Carriage Alerts Mapping Platform
Real-Time GIS to Manage Tours & Equine Waste
A. SYSTEM

1. Name

Carriage Alerts Mapping Platform (CAMP) | Real-Time GIS to Manage Tours & Equine Waste
A Single Process System

2. Letter from Executive Admin

Attached.

3. One Page Summary

Known for our unique history and rich architecture, the City of Charleston, South Carolina is a popular travel destination that saw approximately 6.9 million tourists in 2017 (2018 College of Charleston Office of Tourism Report). Horse Drawn Carriage Tours are one of the most popular ways for visitors to see Charleston, with over 41,000 carriage tours running in 2018. The system used for managing both the carriage tour details and the equine waste (spills) generated by the horses and mules was inefficient and lacked accountability. As a result, most of the calls to the City of Charleston’s tourism office were complaints from citizens and business owners regarding areas that had not been properly cleaned and the equine urine smells that were hard to ignore. City code requires tours be limited to assigned zones and carriage companies identify and report locations in need of equine waste clean-up (sometimes referred to as spills). The Carriage Alerts Mapping Platform (CAMP) was developed to provide a more accurate, efficient, and safer method of managing the location details of carriage tours and the equine waste they generate.

The old system required carriage trip details (company, driver name, number of passengers, horse names) to be logged on paper by City staff; for equine waste, carriage drivers were tasked with dropping a flag at the location that required cleaning and making a call to report the marked location. Given the dangers associated with phone use while driving a carriage, the drivers would wait until the conclusion of their tour to make the report. A tour could last as long as 60 minutes, making it difficult to remember the exact location. Moreover, drivers would often forget entirely. It is estimated only 25% of equine waste was reported as a consequence of the flawed system.

CAMP has transformed the process of logging carriage trips and allows for real-time carriage tracking and waste reporting with the press of a single button on a simple, low-cost, and durable GPS device. This eliminates the safety risks associated with using a mobile phone while driving or the need for carriage drivers to remember waste location(s). Reported locations are processed, tagged with other trip-relevant
details on a central server, and mapped within seconds, avoiding the need for calls and reducing follow-up citizen complaints. Trip details and waste sanitation statistics are analyzed and custom reports serve as reference for better planning.

Sanitation crew members use the CAMP interactive map to see all of the day's waste locations at once, allowing them to plan which areas have a more immediate need of sanitation services and route accordingly, enabling more efficient streets cleaning. Implementation of this new system has vastly improved communication between the carriage industry and the sanitation crews, as well as City staff.

CAMP System Workflows Diagram

The CAMP system is exemplary because it has digitized, simplified and improved the previous carriage trips log and equine spill management workflows by leveraging various GIS technology components: low-cost, one-click GPS devices and Esri’s GeoEvent Server to process the equine waste locations and generate notifications, as well as Esri’s ArcGIS Online, JavaScript API and Operations Dashboard for the tools developed to monitor and manage the follow-up workflows required for each equine waste location. Sanitation crew and carriage operator communications have improved and sanitation response times have been reduced. CAMP also provides the City with analytical data that can be used to help further improve the City’s management of this important aspect of its tourism industry.
4. User Testimonials

“Using the GPS units to report horse waste is much easier than it used to be. With the push of a button, I can report a spill when and where it happens, during every tour I take, without having to make any mental notes. That means keeping my passengers safe and getting to stay completely engaged with my audience.”

**Alex Levine, Tour Manager**
Palmetto Carriages

“The data collected via the CAMP system is showing to be tremendously helpful in following the communication and workflows between carriage companies and the sanitation crew. The maps and dashboard figures are my daily go-to when determining actions related to the enforcement of waste management codes.”

**Shannon Tilman, Equine Manager**
City of Charleston

“The CAMP system has been a game-changer. This system adds a new layer of accountability that we have never had before. Many people would claim that they always called in to the equine waste clean-up company, but in truth, never would. It is so much easier to notify the cleaning company to the “spill”, and it allows us to know who is and is not doing their part. It also shows the public that real work is being done.”

**Lee Burbage, Tourism Commission Manager**
City of Charleston
B. JURISDICTION

1. Name of Jurisdiction
   City of Charleston, South Carolina

2. Population served by the organization/agency
   Approx. 135,000 Residents & 6,900,00 Yearly Tourists (per 2017 report)

3. Annual total budget for jurisdiction
   $183,192,391 (proposed)

4. Name, title, and address of chief elected and/or appointed official
   John J. Tecklenburg, City of Charleston Mayor
   P.O. Box 652
   Charleston, SC 29402

5. Name, title, address, telephone, FAX, and email for contact person for system
   Emma Paz, GIS Developer
   2 George St, Suite 2800
   Charleston, SC 29401
   T: 843-724-3769 | F: 843-965-4076
   paze@charleston-sc.gov
C. SYSTEM DESIGN

1. What motivated the system development?

   It is estimated that only 25% of horse drawn carriage tour equine spills were successfully reported and cleaned as a consequence of the existing flawed system. As a result, most of the calls to the City of Charleston’s tourism office were complaints from citizens and business owners regarding areas that had not been properly cleaned and the equine urine smells that were hard to ignore. It was essential the City replace the old system to improve communications between the carriage drivers and the contracted sanitation crew, while maintaining records of all trips and spills for quantified data analysis. A real-time, GIS-based system with increased ease of use, accuracy, and accountability was needed to resolve the issues of the old system.

   Internal development was approved to ensure the new system included the features needed for the system's success for all parties and workflows. Off-the-shelf GPS tracking solutions investigated during the research phase of the project lacked key features. Some sample issues were lacking the ability for a sanitation contractor to 'resolve' the status of a spill once it was cleaned or simply requiring all parties to use a smart phone, an option that was not viable for the carriage drivers given the dangers associated with phone use while driving a carriage.

2. What specific service or services was the system intended to improve?

   The Carriage Alerts Mapping Platform (CAMP) replaces and improves the following key aspects of the old system used to track horse drawn carriage tours and the equine waste generated.

   **Logging of Tour Details**

   The old system required the details of each carriage trip (company, driver name, number of passengers, horse names) to be logged on paper. At the end of each day, City staff would then have to transcribe the paper entries into a spreadsheet for reporting. With often more than 100 entries per day, this process was a time consuming and tedious task prone to data entry errors. Staff now record trip details into the CAMP system using a tablet that includes easy to use drop downs for selecting carriage companies, tour guide names, and horse names. A GPS device is then assigned and linked to the trip using a unique ID.

   **Marking of Equine Spill Locations**

   Carriage drivers were tasked with dropping a physical marker at each location that required cleaning and used a mobile phone to report the location to the sanitation crew. Given the dangers associated with phone use while driving a carriage, the drivers would wait until the conclusion of their tour to make the report. Spills were forgotten, and markers were moved or lost. The CAMP system immediately
communicates the location of the spill directly to the sanitation crew without any action from the driver other than pressing a single button.

**Tracking of Equine Spills**

The old system was a word-of-mouth system that did not keep records of equine waste reports or sanitation efforts. There was little way for the sanitation crew to know which locations should be cleaned first or if there were other spills located nearby before moving on to a different area of the City. The new system records the location and time of each spill, and logs when the spill clean-up is completed by the sanitation crew. Crews are also able to see all current spills on the map to aid in efficient routing and assignment of areas by multiple contractors on busy days.

**Analysis of Trips and Spills**

Behind the scenes, each spill is tagged with the necessary carriage trip details and the "minutes open until sanitation" calculations that provide City staff with the real-time daily metrics and the longer-term statistical reports they need.

**3. What, if any, unexpected benefits did you achieve?**

Now that the carriage trip details have been digitized and equine spills are being tracked in real-time, the data collected is helping City tourism staff with the enforcement of City ordinances, specifically the requirement to follow tour zone assignments (to reduce the impact on City traffic) and the waste management codes requiring companies to report the equine spills. Through the CAMP maps, dashboard, and digital Carriage Trip Log reports, staff are now able to see which companies and drivers are properly or improperly following City ordinances.
Additionally, even though it wasn’t the intended purpose, the data collection process has brought forth a lot of additional, unforeseen opportunities for data analytics. One example of this is the previous anecdotal idea that horses followed each other’s scent and thus, equine spills happened frequently in the same areas. Through the GPS reported spills data, the City is now able to visualize these hot spots in real-time, which in turn, highlights the repetitive absence of spills on certain streets. Further, the City hopes to be able to re-visit the data for analysis of larger seasonal trends.

4. What system design problems were encountered?

The GPS devices available through vendors did not natively integrate with internal City data structures or workflows. While the in-house GeoEvent server software was perfect for ‘listening’ for incoming signals, the GPS units’ Transmission Control Protocol (TCP) communication mechanism had not yet been implemented within the local environment—mastery of this configuration required research and time. Multiple configuration trials (and errors) were required throughout the initial phases of the project. In addition, the GPS devices required custom configuration from the vendor, leading to some unforeseen delays.

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CAMP GeoEvent Input Service Details

<table>
<thead>
<tr>
<th>Name*</th>
<th>carriages-tcp-text-in (Receive Text from a TCP Socket)</th>
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</thead>
<tbody>
<tr>
<td>Server Port*</td>
<td>5500</td>
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<tr>
<td>Message Separator</td>
<td>$</td>
</tr>
<tr>
<td>Attribute Separator*</td>
<td>,</td>
</tr>
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<td>Expected Date Format</td>
<td>YYYYMMDDHHMMSS</td>
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<tr>
<td>Incoming Data Contains GeoEvent Definition</td>
<td>Yes @No</td>
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<tr>
<td>Create Fixed GeoEvent Definitions</td>
<td>Yes @No</td>
</tr>
<tr>
<td>GeoEvent Definition Name (Existing)</td>
<td>carriages-geodef.gps</td>
</tr>
<tr>
<td>Construct Geometry From Fields</td>
<td>Yes @No</td>
</tr>
<tr>
<td>X Geometry Field</td>
<td>Longitude</td>
</tr>
<tr>
<td>Y Geometry Field</td>
<td>Latitude</td>
</tr>
<tr>
<td>Z Geometry Field</td>
<td>Altitude</td>
</tr>
</tbody>
</table>

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5. What differentiates this system from other similar systems?

**Backend Tools and Data Management**
The off-the-shelf back-end management solutions considered lacked key features needed for overall system success. While they were good at logging initial locations and managing devices, they did not allow for the management of the spills themselves by the sanitation crew and lacked the ability to make customizations. The City’s systems integration with Esri’s GeoEvent Server allows the GIS Division to develop custom, lightweight apps and dashboards to meet the Livability & Tourism department’s specific needs with the freedom to expand and further customize the project in the future.

**Hardware**
Many similar GPS-enabled systems rely on the use of expensive smart phones or tablets, often requiring devices to be assigned to individual users. This system is different in that it utilizes small, single button GPS devices that are easy to use, are low cost, rugged, and can be easily shared among multiple users.
D. IMPLEMENTATION

1. What phases did you go through in developing the system?

   a. **Problem Identification**

      - A growing volume of citizen complaints prompted concern that City ordinances related to traffic and waste management were not properly enforced. An idea was born to seek technology-based resources.

   b. **GIS Consultation**

      - Livability & Tourism Department management turned to the City’s GIS Division for advice, after which a decision was made to leverage an existing GeoEvent Server.

      - GPS device research and selection was based on the ability to leverage the City’s existing GeoEvent servers.

   c. **GIS Implementation**

      - GeoEvent server was configured to receive the GPS data via TCP, after entering our external DMZ.

      - GeoEvent server was trained to parse the incoming signal into the necessary GIS data sets.

      - The GPS devices were tested for delays and accuracy in different areas of the City.

      - A mobile-ready interactive mapping application was developed for City staff and sanitation crews to be able to follow and manage (‘Close’) spills throughout the day.

   d. **CAMP Deployment**

      - Beta Testing of the CAMP mapping application began with the sanitation crew (3 weeks)

      - Pilot Testing with the GPS units began with training of a low-volume carriage company (1 week)

      - Pilot Testing was expanded to all carriage companies (1 week)

      - Full deployment of CAMP; City staff on stand-by to observe the incoming data
e. **CAMP Dashboard & Reports Development**

- Preliminary data analysis led to specific lists, charts, and maps for internal City staff:
  - Daily and weekly sanitation crew response statistics
  - Daily, weekly and monthly carriage company trends
  - Heatmap of daily equine spills activity
  - Carriage trips and driver reports based on GPS-reported spills/carriage trips log details.

f. **CAMP System Enhancements**

- A public dashboard was developed in the interest of providing government transparency related to carriage tour activity in the City.
- Future enhancements include implementing GeoEvent’s geofencing rules to enforce tour zones assigned to each carriage trip.

2. **Were there any modifications to the original system design? Why? What?**

A long-press functionality of the GPS units was originally intended to be used as an ‘SOS’ alert for the tour driver to notify the City of a problem. It was found that many unintended long presses were being recorded for normal spill locations. Additionally, the City needs to evaluate its ability to respond effectively to an SOS sent from a device and the legal liability involved. It was decided to record both long and short presses as a normal waste location, leaving drivers to rely on mobile phones to notify the City or call 911.
E. ORGANIZATIONAL IMPACT

1. What user community does the system serve and how?

The Carriage Alerts Mapping Platform (CAMP) serves various user types, as follows: Using the integrated GPS devices, Carriage Drivers can easily report equine spills as they happen while out on tour. The Sanitation Crew can follow the interactive mapping application and see new alerts as they're reported, open directions to the reported alerts, and report when the spills are cleaned up by marking the alerts as 'CLOSED'. City Staff can log carriage trip details and follow the data via dashboards with the intent of understanding daily, weekly and monthly trends while keeping City ordinances related to carriage tours. Lastly, in the spirit of government transparency, City residents are also able to follow equine spills as they're reported and sanitized by way of a simplified dashboard.

2. What are the ultimate decisions/operations/services being affected? If appropriate, provide a few examples including, but not limited to: screen input/output forms, paper products, or other descriptive graphics.

- Digitizing the carriage trips log has provided a way to track and analyze tour activity for planning purposes.
3. What were the quantitative and qualitative impacts of the system?

- Simplifying and automating spill reports via GPS (instead of waiting on potentially inaccurate post-tour phone calls) has increased the number of spills reported to an approximate rate of once every 2-3 carriage tours and is now providing metrics that can be further analyzed over time.

- Efficient sanitation response times and real-time conditions shared with the public has reduced Tourism office complaint calls.

### APRIL 2019 CARRIAGE STATISTICS

<table>
<thead>
<tr>
<th>Carriage Trips</th>
<th>Spill Reports</th>
<th>Closed Spills</th>
<th>Avg. Minutes Open</th>
</tr>
</thead>
<tbody>
<tr>
<td>5013</td>
<td>1964</td>
<td>1948</td>
<td>77</td>
</tr>
</tbody>
</table>

- Trend charts showing weekly and monthly trends have dramatically increased accountability, for both carriage drivers and sanitation crews. Driver reports detail trip and spill report counts, per date range. The dashboards show sanitation statistics, the most important of which relies on working to keep the average minutes until sanitization under 20 minutes.

Sample Driver Statistics Generated for April 2019
4. What effect has the system had on productivity?

Sanitation of the streets occurs in a more timely manner than before which is appreciated by local residents. Complaints related to animal waste have been greatly reduced. Staff have more time to focus on other aspects of their work, including data analysis to use in enforcement practices of City ordinances.

5. What, if any, other impacts has the system had?

In addition to confirming the geospatial clustering of equine spills that was previously thought, it has been beneficial for the sanitation crew and the City to see the most frequently reported locations for equine waste; these are monitored most closely for on-going sanitation. Furthermore, the clustering of spills is also drawing attention to streets that are never reported, as there may be opportunities for the City to encourage tour guides to enhance their talking points by taking new routes and exposing visitors to a variety of neighborhoods.
6. How did the system change the way business is conducted with and/or service delivered to clients? Give specific examples comparing the old way with the new.

The workflow for managing horse drawn carriage tours and the waste they generate was changed beginning to end. Equine waste (most often in the form of urine spills) is being sanitized more quickly and effectively. The old system of paper logs, physical markers, and phone calls was replaced with a more efficient and easier to use GIS-based platform. The multi-step process of leaving a marker and placing a cell phone call was replaced with a click of a single button.

Previously, it was random chance that a code enforcement officer found a missed cleanup or a carriage driver out of their assigned zone. Real-time access to carriages and the waste locations that need cleaning has allowed the City to more easily enforce the codes meant to limit any negative traffic and safety impacts on residents, businesses, and visitors.

Implementing the CAMP system has brought forth a different perspective on GIS and its usefulness in solving problems. There is an enhanced appreciation of this technology as a resource whose usefulness extends far beyond map-making. There is a renewed focus and greater awareness and confidence in geospatial data as an essential component of municipal information to complete the City’s mission efficiently, communicating results to the greater public.
F. SYSTEM RESOURCES

1. What are the system's primary hardware components? Give a brief list or description of the hardware configuration supporting the system.
   - ZenPad Tablets used by Carriage Companies to Log Trips
   - QuecLink GL300MA GPS Units (connected to Verizon LTE Network)
   - Windows Server 2016 Standard (64GB) w/ ArcGIS Server 10.7
   - Windows Server 2012 R2 Datacenter (32GB) w/ MS SQL Server 2014
   - Windows Server 2016 Standard (16GB) w/ ArcGIS Server 10.7 and GeoEvent Server
   - Windows Server 2012 R2 Datacenter (16GB) w/ IIS (DMZ for City GIS Division)

2. What are the system's primary software components? Describe the primary software and, if a commercial package, any customizations required for the system.
   - IIS 7 on Windows 2016 Server (DMZ for City GIS Division) with Esri WebAdaptors
   - Esri ArcGIS GeoEvent Server 10.7 to listen for incoming TCP messages
   - Esri ArcGIS Server 10.7 to host map and feature services
   - Carriage Alerts Interactive Map (Custom Development by GIS Division using Esri’s Javascript API)
   - Carriage Alerts Admin Dashboard for City staff (Esri Operations Dashboard configured for project)
   - Carriage Alerts Public Dashboard (Esri Operations Dashboard configured for project)

3. What data does the system work with? List and briefly describe the database(s).
   - Microsoft SQL Server 2014 - SDE database using versioned datasets
4. What staff resources were required to implement the system? (i.e., report approximate staff and consultant time as FTE's)

Planning & Research (3 months)
- Tourism Director (.02 FTE) 40 hours
- Tourism Manager (.05 FTE) 104 hours
- GIS Director (.04 FTE) 80 hours

GIS Implementation (4 months)
- GIS Director (.02 FTE) 40 hours
- GIS Developer (.18 FTE) 380 hours

Testing & Deployment (1 month)
- Sanitation Crew (.07 FTE) 145 hours
- City Tourism Staff (.07FTE) 145 hours
- Carriage Companies (.07 FTE) 145 hours

5. Comment on anything unusual about the resources used to develop your system, such as data, software, personnel and financing.

CAMP is a hybrid system, developed using a combination of inter-departmental City resources and staff in collaboration with the external GPS device vendor who is responsible for the network service and hardware management. Additionally, while it was the City’s Department of Livability and Tourism who initiated the investment and took the responsibility of the initial funding for this project, the on-going management and maintenance costs associated with the GPS devices will be rolled into carriage company waste management fees. The rest of the system components will continue to fall within the expenses of the City’s GIS Division.
May 14th, 2019

Dear Review Committee,

On behalf of the GIS Division of the Department of Information Technology, I am pleased to authorize the nomination of the Carriage Alerts Management Platform (CAMP) for the 2019 URISA Exemplary Systems in Government (ESIG) Award.

The City of Charleston needed better tools to manage and monitor the 40,000 horse drawn carriage tours that occur every year. The GIS Division and the Department of Livability and Tourism worked together on an innovative solution that addressed the problems of an existing inefficient system.

The platform allows the City, carriage tour companies, and clean up contractors to work in concert to efficiently manage equine spills, minimizing the potential negative impact on residents, tourists, and business. The system increases accountability and we are able to provide transparency to stakeholders through public facing dashboards.

CAMP has enhanced the City's ability to manage and mitigate the negative impacts of an important part of our vibrant tourism industry.

I am proud to share this exciting project with the committee and thank you for the opportunity and your consideration.

Sincerely,

Dan Riccio
Department of Livability and Tourism Director
City of Charleston