Efficiency Compounded: How Portland used a simple GIS app to coordinate a multi-million dollar, city-wide LED conversion.

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In summer 2012, Portland, Oregon began planning to retrofit its street lighting to LED technology. In over two years of negotiations with our public utility, the added time allowed the City to carefully construct a system that would allow the update to provide better information on the street lighting inventory using off the shelf technology. This project represented the largest energy efficiency project in the history of the City. With a goal of converting over 45,000 street lights to LED in 2-3 years, asset management, cost tracking, and project work flow became critical elements for success. Coordinating these aspects of a geographically large-scale project required a mechanism accessible by all users involved. Providing a method for multiple contractors to simultaneously update records in real-time allowed engineers and technicians in the office to follow the conversion progression throughout the city using GIS.

BACKGROUND

The City owns almost 60,000 outdoor lights that brighten the streets and the paths in our parks. Research has shown that lighting makes the community safer by reducing crime and making travel safer[1]. Cities across the United States[2, 3, 4] are modernizing their lighting to save energy and maintenance costs by upgrading their streetlights to LED technology. The City's Bureau of Transportation and the Parks Bureau are working together to accomplish this task over the next five years.

The majority of lights in Portland before the LED retrofit project were High Pressure Sodium "cobraheads" that are common in most cities. Manufacturers were working on LED fixtures that replace the older technology delivering enhanced lighting using less energy. The enhanced lighting changes the color of the light from yellow to a pleasant white light. The bottom line cost savings of conversion was estimated to be approximately $2.4M annually based on (Year 2012) energy costs. City projections suggest that the savings are likely to increase over time as energy becomes more expensive to produce. The environmental benefits reduce the equivalent of 10,500 tons of greenhouse gases out of the atmosphere.

The estimated $19.5M upfront costs to modernize the City's lighting was a major expense, but was estimated to result in a net financial benefit due to lower electricity and maintenance costs. To pay the upfront costs, the City used a General Obligation Bond based on future estimated general fund expenditures using the savings to pay the debt service resulting in a net zero cost to the City.

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[1] Clarke, Ronald V., "Improving Street Lighting to Reduce Crime in Residential Areas" in Problem-Oriented Guides for Police Response Guides Series No. 8, U.S. Department of Justice, December 2008.
[2] City of Boston webpage, http://www.cityofboston.gov/publicworks/lighting/led.asp, visited November 8, 2012.
[3] "Seattle Starts Second Phase of LED Street Light Program", Sustainable Business Forum, http://sustainablebusinessforum.com/imigyjunia/53088/seattle-started-second-phase-led-street-light-program, visited November 8, 2012.
[4] City of San Francisco Water Power Sewer Public Utilities webpage, http://sfwater.org/bids/projectdetail.aspx?prj_id=270, visited November 8, 2012.

GIS ASSET MANAGEMENT

Paper records are becoming obsolete in an increasingly digital workspace. In keeping with the goal to incorporate existing asset management resources, ArcGIS laid the framework for the conversion tracking toolkit. One of the important methods for success was to identify what data was available, what data was needed, and what features would be beneficial that don't yet exist. It was relatively simple to identify the available data by mirroring the existing street lighting GIS layers. The missing information from the conversion layer came in the form of the type of light fixture, and the affiliated fields. New fields were created that identified the type of LED fixture to replace the old HPS luminaire, as well as Serial number and date of installation. These three fields were critical for establishing rebate incentives, maintaining a warranty on the new fixtures, and to update billing. Additionally, an inspection and problem field were added, along with a comment field. These provided the opportunity for contractors to communicate with engineers and technicians on different issues encountered in the field. Furthermore, this allowed technicians to make notes to a particular light, pre-conversion, to prepare the contractors for unusual situations.

Existing street lighting layers in GIS were incorporated into a shared, editable layer, accessible via a mobile app. PBOT GIS Technicians worked with the City's corporate GIS to design a shared conversion map. The ArcGIS Collector app became a powerful tool for the contractors to use during conversion. As the contractors changed an HPS light fixture to LED, they would select the light on the map, update the conversion status (including date and serial number for warranty purposes), and move on to the next light. Simple, concise, and practical. The changes were reflected in real-time on GIS servers in-office, allowing the City to track material needs and update billing precisely and accurately. With the ability to know the exact number of lights converted on a temporal or regional basis, the City can more accurately predict future costs for materials and labor. Additionally, management can more accurately project savings, both in the form of energy usage and rebate incentives. With an aggressive conversion schedule, being able to easily and methodically identify street lights for conversion was important to keep pace. Quarter-sections of a city-wide map based on previous GIS layers were formed in a grid pattern, with monthly conversion goals. As work progressed, project managers were able to check the pace against monthly goals; the conversion is presently ahead of schedule. An added benefit of utilizing GIS through the conversion process is long term future asset management. By coding each light with a specific GIS location, comments can be added regarding repair, damage, or modifications from the office or in the field on-site. Furthermore, by utilizing similar exporting features, accounting and billing personnel were able to interpret the conversion details in a common format.

The Arc Collector app allowed contractors to edit features within the conversion layer, without editing features in the street lighting layer. This provided the ability to restrict editable data to conversion related information only. Previous mobile GIS functions, prior to the LED conversion, gave users the option the add lights and relocate the light position. While this was helpful for inspections, it was not something that was warranted for the conversion process. If contractors came across lights that were mismapped or missing, a simple comment describing the scenario would be added to the light information, and addressed at a later time. An added benefit of a city-wide LED conversion, using existing GIS information, is the opportunity to audit the street light inventory. Contractors would provide notes on pole numbers, placement, and missing light locations.

TOOLS FOR SUCCESS

The tools used for the Portland LED conversion are relatively limited, and are almost entirely reflected in contractor usage. Each team of contractors (each crew) needs a smart device to access the app and a Bluetooth barcode scanner. The smart device used for this project was an iPad Mini, which was light enough to be toted around without burdening the contractor during luminaire installation; the iPad was equipped with a drop-resistant, water-proof case and has a Verizon mobile plan so it is always connected to the internet. The barcode scanner that is used is the Socket Mobile CHS, which is rated for outdoor use and functions well under unusual lighting and scanning conditions. The cost to equip each crew with the necessary conversion tools was less than $1,000, an amount easily recoverable within a few days of converting lights. At most aggressive pace, 4 crews have been used concurrently, requiring 4 setups. The Collector App itself is a free application, and can be downloaded to any smart device. When opening the app, the user is prompted to login, which corresponds with an uploaded GIS layer; this GIS layer is synced with the GIS server in office. Aside from initial setup costs by the GIS technician, there is no cost affiliated with using the Collector App. A crucial detail to any project involving an assortment of vocational backgrounds is simplicity of use for any technologic interface. The Collector app provides an interface that helps to ensure limited potential for erroneous data entry during the conversion.

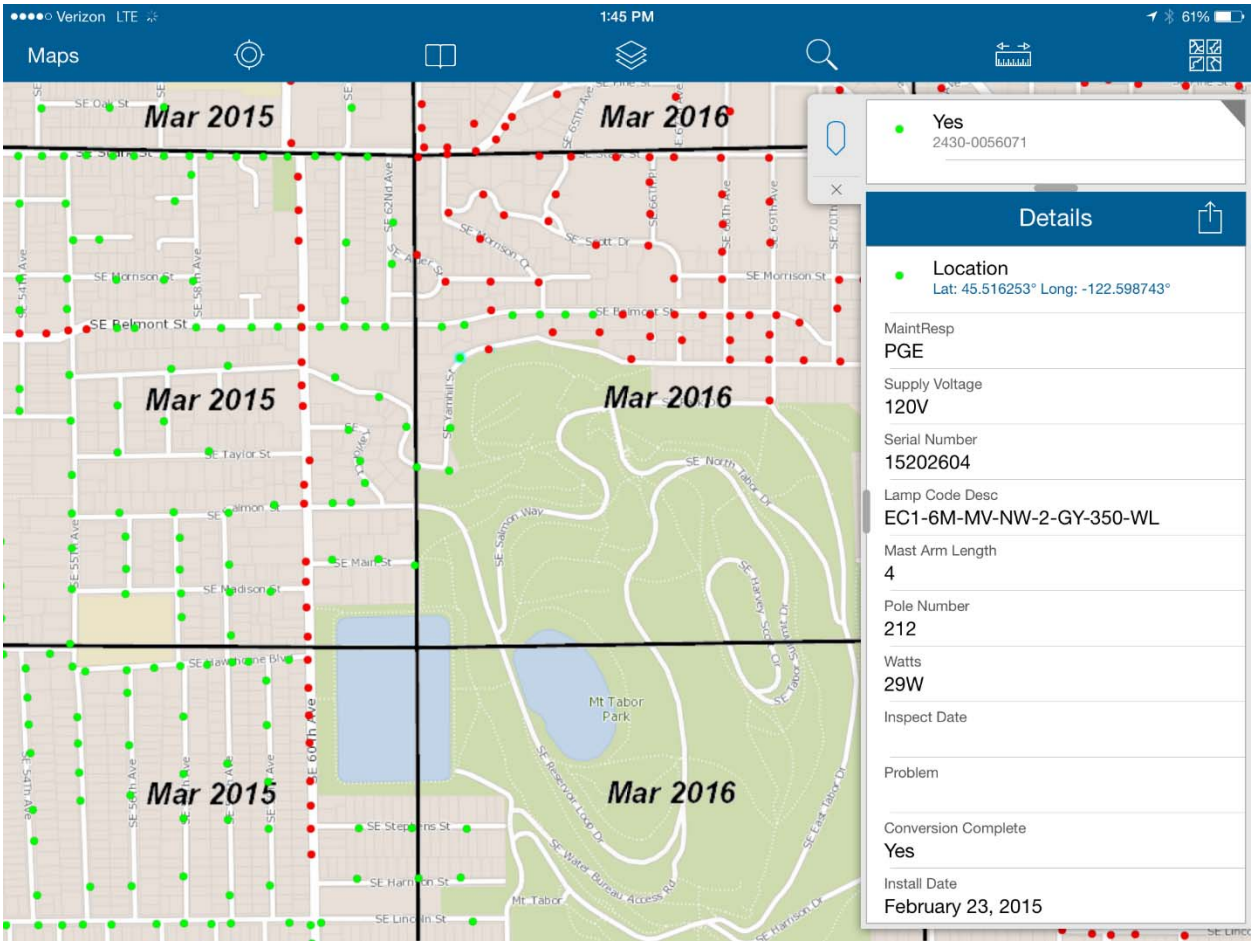

Figure 1 -Editable details for cobrahead luminaire. The contractor adds serial number and install date, as well as any comments as necessary. The contractor is also able to check pole number in GIS against pole number on pole tag.

METHODS

The process that the contractors follows for updating data is as follows: The contractor identifies the light, based on GPS location and location in the field. Tapping on the light (on the iPad) brings up the data fields for viewing. The contractor confirms the pole number shown on the app with the pole tag on the pole. After confirming the correct pole has been identified, selecting the "edit features" button allows notes to be added. The "lamp code description" alerts the contractor as to which type of luminaire fixture to install, and to which setting. The contractor then selects the "serial number" field, to enter a unique serial number for each individual luminaire that is installed; in this manner, we are able to keep a record of installation date for each luminaire, for warranty purposes. To eliminate an opportunity for error, Bluetooth barcode scanners are utilized to scan the serial number into the respective field. The date of conversion is added, as well as toggling the "conversion" field to "YES." The contractor then saves the entries, which updates the GIS server and is instantly reflected in real time on the Conversion Layer. The "comments" field has become an important conduit for delivering messages from the engineer to the contractor, and vice versa. The engineer most often uses this field to provide additional instructions to the contractor regarding a specific luminaire conversion. An example is the installation of an in-line fuse on the service wire. Similarly, the contractor uses this field to alert the engineers and technicians about problems encountered, or utility connections needing attention. Furthermore, this field has been used in assessing LED outages and modifications. When a daily light outage report is prepared, the contractor uses the Collector App to enter notes about the repair (repair date, replacement information, and modifications).

The real power in real-time asset management, as it pertains to this street light conversion project, can truly be understood when incorporating public engagement. By sharing the real-time conversion map with the public, individual residents can track the project progress. Residents curious to know when the lights on their block will be converted to LED can simply find their address on the map, and note the projected conversion date. Similarly, if customers have questions or concerns pertaining to a specific location, they are able to identify the light on the map directly, and send an inquiry to the engineering office via email. Another reason to share the map with the public is to increase the transparency of government work. The project scope included equity as an important factor in determining conversion schedule geography, in terms of communities of color, income, and other social factors. While an emphasis was laid on the age of the existing HPS lights to be converted, equity analysis played a role in identifying areas were conversion could have a positive impact on safety and livability. The large-scale conversion has attracted the attention of local media outlets, discussing the cost-savings benefits as well as the reduction in light pollution.[5] In addition to describing the benefits of the LED conversion, blogs have been used to encourage resident feedback for comments and suggestions.[6]

[5] Korn, Peter. "Rose City's bright idea." Portland Tribune. October 2, 2014. Pamplin Media Group.
[6] Maus, Jonathan. "Help us make PBOT's streetlight conversion project better for bike riders." BikePortland.org. http://bikeportland.org/2015/06/18/help-us-make-pbots-streetlight-conversion-project-better-bike-riders-143375, Published June 18, 2015.

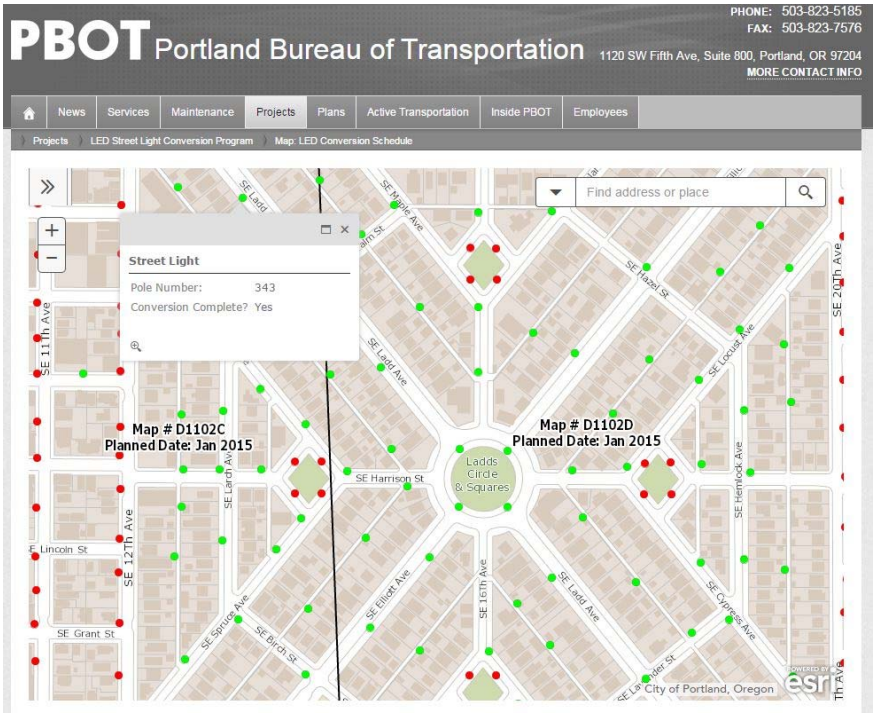

Figure 2 - The PBOT LED Conversion website allows the public to provide feedback for a specific light, by finding the Map and Pole Number on the shared conversion map, the same map used by conversion contractors.

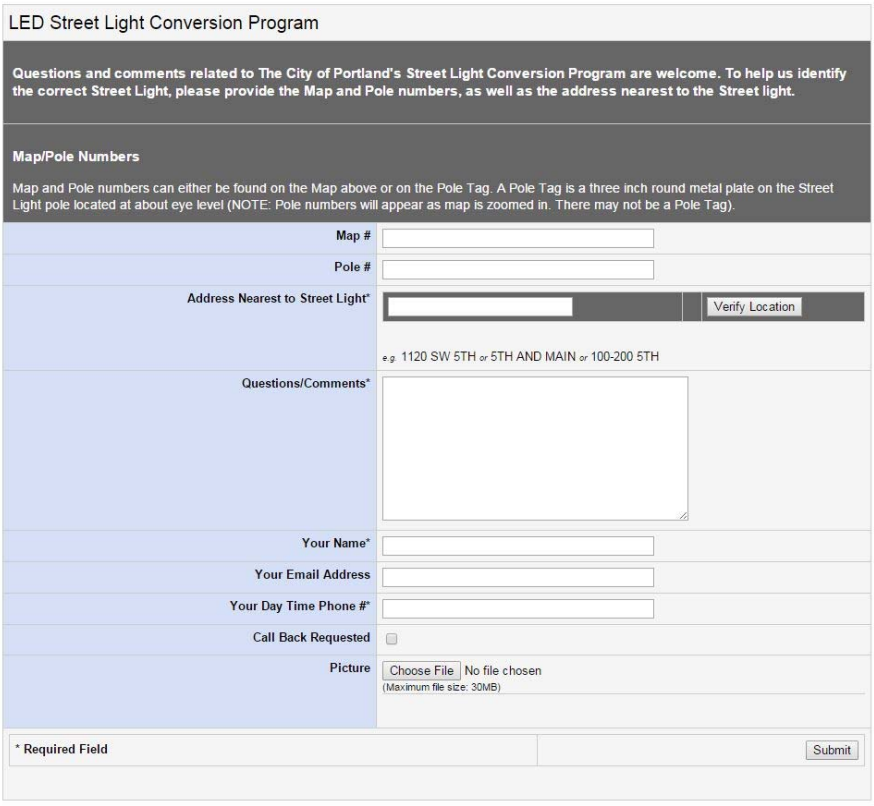

Figure 3 - Feedback is encouraged. The City uses the feedback to address concerns and requests of residents to remedy potential glare issues and safety concerns. The submitted form sends an email to the street lighting inbox for review and resolution.

A GLOWING RECOMMENDATION

The positive experience of using the Arc Collector app for the LED conversion has the City looking for future applications. Electrical maintenance staff have expressed interest in using the app for tracking repairs to signals and beacons, as well as identifying underground conduits where applicable.

The success of the conversion process, thus far, can be directly attributed to the team members involved, with a strong foundation of GIS resources. The savings of using a digital database for such a large scale conversion are innumerable, both in labor and resources. Streamlining the monthly conversion reports for utility billing through a single spreadsheet, pulled from the GIS conversion layer, eliminates the need to cull through thousands of data entries spread over stacks of paper. The ability to quantify a total sum for each wattage of LED installed with the click of a mouse eradicates hours of bookkeeping and cross-checking. Digitizing the details of the conversion within a single GIS layer is a method that has proven itself invaluable, and comes with an overwhelming recommendation.