include conversations to assess the use of LPR data for non-enforcement (i.e. planning) purposes.
- Determine desired parameters for standardized City-wide LPR program in the future.
- Procurement lead time
- Training of personnel

Relevant Existing Contracts

- Contract with Duncan to provide LPRs and process parking citations.
- Contract with gtechna to provide and support parking and traffic enforcement software.
- Exploring contract with United Public Safety for parking adjudication in coordination with neighboring jurisdiction.

Potential Uses of Grant Funding

License Plate Readers

Potential Vendors

- AimsParking
- OmniPark

- Parkhelp
- Quercus
- Quest HTS
- SKIDATA
- Survision

Dependencies

N/A

Related On-going Processes

Finance – Parking Adjudication Contracting

5.2 *Develop Electric Vehicle Charging Station Business Model*

Implementation Steps

Participate in discussions of EV transition strategy efforts.

Relevant Existing Contracts

EV Charging Implementation Strategy Study

Potential Uses of Grant Funding

N/A

Potential Vendors

N/A – to be identified through City of Alexandria EV deployment study/strategy

Dependencies

N/A

Related On-going Processes

City of Alexandria EV deployment study/strategy

5.3 *Install Percentage of Electric Vehicle Stations in Garages*

Implementation Steps

Participate in discussions of EV transition strategy efforts.

Relevant Existing Contracts

EV Charging Implementation Strategy Study

Potential Uses of Grant Funding

N/A

Potential Vendors

N/A – to be identified through City of Alexandria EV deployment study/strategy

Dependencies

N/A

Related On-going Processes

City of Alexandria EV deployment study/strategy

Parking Technology Implementation Plan

		TASK	Dependency	PLAN START	PLAN DURATION (Quarters)
1. User Experience/Payment & Pricing	A. Remote System Access	**1. Advance Reservation of Spaces in Garages**			
		Assess capability of existing PARCS infrastructure.	Dependent on 1.A.2, Real Time Occupancy Rates in	3	3
		Coordination Strategies between parking app developers and U-Street.		4	5
		2. Real Time Occupancy Rates in Garages			
		Establish sharing agreements.		1	2
		Establish agreements with U-Street on reporting.		3	4
		Develop a plan for the most beneficial use of real-time occupancy data.		3	2
	B. Off-Street Parking Facilities	**1. Dynamic signage**			
		Coordinate methodology to transfer occupancy (count) data.	Dependent on 1.A.2, Real Time Occupancy Rates in Garages	3	2
		Develop a Marketing Plan for "branding" off-street locations.		3	3
		Design dynamic signage installations.		4	2
		Architectural Review process and other relevant approvals.		5	4
		Procurement lead time for dynamic signage.		8	4
		3. Contactless Garage Operation			
		Coordinate methodology with U-Street Parking for transition.			
		Determine which garages will be prioritized as test-bed locations.			
		Acquire PARCS infrastructure (gates, code-readers, walk-up payment machines)			
	C. On-Street Parking Facilities	**1. Implement meter rate variability by time of day**			
		Assessment of existing meter infrastructure.	Dependent on: 2.1, Payment-based data collection	5	2
		Establish price adjustement rules and frequency of rate adjustments.		8	3
		Coordinate the information to be communicated to the public.		8	4
		Determine whether and how rate information will be made available.		8	2
		3. Transition to pay-by-plate stations			
		Identify specific locations for replacement of pay & display stations.		1	2
		Coordinate with VDOT on necessary infrastructure replacements.		3	3
		Update CIP		6	2
2. Data Collection/ Management		**1. Payment-based data collection**			
		Coordination with U-Street.		1	5
		Coordination with ParkMobile.		1	4
		Coordination with Cale.		1	4
		2. Conduct pilot program to collect occupancy rates of on-street spaces			
		Investigate portable camera systems to record vehicle occupancy rates.		3	3
		Obtain policy approvals from internal stakeholders.		6	4
		Procurement lead time.		8	4
		3. Develop a purposeful IT architecture for parking management		5	6
		4. Curbside management framework		3	6
3. Permitting		**2. Virtual permitting via license plate numbers**		9	4
		3. "Virtual" freight loading zones integrated into parking apps			
		Initiate a conversation with business owners/		10	8
		Contact app developers (Curbflow) that offer loading zone reservations.		11	8
4. Enforcement		**1. Unified enforcement systems**		12	3
		2. Deployment of LPRs and integration into ticketing systems			
		Discuss data sharing agreements with APD, VDOT.		8	6
		Determine desired parameters for standardized City-wide LPR program.		8	4
		Procurement lead time.		14	3
		Training of personnel.		15	2
5. Alternative Vehicles		**2. Develop EV charging station business model.**		1	15
		3. Install % of EV stations in garages (need to determine appropriate percentage).		1	15

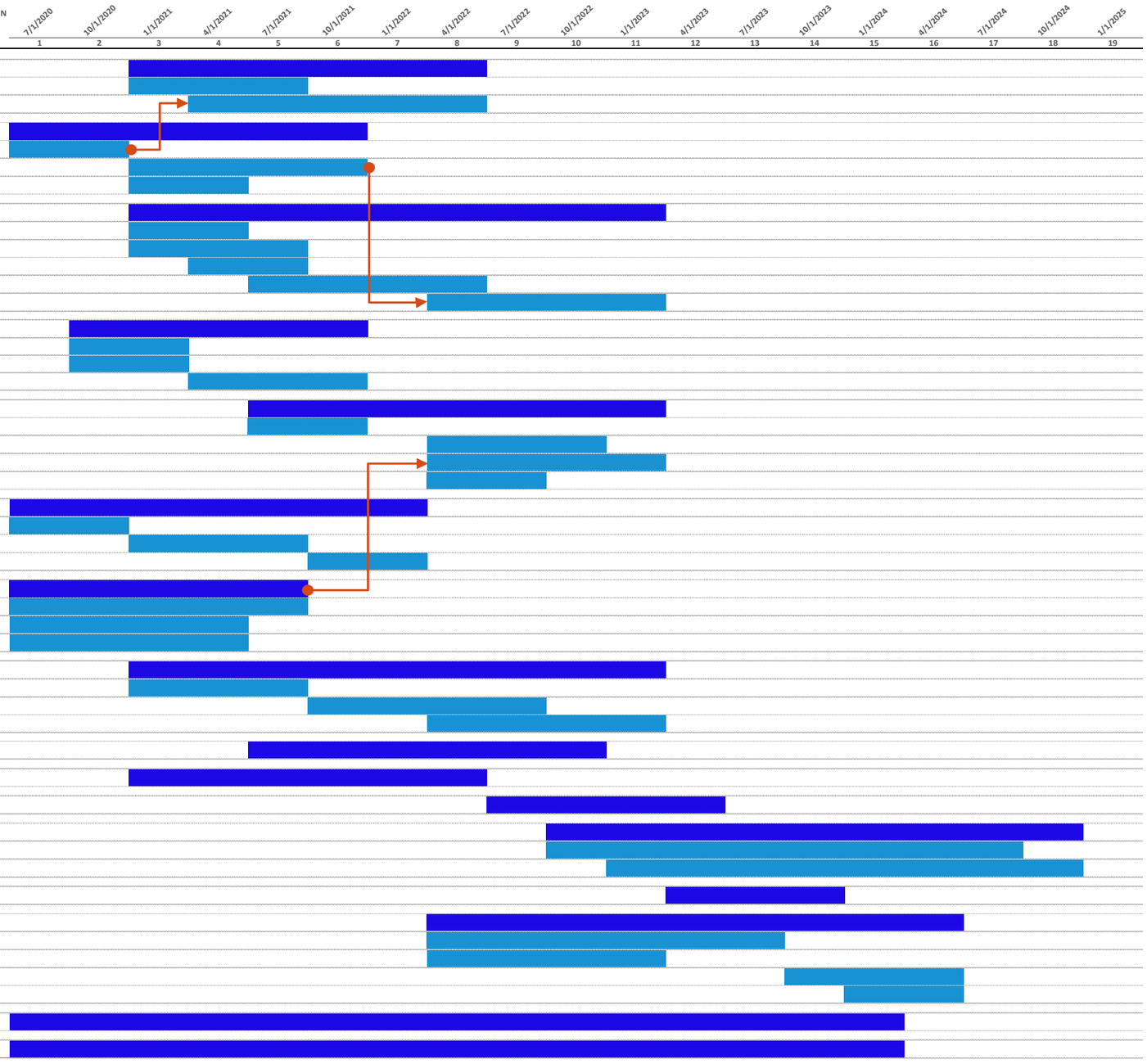

Figure 3: Implementation Timeline for all Selected Technology Applications

Appendices

Appendix I: Matrix of Recommendations from Prior Planning Studies

Study	From	To	INTER-SECTION	Improvement
Residential Pay by Phone Program	Princess Street and Washington Street	Wolfe Street and N Union Street	n/a	Residential pay by phone program on blocks adjacent to metered blocks or other residential pay by phone blocks. Payment made by phone/ appm purchase a 2-hour pre-paid scratch-off permit or meter on a nearby block. Residents and guests use permits to park for free.
Parking Standards for New Development Study	See map in document	See map in document	n/a	Change parking requirements within Enhanced Transit Area to modify the parking requirement minimums and maximum
Parking Standards for New Development Study	See map in document	See map in document	n/a	Hotel per room minimum maximum within enhanced transit area is .2 and .4
Parking Standards for New Development Study	See map in document	See map in document	n/a	Office per 1,000 sf minimum maximum within enhanced transit area is .25 and 1.5
Parking Standards for New Development Study	See map in document	See map in document	n/a	Specific Commercial per 1,000 sf minimum maximum within enhanced transit area is .25 and .3
Parking Standards for New Development Study	See map in document	See map in document	n/a	Restaurant per 1,000 sf minimum maximum within enhanced transit area is 1.0 and 3.0
Review of a Policy for Residential Parking Permits for New Development	See map in document	See map in document	n/a	Restrict future residents of some new residential buildings from obtaining district parking permits.
Del Ray Parking Study	n/a	n/a	n/a	Shared parking: broker shared parking agreements with private property owners.
Del Ray Parking Study	Raymond Avenue	Bellefonte Avenue	n/a	Extend time restrictions on Mount Vernon Avenue: Extent two hour parking restrictions until 9 PM
Del Ray Parking Study	n/a	n/a	n/a	Parking meters along Mount Vernon Avenue: Consider the concept of meters on Mount Vernon Avenue, but not implement until residential restrictions are in place on adjacent residential blocks.
Del Ray Parking Study	n/a	n/a	n/a	Consider expanding District 11 or creating a new residential permit parking district. This would allow for time restrictions on these blocks to discourage extending parking by non-residents.
Del Ray Parking Study	n/a	n/a	n/a	add meters to this lot
Del Ray Parking Study	n/a	n/a	n/a	Improve wayfiding signage program in Del Ray to direct people to available off-street lots and consistently brand off-street parking to make it easy for drivers to see. Also work with existing and new businesses to promote off-street parking locations.

Study	From	To	INTER-SECTION	Improvement
Old Town Area Parking Study	n/a	n/a	n/a	Extend maximum time limit of meters from 2 to 3 hours
Old Town Area Parking Study	n/a	n/a	n/a	End meter times at 7 PM for meters west of Alfred Street and no changes to end time for meters east of Alfred Street
Old Town Area Parking Study	n/a	n/a	n/a	Reduce ticket fees for meter violations, but maintain the current fee for residential parking violations
Old Town Area Parking Study	n/a	n/a	n/a	Adjust pricing of City garages/surface lots to be lower than cost of parking at a meter
Old Town Area Parking Study	n/a	n/a	n/a	Reduce rates at City garage/surface lots on weekends/evenings
Old Town Area Parking Study	n/a	n/a	n/a	Make City owned surface lots available for long term parking and coordinate hours of operation with meters hours
Old Town Area Parking Study	n/a	n/a	n/a	Coordinate operations, maintenance and policies of facilities between City Departments
Old Town Area Parking Study	n/a	n/a	n/a	Provide/promote digital wayfinding with parking garage information through mobile apps and websites and maintain a current City parking map.
Old Town Area Parking Study	n/a	n/a	n/a	Direct staff to add additional parking wayfinding signage consistent with the City's Wayfinding Plan guidelines
Old Town Area Parking Study	n/a	n/a	n/a	Explore adding appropriate real-time information for garage sings.
Old Town Area Parking Study	n/a	n/a	n/a	Direct staff to work with Visit Alexandria and AEDP to provide better marketing of transit and parking options available in the City, including the City's Pay by Phone feature.
Old Town Area Parking Study	n/a	n/a	n/a	Provide more off-street parking options for City employees on the waitlist by increasing the number of monthly garage spaces in City garages or applying the City's garage subsidy to private garages.
Old Town Area Parking Study	n/a	n/a	n/a	Direct staff to help facilitate coordination with private garage owners for garage spaces and promoting transit programs for private employers.
Old Town Area Parking Study	n/a	n/a	n/a	Implement a pilot program for adding a pay-by-phone payment requirement for residential blocks following public engagement with the residents of the proposed blocks. The pay-by-phone payment requirement would not apply to residents of the district where that block is located nor would apply to those resident's guests.
Old Town Area Parking Study	n/a	n/a	n/a	Do not implement resident only parking.
Old Town Area Parking Study	n/a	n/a	n/a	No universal restriction be placed on the availability of residential parking permits in new residential developments in districts 1-5 and each DSUP be considered on its own merits with respect to the issuance of residential parking permits
Old Town Area Parking Study	n/a	n/a	n/a	Do not limit the number of residential parking permits.
Old Town Area Parking Study	n/a	n/a	n/a	Maintain the current residential parking permit fees for the first and second vehicle registered to a household but increase the fee for any additional vehicles.

Study	From	To	INTER-SECTION	Improvement
Old Town Area Parking Study	n/a	n/a	n/a	Amend the City Code to allow one hour parking as an option for residents to request through the residential permit parking district process.
Old Town Area Parking Study	n/a	n/a	n/a	Reexamine current district boundaries to determine if a smaller district adjacent to King Street would be appropriate.
Old Town Area Parking Study	n/a	n/a	n/a	No change to the process for amending/creating residential permit parking districts
Old Town Area Parking Study	n/a	n/a	n/a	Increase funding to modernize citation/enforcement equipment
Old Town Area Parking Study	n/a	n/a	n/a	Increase funding to support additional PEOs
Old Town Area Parking Study	n/a	n/a	n/a	Reinstate the adjudication process.
Old Town Area Parking Study	n/a	n/a	n/a	City should consider going through the public process to update their zoning ordinance to address in-lieu fees and reduced parking requirements in this arena. The updated ordinance should allow the City a mechanism to implement shared parking agreements, in-lieu fees and reduced parking requirements within the Old Town North Area.
Old Town North Parking Study	n/a	n/a	n/a	Update zoning ordinance similar to Fairfax County to address reduced parking requirements and in-lieu fees.
Old Town North Parking Study	n/a	n/a	n/a	Consider retail area as Parking Benefit District and implement short-term meters and shared parking agreements
Old Town North Parking Study	n/a	n/a	n/a	Development needs to accommodate appropriate parking demand with new facilities. Option could be constructing a garage publicly accessible and managed by City and Developer together.
Old Town North Parking Study	Montgomery Street	Fairfax Street	n/a	Add meters to streets including First Street, Montgomery Street, Madison Street, N Saint Asaph Street, N Pitt Street, N Royal Street and N Fairfax Street.
Old Town North Parking Study	n/a	n/a	n/a	City as a whole to reduce commercial parking requirements.
Old Town North Parking Study	n/a	n/a	n/a	City should continue to issue residential parking permits in Old Town North area but consider increasing cost of permits closer to market rate to encourage residents to park in their designated residential parking areas as opposed to on the street.
Old Town North Parking Study	n/a	n/a	n/a	City should explore shared parking agreements within the identified walk-shed that would create opportunities for residents to park overnight in a nearby garage.
Old Town North Parking Study	n/a	n/a	n/a	Look into technologies that modernize parking enforcement practices for parking meters.
Old Town North Parking Study	n/a	n/a	Madison Street/Washington Street OR Madison Street/N. Saint	Enhance signage to provide clear direction to parking available.

Study	From	To	INTER-SECTION	Improvement
			Asaph Street	
Alexandria Master Plan & Citywide Chapters	n/a	n/a	n/a	Change parcels at 5401 Seminary Road and 5188 Dawes Avenue from RL/Residential Low to I/Industrial, with proffer limiting use of parking.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Establish curbside management policy.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Implement real-time variable rate parking meters.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Implement electric vehicle charging station management.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Install parking garage guidance systems.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Implement near real-time parking information systems.
City of Alexandria Smart Mobility Framework Document 2018	n/a	n/a	n/a	Install parking sensors.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Parking should be located below-grade. Each building and block within North Potomac Yard is required to provide a minimum of one level of underground parking.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Above-grade structured parking may be located within the central portion of the block at grade, provided that a minimum of one level of parking is provided below grade and each level of the entire street and/ or park/ open space frontage is devoted to active uses.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Require shared parking throughout North Potomac Yard.
North Potomac Yard Small Area Plan	within North Potomac Yard	within North Potomac Yard	n/a	Add on-street parking in both directions at all time except AM and PM peak directions.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Parking garages should employ smart parking technologies including variable pricing and available parking space technologies.

Study	From	To	INTER-SECTION	Improvement
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Parking garages should accommodate electric vehicle charging stations and consider autonomous vehicles and other emerging transportation technologies.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Wayfinding signage should be employed to efficiently direct drivers to parking garages and clearly indicate price and availability of parking.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Parking garage entrance widths shall be minimized.
North Potomac Yard Small Area Plan	n/a	n/a	n/a	Shared parking iss a key element of the on-site parking program and is required.
Oakville Triangle and Route 1 Corridor Vision Plan	n/a	n/a	n/a	Provide on-street parallel parking where feasible for new streets (excluding Route 1)
Oakville Triangle and Route 1 Corridor Vision Plan	n/a	n/a	n/a	"A" Streets: Curb cuts, entrances to parking garages and service bays are prohibited.
Oakville Triangle and Route 1 Corridor Vision Plan	n/a	n/a	n/a	Parking for townhouses shall be provided from a rear alley. Front loaded townhouses are prohibited. Detached parking garages are encouraged.
Oakville Triangle and Route 1 Corridor Vision Plan	n/a	n/a	n/a	Townhouse standards: Permanent surface parking lots are prohibited

Appendix II: Stakeholder Interviews Summary

Stakeholder interviews took place in September 2019, and included sessions with representatives from the City agencies listed below and Visit Alexandria. This summary details the key insights from those interviews.

- Alexandria Police Department
- COA – Department of General Services
- COA – Finance Department
- COA – Information Technology and Geographic Information Services
- COA – Planning and Zoning
- COA – Transportation & Environmental Services
- Visit Alexandria

Parking Supply/Utilization

1. Measured **reality does not match the perception** that parking is in short supply in Old Town
2. The times when parking is in short supply are **weekday midday and on weekends**, and lack of supply is typically only in Old Town

Garage Management

3. **Garages are underused** because drivers do not know where they are.
4. **Signage overall is lacking**. Would benefit from more signage at eye level and more signage that directs drivers to parking, possibly located on ingress routes to Old Town. Information on the availability of parking (space counts, color codes, or simple binary info) would help direct drivers to the right areas.
5. City has created **standardized signage** that is not well used. Signs need to be externally illuminated in Old Town.
6. **Better coordination of pricing** between garages and on-street and among garages (include private operators?)

Curbside Management

7. **Gradual phaseout of meters and pay stations** would be desirable to reduce maintenance/replacement needs.
8. **Greater flexibility of rates would be a benefit**, specifically the ability to adjust rates within a range without Council action and the ability to adjust rates by time of day based on demand.
9. **Use by ridehailing companies does not seem to cause major issues**, but…
10. **Freight deliveries are an ongoing issue**, with frequent issues of double-parking and blocking lanes. Stakeholders would like to consider restricting delivery times.
11. **Dedication of curb space or parking spaces to bikes & scooters** is seen as a positive.
12. **Improper use of handicap hang-tags** has been an issue, specifically around the Patent & Trademark Office. State law mandates that the first four hours of parking are free for tagholders.
13. **Pay by plate meters have been accepted readily**. Connecting the system to LPRs would boost efficiency.
14. **Better coordination of pricing** (see above)

Admin/Systems

15. Several stakeholders expressed the desire for a **comprehensive strategy for parking** involving all entities. It was mentioned specifically that this is not done for major events (short term) or long-term.
16. **Multiple systems hinder integration**. For example, APD uses different systems for moving violations and parking infractions. APD officers and PEOs use separate systems for LPRs.
17. Need to strive for **real-time data** to better inform visitors and to aid in management and enforcement.

18. Need to formalize an **open data policy**.
19. There are many categories of **GIS data that the City currently does not have** that would be beneficial: private garage utilization, parking service feeds (e.g. Spothero, Parking Panda), ride-hailing services data feeds, EV station locations, and bikeshare/scooter services data feeds. Would also be beneficial to pull data from ParkMobile, Cale, and Republic, and LPR Enforcement together via APIs, and to expand the curbside inventory city-wide.
20. A high priority for APD would be **reducing manual inputs for citations**.

Parking Apps

21. **ParkMobile has been a success**. It is simple to support and has increased use over PanGo.
22. **Ability to reserve spaces and pay in advance** would be beneficial, would increase utilization and decrease searching time.

EV Charging

23. The City now requires a certain percentage of charging stations for new developments, but there are **a lot of questions surrounding EV charging** in public facilities or on-street. How would they be managed and how would users be charged? Would they be supplied through a new contractor, or possibly rolled into the contract for garage operator?

Residential Permits

24. **Tax assessment system is poorly suited for handling parking permits**, need to move process away from tax administration. Not set up to address tenant situations, multiple vehicles, etc. Would be beneficial to unify all permitting under the Apex system. However, elimination of the decal system has temporarily resulted in PEOs having to enter tags manually, reducing efficiency.
25. **The three-hour parking limit in some residential zones presents enforcement challenges**, since PEOs must be able to check the same car multiple times separated by at least three hours. This can be very difficult during a single shift.

Procurement/Implementation/Contracts

26. **Existing technology infrastructure should be able to handle new systems.**
27. City needs to negotiate the **ability to run reports** from the contractors' systems without going through the contractors.
28. **Frustration with existing ticketing and adjudication vendors** – not responsive, supplied obsolete equipment to the City.
29. **ITS department should be consulted in advance of procurement.** IT support and the eventual uses of data are often not considered. Need to build future technologies into the ITS workplan.

Appendix III: Details of the Technology Evaluation Process

Initial Set of Technology Applications Evaluated

The section below details the initial set of technology applications assessed, which have been catalogued into five focus areas: User Experience/Payment & Pricing (13 implementations), Data Collection/Management (5), Permitting (3), Enforcement (4) and Alternative Vehicles and Policies (3).

1. **Pricing, Payment, and User Experience** This category encompasses those technology applications that would directly affect how the user experiences parking within the City, from reserving a spot, to payment, to accessing a garage. As this encompasses the majority of technical solutions, it has been broken into sub-categories covering remote system access, off-street parking facilities, and on-street parking facilities.

   A. Remote System Access

   This sub-category covers technology applications related to parking apps and enabling remote access to the City's parking system, either for information or to conduct payment transactions.

   1. Enable **advance reservation of spaces**; garages and on-street
   2. Enable **real-time occupancy rates** for garages and curbside parking (by block) to be incorporated into parking apps and website through data feeds from Republic, Cale, etc. Also, wayfinding signs that include real-time parking information.
   3. Consider **additional incentives for users**, such as bank-able rebates for later use.
   4. Potential technology: **online 'wallet' for payments**, potentially including electronic credentialing systems (disabled, special event, office visitor, residential, etc.)
   5. **Integration: Transit pass/Park & Ride App/Bike Share payment system**

   B. Off-Street Parking Facilities

   This sub-category covers technology applications related to wayfinding, access, and payment at the City's garage and surface lot facilities.

   1. **Dynamic signage indicating space availability at garage entrances**.
   2. **Remote dynamic signage** indicating space availability at multiple garages. Likely located at highway off-ramps or major gateways to core areas.
   3. **Gateless operation pilot program** (All payment via mobile devices or pay-by-plate pay stations in garage, regular enforcement by PEOs).

   C. On-Street Parking Facilities

   This sub-category covers technology applications related to regulation, signage, pricing and payment for curbside parking facilities throughout the City, excluding residential permit parking zones.

   1. Incorporate **rate variability by time of day** into IT systems governing meters.
   2. **Enable dynamic pricing** with automatic rate adjustments based on utilization patterns.
   3. **Transition of existing pay & display stations to pay-by-plate stations**.
   4. Transition to **100% pay-by-mobile** device, eliminating all pay stations.
   5. **Integrate with ridehailing apps** to encourage use of designated pickup/dropoff zones or integrate short-term parking fees into rates.

2. **Data Collection/Management:** All technological solutions related to the collection, warehousing and utilization of parking occupancy and payment data to shape policies and operations for the future.
    1. **Payment-based data collection** Continuous collection of data from app payment streams and integration with data from meters and garages/lots
    2. **Sensor-based data collection** (LPR, smartphones, video) Analysis of historical data (transactions, occupancy)
    3. **Integration of existing data sources** (meters, ParkMobile, others?)
    4. Develop a purposeful **IT architecture for parking management**, possibly through a contractor-developed parking data cloud hub.
    5. Potential technology: supporting the **Mobility Data Specification** (MDS) or other curbside management frameworks, to include E-bike/E-Scooter policies and management as related to parking

3. **Permitting:** Technology solutions related to the residential parking permits and other curbside access permits.
    1. **Expansion of program to allow paid parking in residential zones** citywide (mobile app payment only). Would have to integrate RPP data and utilization numbers to determine the number of paying customers allowed by time of day in order to guarantee sufficient spaces for residents of home zones.
    2. **Complete disconnect of RPP program from tax payment**. Establish virtual permitting via license plate numbers. Would require full rollout of License Plate Readers (LPR).
    3. **"Virtual" freight loading zones** integrated into parking apps, including ability to reserve a loading zone in advance. Would include discounts up to free for deliveries during low-demand times.

4. **Enforcement**
    1. **Unify systems used for enforcement** (moving violations vs. parking infractions), multiple LPR systems.
    2. **Full deployment of LPRs** and integration into ticketing systems to eliminate manual entry of citations.
    3. Consideration of **non-enforcement LPR use for data collection**; particularly for handheld applications.
    4. **Enable handicap parking by license plate**, eliminating the need for hang-tags.

5. **Alternative Vehicles and Policies**
    1. **Pilot project of curbside EV charging stations**. Study underway to identify locations. Research integration with pay stations.
    2. **Develop EV charging station business model**.
    3. **Install % of EV stations in garages** (need to determine appropriate percentage).

Evaluation Criteria for Technology Evaluations

Each parking technology was evaluated by a series of criteria, reflecting the trade-offs of each option. The goal was for the combined benefits of each implemented technology to compensate for the combined shortcomings. Technologies were evaluated both by their impact on the COA and on the public.

Cost – This evaluation criterion looks at the overall cost to the City of Alexandria and also looks at the cost to the parking public. Example: New parking application that works for on-street parking and off-street parking (incl. garages) would have a medium to high cost for the City but the cost for the downloaded app would be free to the public. This criterion is scored on a low/medium/high basis, with relevant context noted. Also noted is whether the costs would be borne primarily by the City or the potential parking users, and which costs would fall to either party. This evaluation criterion also looks at the ongoing costs to both the City and the public. Costs could include subscriptions to software and data management services for the city, as well as transaction costs imposed on users to use a particular platform.

Up Front – Initial deployment costs.

Ongoing – Operational and long term maintenance and support costs.

Implementation Complexity – This evaluation criterion looks at the difficulty in deployment and usage by the public. Example: Parking enforcement technology may require data interfaces with special permit offices [loading zones, disability, residential permits by jurisdiction, law enforcement databases (stolen or amber alerts, etc.)]. The complexity would be very high for COA coordination and training. The complexity level for the public could be very low in that no new procedures are required that don't already exist. Conversely, the system may require extensive training for the public to understand how to use the technology and to explain what types of phone capabilities are compatible with the new system. This criterion is scored on a low/medium/high basis, with relevant context noted. Also noted is whether the complexity would be borne primarily by the City or the potential parking users.

Population Served – This evaluation criterion looks at the number of parkers that would be impacted. Example: A new parking permit system designed to offset the parking challenges caused by the influx of Amazon staff would provide a good incentive for the Amazon employees but this is a small segment of the larger COA population. A technology selection with a large cost to address a small segment of the population may not be in the best financial interest of the COA. This criterion is scored on a small/medium/large basis, with relevant context noted.

In addition, it important to consider equity across different groups, especially those that are historically underrepresented or vulnerable such as people with disabilities, people who are transit dependent, people of low income, bicyclists, carpoolers, etc. This criterion looks at the ways in which a new technology might benefit certain groups at the expense of others or disproportionally impact socioeconomically disadvantaged populations. Innovative technologies can also be supplemented with more widely accessible options, such as kiosks where one can pay with cash. This criterion is scored on a yes/no basis, with relevant context noted.

Challenges Met – This evaluation criterion looks at the impacts to the existing COA challenges. A particular technology may address multiple challenges or the technology may only address a single challenge. When looking at investment, the number of challenges met for the investment dollars should be a major part of the evaluation criteria. The challenges addressed may be those administrative ones faced by the COA or the technology may address challenges faced by the public as they consider mode choice or search for parking. This criterion is scored on a narrow/medium/high basis, with relevant context noted.

Sustainable and Upgradable Platform – This evaluation criterion looks at the technology's capability for future enhancements. These criteria also look at sustainability characteristics. Examples: The enforcement officers must issue paper-based citations in an environment where the COA intends to move to a more environmentally conscious paperless operation. The COA intends to purchase smart meters that accept credit cards but do not have the capability to upgrade to 'tap-and-go' technology nor the ability to incorporate scanning technology for barcodes or QR codes. This criterion is scored on a yes/no basis, with relevant context noted.

3rd Party Platform (proprietary) or COA Owned – This evaluation criterion looks at the long-term impacts of deployment that have left parking operators in a position of being 'locked' in to a vendor and his/her services with no other options due to the large initial investment. In the case of software solutions, the code can be proprietary or it can be purchased by COA for full ownership and the decision-making ability to modify or upgrade in the most economical manner (competitively). This criterion is scored on a yes/no basis, with relevant context noted.

Implementation Timeframe – This evaluation criterion looks at the speed of implementation. Public perception of the COA taking action to address parking problems can be influenced by how quickly they can see activity. Example: Some

technologies may be deployed in as little as 4 to 6 months (or less) while others may require higher costs and heavier construction activity and can take up to 2+ years before completion. This criterion is scored on a short/medium/long basis, with relevant context noted.

Traffic Impact – This evaluation criterion looks at whether new parking technologies increase or reduce traffic, or change congestion patterns altogether. Example: A technology which allows drivers to reserve a parking spot reduces the traffic from vehicles circulating throughout the area in search of an available spot. This measure is also related to a technology's impact on Vehicle Miles Traveled (VMT). This criterion is scored on a small/medium/large basis, with relevant context noted.

Evaluation Documentation

The table on the following page details the results of the evaluation of the initial set of 28 technology applications. This information formed the primary source material for the joint work session held in February of 2020. While the criteria were not quantified in terms of an overall score, the ratings provided the team a solid framework upon which to rank each application and determine whether each one would be a carry forward item or would be tabled. The team the evaluation process results, as well as additional factors such as the political landscape in the City, how well each technology application matched to the sources of available grant funds, and related ongoing efforts that may advance certain items on the list, such as the effort to promote electric-powered vehicles.

Table 9: Evaluation Matrix of initial Set of Technology Applications

	Technology Applications	Cost				Complexity		Population Served		Challenges Met		Sustainable and Upgradable Platform	Third Party Platform	Implementation Timeframe	Traffic Impact
		Up-Front		Ongoing											
		low/medium/high		low/medium/high		low/medium/high		small/ medium/ large	Equitable Application	low/medium/high		yes/no	yes/no	short/ medium/ long	small/ medium/ large
		City	Public	City	Public	City	Public			City	Public				
1. User Experience/Payment & Pricing															
A. Remote System Access															
1	Enable advance reservation of spaces; garages and on-street.	Low	Low	Low	Low	Low	Low	Large	N/A	High		Yes	Yes	Short	Medium/ Large
2	Enable real-time occupancy rates for garages and curbside parking (by block) to be incorporated into parking apps and website through data feeds from Republic, Calé, etc. Also, wayfinding signs that include real-time parking information.	High	Low	Medium	Low	Medium	Medium	Medium		High	High	Yes	Yes	Medium	Large
3	Consider additional incentives for users, such as bank-able rebates for later use.	Medium	Low	Low	Low	Low	Low	Medium		Medium	Medium	Yes	Yes	Short	Large
4	Potential technology: online 'wallet' for payments, potentially including electronic credentialing systems (disabled, special event, office visitor, residential, etc.).	High	Low	Medium	Low	High	Low	Medium		Medium	Medium	Yes	Yes	Short	Large
5	Integration: Transit pass/Park & Ride App/Bike Share payment system.	Low	N/A	Medium - High	N/A	Low	Low	Large	Elderly	High	High	Yes	Yes	Short	Large
B. Off-Street Parking Facilities															
1	Dynamic signage indicating space availability at garage entrances.	Low - Medium	N/A	Low	N/A	Low	Low	Low - Medium		High	High	Yes	Yes/No	Short	Large
2	Remote dynamic signage indicating space availability at multiple garages. Likely located at highway off-ramps or major gateways to core areas.	Low - Medium	N/A	Low	N/A	Low - Medium	Low	Medium		High	High	Yes	Yes/No	Short	Large
3	Contactless payment and access (All payment via mobile devices or walkup paystations in garage).	Low	Low	Low	Low	Low	Low	Large		Medium		Yes	Yes	Short - Medium	Medium
C. On-Street Parking Facilities															
1	Incorporate rate variability by time of day into IT systems governing meters.	Low	Low	Low	Low	Medium-High	Medium	Large		Medium-High		Yes	Yes	Medium	Medium/ Large
2	Dynamic pricing with automatic rate adjustments based on utilization patterns. (*See A.2 Evaluation)	High	Low	Medium	Low	Medium	Medium	Medium		High	High	Yes	Yes	Medium	Large
3	Transition of existing pay & display stations to pay-by-plate stations.	Medium	Low	Low	Low	Low	Low	Medium		High		Yes	Yes	Medium	Small
4	Transition to 100% pay-by-mobile device, eliminating all pay stations. (*See A.4 Evaluation)	High	Low	Medium	Low	High	Low	Medium		Medium	Medium	Yes	Yes	Short	Large
5	Integrate with ridehailing apps to encourage use of designated pickup/dropoff zones or integrate short-term parking fees into rates.					Medium-High		Large							
2. Data Collection/Management															
1	Payment-based data collection (continuous collection of data from app payment streams and integration with data from meters and garages/lots)	Low	N/A	Medium - High	N/A	Medium	Low	Large	Elderly	High	High	Yes	Yes	Medium	Medium
2	Sensor-based data collection (LPR, Smartphones, video? Other?)Analysis of historical data (transactions, occupancy)	Low - Medium	Low	Low - Medium		Low - High	Low	Large	disabled, electric vehicle drivers, on-street parkers and parking garage patrons	High	High	Yes	Hybrid	Short - Medium	Large
3	Integration of existing data sources (meters, Parkmobile, others?)	Variable	N/A	Low	N/A	Medium	N/A	N/A		High		Yes	Yes, City would own data.	Medium	Large
4	Develop a purposeful IT architecture for parking management, possibly through a contractor-developed parking data cloud hub.	Medium	N/A	Low	Low	Medium	Low	Large		High	High	Yes	Hybrid	Short - Medium	Large

Technology Applications		Cost				Complexity		Population Served		Challenges Met		Sustainable and Upgradable Platform	Third Party Platform	Implementation Timeframe	Traffic Impact
		Up-Front		Ongoing											
		low/medium/high		low/medium/high		low/medium/high		small/ medium/ large	Equitable Application	low/medium/high		yes/no	yes/no	short/ medium/ long	small/ medium/ large
		City	Public	City	Public	City	Public			City	Public				
5	Potential technology: supporting the Mobility Data Specification (MDS) or other curbside management frameworks.	Medium - High	N/A	Low	N/A	Medium	N/A			High		Yes	Hybrid	Medium	Large
3. Permitting															
1	Expansion of program to allow paid parking in residential zones citywide (mobile app payment only). Would have to integrate RPP data and utilization numbers to determine the number of paying customers allowed by time of day in order to guarantee sufficient spaces for residents of home zones.	Medium	N/A	Medium	N/A	Medium	Low	Large		High	High	Yes	Hybrid	Medium	Medium
2	Complete disconnect of RPP program from tax payment. Establish virtual permitting via license plate numbers. Would require full rollout of License Plate Readers (LPR).	Medium	N/A	Low	N/A	Medium	Medium	Large		High	Medium	Yes	Yes	Medium	Small
3	"Virtual" freight loading zones integrated into parking apps, including ability to reserve a loading zone in advance. Would include discounts up to free for deliveries during low-demand times.	Low	N/A	Medium	N/A	Low	Low	Large		High	High	Yes	Hybrid	Short	Large
4. Enforcement															
1	Unify systems used for enforcement (moving violations vs. parking infractions), multiple LPR systems.	Low	N/A	Low	N/A	Medium	Low	High		High	N/A	Yes	Hybrid	Medium	Low
2	Full deployment of LPRs and integration into ticketing systems to eliminate manual entry of citations.	Low	N/A	High	N/A	Medium	Low	Large		High	High	Yes	Yes	Medium	Medium
3	Consideration of non-enforcement LPR use for data collection; particularly for handheld applications.	Low	N/A	Medium - High	N/A	Medium	High	Large	Equity concerns if some areas are examined more than others	High	High	Yes	Yes	Medium	Medium
4	Enable handicap parking by license plate, eliminating the need for hang-tags.	Low	Low	Low	Low	High	Low	Small	May conflict with state regulations. Vehicle/license plate information on state placard-holder may be unavailable.	Medium	Medium	Yes, if implementation considerations are overcome.	Hybrid	Medium	Low
5. Alternative Vehicles															
1	Pilot project of curbside EV charging stations. Would require study to identify locations. Research integration with paystations.	Medium - High	N/A	Low - Medium	Low	High	Medium	Medium		High	High	Yes	Yes	Medium	Small - Medium
2	Develop EV charging station business model.	Medium - High	N/A	N/A	N/A	High	Medium	Small	lower and middle income family cannot afford electric vehicles	High	High	Yes	Yes	Short	N/A
3	Install % of EV stations in garages (need to determine appropriate percentage).	Low - High	N/A	Low	N/A	Medium	Low	Small	lower and middle income family cannot afford electric vehicles	High	High	Yes	Yes	Short - Medium	Small

Revised Set of Technology Applications

The application process, including the joint work session conducted between City and consultant staff, resulted in the following revisions to the original list.

User Experience/Payment & Pricing

The set of technology applications within this category was trimmed from 13 to 5, with the following applications carried forward:

- **1.A.1 – Advance Reservation of Spaces** was carried forward because it was viewed as a relatively low-cost implementation that could be achieved through the existing U-Street Parking contract, which would improve the user experience significantly and reduce wasted driving time in Old Town and other dense areas.
- **1.A.2 – Real-Time Occupancy Data** was seen as an important stepping stone to several other potential applications, and so was carried forward. It was narrowed down to apply only to the City-owned garages, under the recognition that applications 2.1 and 2.2 covered the same data needs for on-street parking facilities.
- **1.B.1 – Dynamic Signage** was carried forward for similar reasons, in addition to the fact that the physical equipment involved in dynamic occupancy signage may be a prime candidate for the use of grant funding.
- **1.B.3 – Contactless Garage Payment and Access** was carried forward in recognition of the emphasis on reducing interactions with staff during the pandemic and the ongoing savings inherent in operations that involve fewer staff, as well as the fact that this application involves infrastructure that would be good candidates for VDOT funding application.
- **1.C.1 – Rate Variability** was seen as a natural next step once payment-based data collection was achieved, and is primarily a policy endeavor with a low cost and existing contract vehicles through which it can be implemented.
- **1.C.3 – Transition to Pay-by-Plate Stations** was a natural choice to include based on the fact that it represented essentially an acceleration of something the City is already in the process of undertaking, as well as a likely candidate for the use of grant funds.

Data Collection/Management

The set of technology applications within this category was trimmed from 5 to 4, with the following applications carried forward:

- **2.1 – Payment-Based Data Collection**, is a necessary first step before some other technology applications, including 1.A.1 and 1.A.2 can be pursued. It is also a low-hanging fruit, as the necessary data is very likely already accessible to the vendors involved, and achieving this application is a matter of coordinating the transfer of data.
- **2.2 – Pilot Program to Collect Occupancy Rates for On-Street Parking.** It was determined that collecting occupancy rates for on-street parking would be significantly more difficult than in garages. A full real-time collection would require a significant investment in sensors or camera systems, but the value of the data for planning purposes would be high, so the team decided that the appropriate approach to achieving this application would be to acquire a mobile camera system that could be set up to record occupancy on a rotating set of streets.
- **2.3 – Integration of Existing Data Sources.** Achieving this application is a matter of aggregating data from multiple sources.
- **2.4 – Develop a Purposeful IT Architecture** was seen as a clear choice to move forward since it would multiply the effectiveness of all applications if a combined IT infrastructure made additional data accessible in real time.

Permitting

The set of technology applications within this category was trimmed from 3 to 2, with the following applications carried forward:

- **3.2 – Complete Disconnect of RPP Program from Tax Payment** was selected to carry forward based on the logic that the City is already working towards this goal. Utilizing the tax payment system to facilitate RPP permit applications has some disadvantages that limit the effectiveness of the program.
- **3.3 – Virtual Freight Loading Zones** was selected to be advanced since the City is undertaking an analysis of freight loading supply & demand.

Enforcement

The set of technology applications within this category was trimmed from 4 to 2, with the following applications carried forward:

- **4.1 – Unify Systems used for Enforcement** was selected to be advanced because a unification of enforcement systems would eliminate inefficiencies currently experienced in the parking enforcement processes, and because the City is currently exploring a contract with a vendor, in conjunction with a neighboring jurisdiction, that would address the issue directly.
- **4.2 – Full Deployment of LPRs** was selected to be advanced because a greater use of LPRs would enable parking enforcement personnel to be more thorough, whereas certain RPP zones are very difficult to enforce currently. In addition, LPRs would be a strong candidate for the use of grant funds.

Alternative Vehicles and Policies

The set of technology applications within this category was trimmed from 3 to 2, with the following applications carried forward:

- **5.2 – EV Charging Station Business Model** was selected to be advanced since the City is undertaking an EV deployment study/strategy.
- **5.3 – Install % of EV Stations in Garages** was selected to be advanced since the City is undertaking an EV deployment study/strategy.

Appendix IV: Master List of Potential Vendors for Technology Applications

Technology Capabilities:	Parking Access And Revenue Control Systems (PARCS)	Automatic License Plate Recognition	Occupancy Monitoring /Indoor Sensor	Occupancy Monitoring / Outdoor Sensors	Mobile Payment and Activity Tracking (for Users)	Software / API / External System Integration - Access Management System	Digital Guidance Signs	Reservation/ Pre-Booking Systems	Enforcement	Pay-by-Plate Meters/ Paystations
Applications from Implementation Plan:	1.B.3, 1.C.1, 2.A.2	4	1.A.2	1.C.1, 2.A.2	1.A.1, 1.A.2, 1.B.3, 2.A.1	2.A.3	1.B	1.A.1, 3.2.3	4.2	1.B.3, 1.C.3
Vendors										
AimsParking	Yes	Yes			Yes (System Integration Capabilities)	Yes			Yes	
Airgarage	Yes *control pricing dynamically for events					Yes			Yes	
All Traffic Solutions	Integrates with other systems such as PARCS and permitting solutions		ParkTrak uses lasers and directional logic to detect when vehicles back up, tailgate or enter or exit the wrong way			ParkingCloud				
CALE										Yes
Carolina Time Equipment							Yes	Event Parking/Valet		
Conduent	Yes		Yes		Yes	Yes *ATLAS® fare collection platform with open APIs to support interoperability	Yes			
Curbflow *Freight/Ridehailing Services	Yes				Yes			$0.10, and $0.02 for every minute thereafter. App allow users to make reservations up to 30 minutes in advance.	Yes	
Designa	Yes		Yes, partnership with hardware, software and vendors			Yes, Offers single server, central server or Real Cloud Service.				
EasyPark					Yes	Cloud-based		Yes *In-vehicle meter device	Yes	
Flowbird	Yes				Apple Pay, Google Pay, Samsung Pay, and credit cards, parking session notifications					
IDEAS SAS	Demand-based, dynamic pricing to pre-booked parking with year-over-year revenue growth.					Yes		Yes		
Indect			Yes *from camera to ultrasonic				Yes			
IPS Permit Management Solution									Handheld citation writer for enforcement officers; web-based Enforcement Management System (EMS), Online Public Portal for motorists	
ITR Parking Solutions	Partnership with Designa	Partnerships with Genetec / Quercus	Multi-Space Parking Sensors/ Partnerships with Parkeon				Signal Tech / Parking Sense			
Metric Parking	Yes									Yes
Monkey Parking					Bidding/Auction Model			Reservation by texts		
OmniPark		Yes *with Enforcement Integration							Yes	

Technology Capabilities:	Parking Access And Revenue Control Systems (PARCS)	Automatic License Plate Recognition	Occupancy Monitoring /Indoor Sensor	Occupancy Monitoring / Outdoor Sensors	Mobile Payment and Activity Tracking (for Users)	Software / API / External System Integration - Access Management System	Digital Guidance Signs	Reservation/ Pre-Booking Systems	Enforcement	Pay-by-Plate Meters/ Paystations
Applications from Implementation Plan:	1.B.3, 1.C.1, 2.A.2	4	1.A.2	1.C.1, 2.A.2	1.A.1, 1.A.2, 1.B.3, 2.A.1	2.A.3	1.B	1.A.1, 3.2.3	4.2	1.B.3, 1.C.3
Vendors										
ParkAssist										
Parker (Streetline)			Yes* Streetline Sensors		Yes			Reservations up to 2 months in advance		Yes *Partnership
ParkGene			Yes * Real-Time		Cryptocurrency (Bitcoin)					
Parkhelp		Yes	Infrared , Ultrasonic, Camera-based , LPR Cameras, Bollard Car Counters, Dual Loop Car Counters, LiDAR Car Counters (Real-time Data)	Magnetic field and micro radar detection	Yes	ParkManager system	Roadway, Entrance, Aisle, Level Count			
Parkhub	Yes				processes and tracks cash, credit card, and NFC (Apple Pay and Android Pay) payments; 7-second processing time.			scans and validates pre-paid passes		
Parking Panda					Apple Pay' Paypal and Venmo					
ParkMe (INRIX)	Yes				Android Pay , Allow price comparison					Yes *Partnership
ParkMobile	Yes		Yes *Real-Time		PayPal	Yes* organize parking transactions by time, payment method, lot, or attendant during and after events				Yes *Partnership
ParkPow	Yes				Yes (System Integration Capabilities)	Yes			Yes	
ParkWhiz (Arrive)					Yes, Integrations with 3rd navigation partie (WAZE/Amazon)			Advance reservation (season ahead) saving up to 60%		
Passport			Yes		Yes, Allow price comparison					Yes *Partnership
Quercus	Yes	Yes	Yes *Queue occupancy at entry/exit							
Quest HTS	Yes	Yes	Yes- HTS Inventory Control Suite					e-permits	Yes (video-based system)	
SKIDATA	Yes	Yes	Yes		Yes	Yes	Yes	Event Parking/Valet		
Smarking	Yes *Partnership with VPNE to provide single platform		Yes * Real-Time			Yes, Predictive Analytics			Yes * Facilitates Data-driven Enforcement Routes	
SpotHero					Yes, Allow price comparison, offers discounted rates			Pre pay and Reservation for Future Use		
Survision		Yes On-street/Off-Street	LPR for access control integrated with video management systems	Yes						
Tiba Parking Systems						Integration with LAZ and SmartKing				
Way								Parking Pass allows flexible Short and Long-Term Parking		

Appendix V: ArcGIS Online Story Map (Electronic Appendix)

In support of this study, an online atlas of relevant maps was produced to act as a reference during the course of the study and as context once the study is complete. The online atlas includes the following information:

- On-Street Parking Inventory/Utilization (Old Town, Old Town-North, and Del-Ray)
- Off Street Parking Inventory/Utilization (Old Town, Old Town-North, and Del-Ray)
- Household and Employment Density (city-wide)
- Land Use (city-wide)
- Transit Service (city-wide)
- Recommendations from Previous Parking Studies

The online atlas can be found at:
https://alexgis.maps.arcgis.com/apps/MapSeries/index.html?appid=868864f3c5d647bbac7bf920a706f5b0