CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

Clean Transportation Program

FINAL PROJECT REPORT

Sustaining and Growing the Redwood Coast Electric Trail

Prepared for: California Energy Commission

Prepared by: County of Sonoma General Services Department, Facilities Development and Management

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-606 to provide funding opportunities under the Alternative and Renewable Fuels and Vehicle Technology Program to install electric vehicle charging stations throughout the state at public, destination and workplace locations. In response to PON-13-606, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards April 4, 2014 and the agreement was executed as ARV-14-020 on October 8, 2014.

ABSTRACT

The County of Sonoma General Services Department solicited a grant from the California Energy Commission to expand the number of electric vehicle charging stations in Sonoma County. The grant application listed eight locations in section 2.1 of the grant application. The construction work occurred primarily in 2016. This report describes the installation of new electric vehicle charging stations and renovation of existing locations, schedules, costs and outcomes of the expansion. The expansion provided benchmarks for project and construction costs, time durations for the projects, obstacles and recommendations for future expansions.

The work funded by the grant is divided into two groups, new construction creating electric vehicle charging stations, and renovations of existing electric vehicle charging stations.

The County of Sonoma pursued a third new location with the remaining grant and matching funds. This site was located at the County's building department, Permit and Resource Management Department site which experiences significant public use on a daily basis. The remaining grant funding was not sufficient to fund the project and construction resulting in cancellation of the third location project.

The three new locations are:

- Cloverdale Veterans Hall, 205 West First Street, Cloverdale California
- Guerneville Veterans Hall, 16255 First Street, Guerneville, California
- County of Sonoma "Permit and Resource Management Department", 2550 Ventura Avenue, Santa Rosa, California (Cancelled 2018)

The five renovated locations are:

- La Plaza A and B office buildings, north parking lot, 2300 County Center Drive, Santa Rosa California
- Santa Rosa Veterans Hall, 1351 Maple Avenue, Santa Rosa, California
- Doran Beach Regional Park, 201 Doran Beach Road, Bodega Bay, California
- Sonoma County Airport, 2200 Airport Boulevard, Santa Rosa, California
- County of Sonoma Administrative Center, 575 Administrative Drive, Santa Rosa, California (Site completed prior to grant award and did not use grant funding)

Keywords: Electric Vehicle Charging Stations, Electric Vehicle Charging Station Expansion Costs, Electric Vehicle Charging Station Construction Schedules, Electric Vehicle Charging Stations Project Best Practices

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EXECUTIVE SUMMARY

Project Goal

The project goal is to increase the number of electric vehicle charging stations in Sonoma County available to the public, and provide code compliant access to them for the disabled community. This goal was realized by using the California Energy Commission grant in combination with the County of Sonoma's matching fund.

Process

The first step was to determine what the scope of the project work could be, based on the funding amount of the grant, plus the County of Sonoma's matching fund. The County of Sonoma's goal was to fund the entire project with the combination of the grant funding and the County of Sonoma's matching fund. The funding was used for real property, services and equipment.

A conservative scope of work was determined that would allow the funding to create new electric vehicle charging stations and renovate existing charging stations to comply with the Americans with Disabilities Act based building codes.

Three new sites were identified that met criteria consisting of:

1. Location - Choose locations that will extend the Redwood Coast Electric Trail to outlying areas of the County
2. Public availability – The location should be a significant draw for the public and accessible to other public locations. The new sites should be located in, or adjacent to, a shopping or civic center
3. Infrastructure – there has to be sufficient electrical capacity at the location to add electrical service for the electrical vehicle charging stations

Results

Costs: The cost including engineering, project management and construction averaged $138,000 per site.

Schedule: Design, permitting and bidding took approximately six months. Construction took approximately one to two months per site.

Usage: The sites have been in operation for several months and are functioning as expected with no complaints.

Five renovated existing sites were updated to meet the California building code Americans with Disabilities Act.

The three new sites were designed and engineered by two local architecture firms and their consultants. The County of Sonoma utilized the job order contracting method for bidding and construction for two of the three sites. The two sites were constructed concurrently. The third new site location that was designed after completion of the first two, did not move forward due to budget and time constraints.

Conclusions

The project funded by the grant/County of Sonoma matching fund extended the range of the County of Sonoma owned EV charging network and provided code compliant access to the disabled community at the seven EV charging stations. EV charging station site selection best practices include convenience, adjacencies to public services, and available existing utilities. The existing renovated EV sites were well known to the EV public and were cataloged in smart phone apps and websites. The two new locations were quickly cataloged in the same apps and websites.

CHAPTER 1:
Purpose and Background

The purpose of the County of Sonoma's grant project is to expand the Electric Vehicle (EV) charging network. The expectation is a greater charging network, in both number and location, will increase the use of alternative renewable transportation fuels, encourage EV adoption, and result in reduction of greenhouse gas emissions.

Increasing the number of charging stations across a greater geographical area of the Sonoma County creates two incentives for use of EVs. First, a greater number of charging pedestals reduces scarcity concern of the public contemplating purchase of an EV. Second, dispersing the charging locations through-out Sonoma County encourages EV use as a viable mode of transportation beyond city limits and even regional limits. Eventually, a robust charging network statewide will encourage EV use across several counties and hundreds of miles as EV range and charging locations increase.

1.1 EV Use at the County of Sonoma

1.1.1 Beginnings

In 2009 the County of Sonoma's General Services Director at the time, Mr. Jose Obregon, directed the Fleet Manager at the time, Mr. David Head, to research electric vehicles and provide feedback regarding incorporation into the County's fleet. Mr. Head, working with now current Fleet Manager, Mr. David Worthington, chose a data gathering method that would yield a product that was both accurate and rigorous.

Fleet purchased two identical Toyota Priuses and outfitted them with two systems. One system was a kit to convert one of the two cars to a plug-in hybrid. The vehicle not outfitted with the plug-in conversion became the "control" vehicle that the performance of the plug-in hybrid was measured against. The other system installed was a Global Positioning System tracker in both cars. The question to be answered by this comparison was "which car gets the best mileage?" The Global Positioning System tracker records the mileage of each vehicle to ensure the variable of miles driven by each vehicle can be compared equally.

The two vehicles were driven by County of Sonoma staff over a period of eight months and 8,234 miles. The plug-in hybrid averaged results of approximately 100 miles per gallon. The control vehicle averaged 43 miles per gallon. With plug-in hybrids available now directly from major automotive manufacturers, Fleet purchased six Toyota Priuses and two Chevrolet Volts for use in the County fleet in 2012. Two charging pedestals were installed at the County Administrative Center to charge the County's EVs.

1.1.2 Growth

Also, in 2012, other County of Sonoma departments were provided with plug-in hybrids for their own fleets. ChargePoint Inc. charging pedestals, equipped with the data package, were installed to charge the vehicles. The data package provided additional data on use, miles driven, charge time duration and frequency. Ultimately, the data can be used to calculate an estimate of pollutants/green–house gases that were not introduced into the environment.

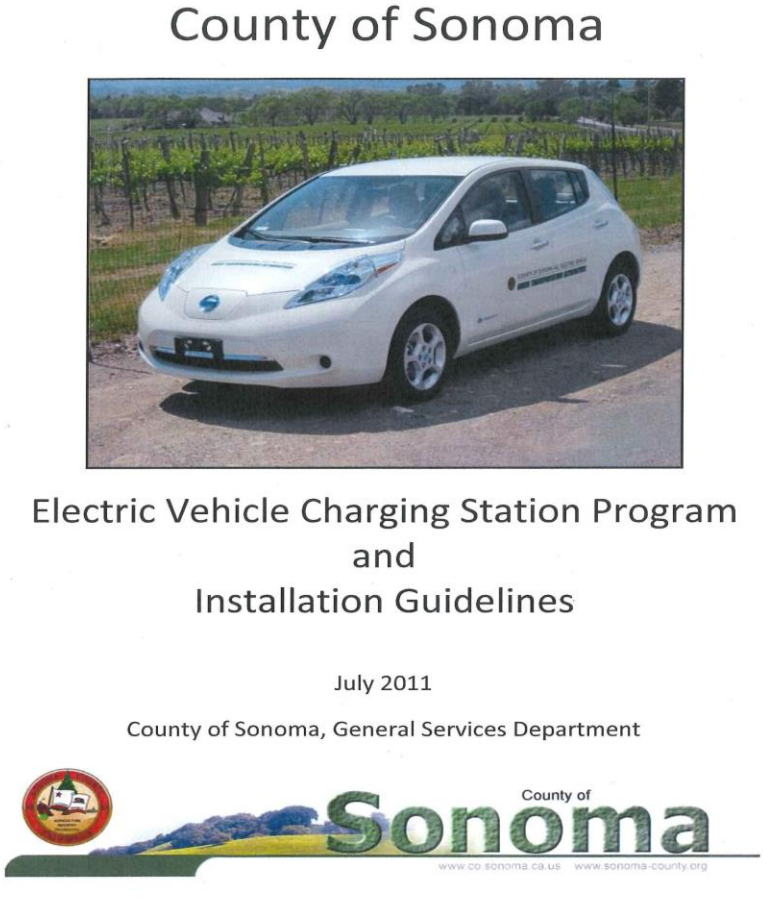
A continued search and procurement of additional (non-CEC) grant funding enabled the County of Sonoma to expand the hybrid fleet that now totals 308 hybrids / all electric vehicles. The current fleet also includes specialized vehicles including an all-electric "bucket" truck, an inmate transfer vehicle, and a mechanics service truck. The additional grant funding also allowed the County of Sonoma to expand the charging network beyond the County of Sonoma Administrative Center to the nearby towns/sites of Cotati, Sebastopol, Petaluma, Windsor, the Sonoma County Fairgrounds and regional parks locations.

1.1.3 Standards

In 2011, the County of Sonoma recognized that there was no consistent framework available to guide the growth of a vehicle charging network at the County, Municipality or even State levels. The County of Sonoma assembled a team of eight County of Sonoma departments, several municipalities, regional and state regulators, vehicle manufactures and other non-governmental organizations. The disabled community added their input to the guideline's development to ensure that EV charging stations are accessible to the disabled community. A consultant was hired to guide the process, the inputs and schedule.

The guidelines effort and subsequent publication in July 2011 as shown in Figure 1 below, positioned the County of Sonoma as a leader in the efforts to grow and manage the EV charging network. The California Division of the State Architects office reviewed the guidelines and they traveled as far as the country of Denmark. The sixty-four-page document also informed subsequent building code additions directing electric vehicle charging station installation.

Figure 1: County of Sonoma Guidelines



Source: County of Sonoma, General Services Department

1.2 Renovations of Existing EV Charging Station Sites

In 2012 the County of Sonoma extended the reach of electric vehicles by building charging stations at locations beyond the County of Sonoma Administrative Center. The locations owned by the County of Sonoma - County La Plaza Offices, Santa Rosa Veterans Hall and Doran Beach Regional Park required minor work to bring the sites into compliance with the building code's access compliance sections. The minor renovation work at these three sites was performed at a total cost of $4,800. A major renovation was necessary at the Sonoma County Airport site to bring the site into access compliance with the building code. The County also renovated the Administration Drive EV charging site but did not use grant funding for the work.

1.3 New EV Charging Station Sites

Two new EV charging sites were created. A third location was selected if sufficient grant funding was available at the completion of the two new sites. The two new sites, one in the City of Cloverdale and the other in the un-incorporated town of Guerneville, greatly extend the reach of the County of Sonoma's public EV charging locations as shown in Table 1 below. The City of Cloverdale is now the northern most point in Sonoma County and Guerneville is the western most town in the County of Sonoma's EV charging network. The County of Sonoma also planned to utilize the grant funding to create a third EV charging location at the County of Sonoma Permit and Resource Management Department located at the County of Sonoma Administrative Center. The building department location receives heavy public use each day due to its function. Construction document plans for the third location were created by an architecture/engineering firm and the bids for construction were solicited. The bid for this location was almost three times higher than the Cloverdale and Guerneville locations for a similar scope of work and was canceled due to cost.

Table 1: EV Charger Locations, Capacity

No.	Name, Renovation (R) or New (N)	Location Address	Pedestal Count
1	County La Plaza Offices (R)	2300 County Center Drive, Santa Rosa, California (north parking lot)	3
2	Santa Rosa Veterans Hall (R)	1351 Maple Ave., Santa Rosa, California	2
3	Doran Beach Regional Park (R)	201 Doran Beach Rd., Bodega Bay, California	1
4	County Center Administration Building (R)	575 Administration Dr., Santa Rosa, California	2
5	Sonoma County Airport (R)	2700 Airport Blvd., Santa Rosa, California	2
6	Cloverdale Veterans Hall (N)	205 West First St., Cloverdale, California	2
7	Guerneville Veterans Hall (N)	16285 First St., Guerneville, California	1

Source: Steve Fiano

CHAPTER 2:
Site Details – Renovations and New Sites

2.1 Minor Renovations at Existing EV Charging Sites

The grant funded minor renovations at existing electric vehicle charging stations at three locations in Sonoma County. The locations are County owned and occupied La Plaza office buildings in Santa Rosa, the Veterans Hall in Santa Rosa and Doran Beach Regional Park at Bodega Bay, California. Work included grinding asphalt surfaces to decrease slopes to two percent or less and re-striping parking stall lines. These two activities bring the parking stalls where the charging pedestals are located, into compliance with the Americans with Disabilities Act building codes. Total cost to have minor work performed at the three locations totaled $4,800 or approximately $1,600 per location.

2.1.1 La Plaza Office Buildings EV Charging Site - Renovation

In spring 2015 a County of Sonoma construction crew removed accessibility barriers at the location by grinding off high spots on the concrete surface. County of Sonoma guidelines call for a minimum of one EV charging stall to meet access compliance building code. The building code requires that the slopes at an accessible parking stall do not exceed two percent in any direction. The concrete surface around the charging pedestal did not meet the building code requirements for slope. The surface exceeded the two percent slope around the charging pedestal. The slope was reduced to two percent slope by grinding off the high spots in the concrete. The work was completed in one day and on budget. See Figure 2.

Figure 2: Santa Rosa Veterans Hall Minor Renovation Site

Source: Steve Fiano

2.1.2 Santa Rosa Veterans Hall EV Charging Site - Renovation

In spring 2015 a County of Sonoma construction crew removed accessibility barriers at the location by grinding off high spots in the concrete surface. County of Sonoma guidelines call for

a minimum of one EV charging stall to meet access compliance building code. The building code requires that the slopes at an accessible parking stall do not exceed two percent in any direction. Between the concrete surface and the location of the charging pedestal, concrete was installed that did not meet the building code requirements for slope. The surface exceeded the two percent slope. The slope was reduced to two percent slope by grinding off the high spots in the concrete. The work was completed in one day and on budget. See Figure 3.

Figure 3: Doran Beach Regional Park Minor Renovation Site

Source: Steve Fiano

2.1.3 Doran Beach Regional Park EV Charging Site - Renovation

In spring 2015 a County of Sonoma construction crew removed accessibility barriers at the location by grinding off high spots in the concrete and asphalt surfaces. County of Sonoma guidelines call for a minimum of one EV charging stall to meet access compliance building code. The building code requires that the slopes at an accessible parking stall do not exceed two percent in any direction. Between the concrete surface and the location of the charging pedestal, concrete and asphalt was installed that did not meet the building code requirements for slope. The surfaces exceeded the two percent slope. The slope was reduced to two percent slope by grinding off the high spots in the surfaces. In addition, the striping that defined the depth of the stall was extended approximately one foot to meet Americans with Disabilities Act building code requirements. The work was completed in one day and on budget. See Figure 4.

Figure 4: County of Sonoma Administration Building Minor Renovation Site

Source: Steve Fiano

2.2 Major Renovations at Existing EV Charging Sites

More involved renovations were completed at the Sonoma County Airport and the County of Sonoma Administrative Center at the Administration Building. The Administrative Center location was not funded by the grant. The major renovation work at these two sites required removal and replacement of concrete and asphalt surfaces to make the locations accessible to the disabled community.

2.2.1 County of Sonoma Administration Drive EV Charging Site - Renovation

In February 2015 a County of Sonoma construction crew removed accessibility barriers at the location by replacing concrete curbs and sidewalk. County of Sonoma guidelines call for a minimum of one EV charging stall to meet access compliance building code. The existing concrete curb was removed, and a new concrete sidewalk was installed flush to the asphalt surface to provide access to the charging pedestal for the disabled community. The project cost was $57,573 and was completed in March 2015. See Figure 5.

Figure 5: Sonoma County Airport EV Charging Site

Shown are the four EV charging stalls. The accessible charging stall was built in concrete to ensure the slope requirements were not exceeded at installation and don't change over time due to settlement.

Source: Steve Fiano

2.2.2 Sonoma County Airport EV Charging Site - Renovation

The existing public use EV chargers were significantly out of compliance with the access compliance building code. While grinding surfaces down to achieve a code compliant slope worked well at the other locations, it would not work at the airport site. A comprehensive approach that removed the non-compliant charging stall surfaces, adjacent sidewalk / path of travel and access to charging pedestals was more economical and quicker.

The construction work was started in June 2016 and completed in August 2016 at a construction contract cost of $62,873.

The airport location had two existing charging pedestals installed prior to the California Energy Commission grant award. However, the charging pedestals and parking stalls at the pedestals, were not accessible to the disabled community. The existing EV charging stalls were not connected to the existing code compliant path of travel across a drive aisle to the terminal building front door. The renovation work removed three Americans with Disabilities Act barriers. The Americans with Disabilities Act charging stall was updated to meet slope, markings and size requirements. The charging pedestal was re-located to provide the clear area around the pedestal needed for access to the operable parts such as the liquid crystal displays, card readers, charging cable and plug end, and the new work connected the Americans with Disabilities Act charging stall to the existing path of travel. All four charging stalls can now access the path of travel to the terminal front door.

The existing asphalt and concrete surfaces had slopes that exceeded the maximum code required slope limit of two percent in the parking stall area. Other code violations included surface edges that were raised up more than 1/4". The project removed the existing asphalt and concrete in the charging pedestal area and the parking stalls. The work required to provide electrical service to the existing charging pedestals was already in place and in good working order. No new trenching for electrical service was necessary. However, the site work to create the flat areas and the path of travel connections was extensive. The construction plans were submitted and approved on the same day October 28, 2015. The schedule had allowed three

months for the plan check review. The Notice to Proceed (start construction) was issued on June 6, 2016. The seven-month lag between the two activities was due to a very wet winter, and time needed to bid, evaluate and sign the construction contract. The Notice of Completion (legal document marking the end of the project construction phase) was issued on August 5, 2016.

The Airport location is providing an average of three charging events a day over the first six months it has been in operation. This location is listed on several web sites such as "Open Charge Map" that provide listings of electric vehicle charging locations. See Figure 6 photo.

Figure 6: Cloverdale Veterans Hall EV Charging Site

Shown above are two of the four EV charging stalls. The accessible charging stall was built in concrete to ensure the slope requirements were not exceeded at installation and don't change over time due to settlement.

Source: Steve Fiano

2.3 New EV Charging Sites

2.3.1 Cloverdale Veterans Hall - New EV Charging Site

The site was a good fit for two new electric vehicle charging pedestals. The main electric service for the facility is located immediate adjacent to the parking lot where the pedestals are located. The adjacency significantly decreases the lineal feet of electrical service installation to the charging pedestals, which resulted in a more economical installation.

The building main electrical service was sufficient to add additional electric loads to power two new charging pedestals serving up to four electric vehicles at a time. The architect/engineering consultants designed the additions to the main electrical service and the design of the four new parking stalls needed for the two pedestals. The site work and EV charging stall were designed to provide access to the charging pedestals by the disabled community. Surface slopes, path of travel, and access to the charging pedestals were designed to meet current accessibility building codes. The construction plans were submitted and approved on the same day October 28, 2015. The schedule had allowed three months for the plan check review. The Notice to Proceed (start of construction) was issued on May 28, 2016. The seven-month lag between the two activities

was due to a very wet winter, and time needed to bid, evaluate and sign the construction contract. The Notice of Completion (legal document marking the end of the project construction phase) was issued on August 5, 2016. The construction contract cost was $68,561.

The Cloverdale location is providing an average of three charging events a day over the first six months it has been in operation. This location is listed on several web sites such as "Open Charge Map" that provide listings of electric vehicle charging locations See Figure 7.

Figure 7: Guerneville Veterans Hall EV Charging Site

Shown above are the two EV charging stalls. The accessible charging stall was built in concrete to ensure the slope requirements were not exceeded at installation and don't change over time due to settlement.

Source: Steve Fiano

2.3.2 Guerneville Veterans Hall – New EV Charging Site

This location extended the reach of the Redwood Coast Electric Trail to the western side of Sonoma County in the unincorporated town of Guerneville. The Veterans Hall was selected as an EV charging location because it is owned by the County of Sonoma, is immediately adjacent to the downtown shopping area, and is a civic and public meeting hall.

Providing electrical service to the new charging pedestal was more difficult than the Cloverdale location. The main electrical room is located at the rear of the building and power to the one charging pedestal was run through the attic to the outside face of building and then down the face of the building and underground to the charging pedestal location. The additional cost created by the more complicated electrical service routing was partially offset by installing one charging pedestal rather than two. The small public parking lot where the pedestal is located did not have capacity to allow four dedicated EV spaces to the exclusion of standard parking spaces serving the facility.

One of the two charging station parking stalls was designed and constructed to be accessible to the disabled community. Surface slopes, path of travel, and access to the charging pedestals were designed to meet current accessibility building codes. The construction plans were submitted and approved on the same day October 28, 2015. The schedule had allowed three months for the plan check review. The Notice to Proceed (start of construction) was issued on

May 25, 2016. The seven-month lag between the two activities was due to a very wet winter, and time needed to bid, evaluate and sign the construction contract. The Notice of Completion (legal document marking the end of the project construction phase) was issued on August 5, 2016. The construction contract cost was $61,478.

The Guerneville location is providing an average of four charging events a day over the first six months it has been in operation. This location is listed on several web sites such as "Open Charge Map" that provide listings of electric vehicle charging locations.

2.3.3 County of Sonoma Permit and Resource Management Department – New EV Charging Site

The County of Sonoma had planned to use the expected remaining grant monies to build a third new EV charging site at the County of Sonoma Permit and Resource Management Department location. The site met the criteria for a desirable location. The main electrical panel has room to accommodate the additional electrical service for new charging pedestals. The location receives hundreds of public visits daily. There is an existing access compliant path of travel to the front door that the new charging site would have been linked to with no difficulty. The new EV sites at the Cloverdale and Guerneville Veterans Hall were both in the mid $60,000-dollar range. When all of the planned renovations and new construction was complete, the County of Sonoma had a grant/County fund balance of approximately $95,000. This amount was sufficient to design, bid and build a third new location at the Permit and Resource Management Department location. The expectation was that in the 18 months that had elapsed the County would still see construction costs in the mid to high $60,000 range. The County of Sonoma proceeded with the design of the Permit and Resource Management Department EV location and then utilizing the same bidding program, requested a bid for construction.

The contractor's bid that came in mid-February 2018 was $173,007 for comparable scopes of work with the two Veterans Hall locations. This represents more than a 250 percent increase in a short period of time. Over the course of a year and a half, market forces had driven the cost of construction up significantly in the bidding program the County regularly uses. The funding available and the cost of construction were so far apart any attempts to bring the cost of the project down would not have been productive. After review, the third new EV location at the Permit and Resource Management Department site was canceled.

CHAPTER 3:
EV Charging Pedestal Usage Data

3.1. Review of Usage Data Table

Table 2, on page 14, indicates the usage of the new and renovated EV chargers from March 1, 2017 through November 30, 2017, a period of nine months. The table provide insight into the public use of both the existing renovated sites, and the new sites. The renovated sites and the new sites were surveyed over the same period of nine months, which makes the data comparable. The new sites at Cloverdale and Guerneville were opened to the public in August 2016. The survey data of the new sites was polled eight months later. The renovated sites were opened to the public a year earlier and likely benefit from wider use by a greater number of EV owners.

The top half of the table presents the use-rate in column five as "Total Duration." The bottom half of the table presents column five as "Average Total Duration." The top half is a summation of total use while the bottom half is a view of each charging event.

For example, the EV charging station at "CoS Guerneville Vet" (row five) recorded 733 charging sessions. A charging session is defined as an electric vehicle being connected to the charger and then disconnected as one charging session. Both the top and bottom halves of the table indicate the same number of charging sessions - 733.

The next column, top and bottom, indicate total and average durations. The top half of the table indicates that the one pedestal in Guerneville has provided 1,037 hours of charging, while the bottom half indicates that the average per vehicle charge lasted one hour and twenty-four minutes on average.

The table indicates that the newly constructed Guerneville Vets EV Charger location is the most popular of the public charging sites. Note that the La Plaza and the Permit and Resource Management Department locations in the bottom half of the table have significantly longer charging durations. These four charging pedestals are largely used by employees who park and charge mostly County Fleet vehicles.

3.2 Conclusions from the Data table

Insights from Table 2 below for the EV chargers available fulltime to the public include:

- Average length of charge session is one hour and forty minutes
- Average charging sessions per month is forty-six
- Average charging session saved a little less than a gallon of gas per session.
- Average charging session saved 335 gallons over the nine-month survey period
- The two new EV charging sites were quickly discovered and added to online maps/registries as evidenced by their comparable usage rates with older sites

Table 2: EV Charging Data per EV Charging Pedestal Location

Station Name	Address	City	Zipcode	Number of Sessions	Total Duration (hh:mm:ss)	Charging Time (hh:mm:ss)	Energy (kWh)	GHG Savings (kg)	Gasoline Savings (gallons)
SONOMACNTYAIRPT / ST2-PRKNGLOOP	2200 Airport Blvd	Santa Rosa	95403	490	758:28:51	655:23:30	2685.54	1127.93	337.03
SONOMACNTYAIRPT / ST1-PRKNGLOOP	2200 Airport Blvd	Santa Rosa	95403	365	534:10:13	467:58:40	2012.63	845.31	252.58
COUNTY SONOMA / SR VETS BLDG #1	1351 Maple Ave	Santa Rosa	95404	401	874:03:33	645:52:01	2777.25	1166.45	348.55
COUNTY SONOMA / SR VETS BLDG #2	1351 Maple Ave	Santa Rosa	95404	265	574:33:48	395:51:13	1707.43	717.12	214.28
COUNTY SONOMA / GUERNEVILLE VET	Church Street & 1st St	Guerneville	95446	733	1037:11:17	889:11:58	3987.82	1674.89	500.47
COUNTY SONOMA / DORAN BEACH	201 Doran Beach Rd	Bodega Bay	94923	319	406:37:30	346:40:45	1687.03	708.55	211.72
COUNTY SONOMA / CLOVERDALE #1	205 W 1st St	Cloverdale	95425	341	537:57:58	498:34:41	2916.03	1224.74	365.96
COUNTY SONOMA / CLOVERDALE #2	205 W 1st St	Cloverdale	95425	427	726:12:46	643:11:49	3664.95	1539.27	459.95
COUNTY SONOMA / CC PRMD #1	2550 Ventura Ave	Santa Rosa	95403	265	6032:40:58	4703:35:29	2170.64	911.67	272.41
COUNTY SONOMA / CC LA PLAZA #1	2300 County Center Dr	Santa Rosa	95403	247	1563:34:08	1535:20:30	876.98	368.33	110.07
COUNTY SONOMA / CC LA PLAZA #2	2300 County Center Dr	Santa Rosa	95403	631	2204:23:50	1168:20:49	4726.68	1985.19	593.21
COUNTY SONOMA / CC LA PLAZA #3	2300 County Center Dr	Santa Rosa	95403	259	1841:26:56	1773:43:54	686.41	288.29	86.15
COUNTY SONOMA / CC ADMIN BOS #1	575 Administration Dr	Santa Rosa	95403	596	1792:52:47	1446:59:03	6661.32	2797.75	836.00
COUNTY SONOMA / CC ADMIN BOS #2	575 Administration Dr	Santa Rosa	95403	621	1665:54:52	1341:48:49	5931.08	2491.05	744.35
			Totals	**5960**	**20550:09:27**	**16512:33:11**	**42491.80**	**17846.54**	**5332.71**

Station Name	Address	City	Zipcode	Number of Sessions	Average Total Duration (hh:mm:ss)	Average Charging Time (hh:mm:ss)	Average Energy (kWh)	Average GHG Savings (kg)	Averagea Gasoline Savings (gallons)
SONOMACNTYAIRPT / ST2-PRKNGLOOP	2200 Airport Blvd	Santa Rosa	95403	490	1:32:53	1:20:15	5.48	2.30	0.69
SONOMACNTYAIRPT / ST1-PRKNGLOOP	2200 Airport Blvd	Santa Rosa	95403	365	1:27:49	1:16:56	5.51	2.32	0.69
COUNTY SONOMA / SR VETS BLDG #1	1351 Maple Ave	Santa Rosa	95404	401	2:10:47	1:36:38	6.93	2.91	0.87
COUNTY SONOMA / SR VETS BLDG #2	1351 Maple Ave	Santa Rosa	95404	265	2:10:05	1:29:38	6.44	2.71	0.81
COUNTY SONOMA / GUERNEVILLE VET	Church Street & 1st St	Guerneville	95446	733	1:24:54	1:12:47	5.44	2.28	0.68
COUNTY SONOMA / DORAN BEACH	201 Doran Beach Rd	Bodega Bay	94923	319	1:16:29	1:05:12	5.29	2.22	0.66
COUNTY SONOMA / CLOVERDALE #1	205 W 1st St	Cloverdale	95425	341	1:34:39	1:27:44	8.55	3.59	1.07
COUNTY SONOMA / CLOVERDALE #2	205 W 1st St	Cloverdale	95425	427	1:42:03	1:30:23	8.58	3.60	1.08
COUNTY SONOMA / CC PRMD #1	2550 Ventura Ave	Santa Rosa	95403	265	22:45:53	17:44:58	8.19	3.44	1.03
COUNTY SONOMA / CC LA PLAZA #1	2300 County Center Dr	Santa Rosa	95403	247	6:19:49	6:12:57	3.55	1.49	0.45
COUNTY SONOMA / CC LA PLAZA #2	2300 County Center Dr	Santa Rosa	95403	631	3:29:37	1:51:06	7.49	3.15	0.94
COUNTY SONOMA / CC LA PLAZA #3	2300 County Center Dr	Santa Rosa	95403	259	7:06:35	6:50:54	2.65	1.11	0.33
COUNTY SONOMA / CC ADMIN BOS #1	575 Administration Dr	Santa Rosa	95403	596	3:00:29	2:25:40	11.18	4.69	1.40
COUNTY SONOMA / CC ADMIN BOS #2	575 Administration Dr	Santa Rosa	95403	621	2:40:57	2:09:39	9.55	4.01	1.20
			Totals	**5960**	**58:42:59**	**48:14:47**	**94.84**	**39.83**	**11.90**

Source: County of Sonoma Fleet Operations Division

3.3 Fee for Charging an EV at County Owned Charging Site

On May 17, 2016 the Sonoma County Board of Supervisors approved the implementation of a pricing plan for County owned, publicly available electric vehicle charging sites.

For approximately two years the public enjoyed the benefit of no cost EV charging at all the County owned locations listed in the table above. Charging an EV was free to the public at County of Sonoma owned charging sites up to September 1, 2017.

The objectives of the pricing plan include:

- A pricing structure that creates station access for EV drivers without access to home charging
- A pricing structure that creates station availability for longer distance EV drivers who rely on public charging access for their daily commute
- Addition of a four-hour time limit to improve access for more EV drivers

- Cost recovery of the electricity, administration, maintenance and operation of the EV network

The pricing plan consists of a $2.00 connection charge, a usage charge of $1.00 per hour up to four hours, and a $10.00 per hour charge for each hour of connection beyond the time limit allowed at the charging station. Violators may also be subject to a charging station citation.

The pricing plan is designed to encourage EV drivers to charge vehicles for no more than four hours by increasing fees after the four-hour mark significantly. The expectation is that the monetary incentive to charge and disconnect at four hours or less will open the charging sites to more users.

CHAPTER 4:
Public Outreach

4.1 Webinars conducted by the County of Sonoma

The County of Sonoma's Fleet Manager, David Worthington, created a 33 slide Power Point presentation titled "EVs and Building a Charging Station Network – Fleet Best Practices and Lessons Learned." The power point presentation was hosted on-line on two dates – January 3rd and 18th, 2018. Presentation topics include:

- Why Electric Vehicles
    - Can reduce green-house gas
- Vehicles and Infrastructure Experience
    - County of Sonoma installs first charging stations in 2009
- Charging Station Site Location Choices
    - Close to services and/or attractions
- Electric Vehicle Supply Equipment
    - "Dumb and Smart Chargers" and costs
- Lessons Learned
    - Include accessibility in design of electric vehicle charging station
- Infrastructure Costs
    - The cost of installing the first Charging Pedestal is the most expensive
    - Proximity to, and capacity of electrical service influences costs
- Maintenance and Repairs
    - Charging cords wear out, circuit breakers trp
- Public Pricing Plan Considerations
    - Charge by connection?
    - Charge by hour or by Kilowatt?
- Accessibility Regulations
    - Chapter 11B in California Building Code
- Additional Resources
    - Governor's Office of Planning and Research
    - California Building Standards Commission
    - California Division of the State Architect
    - United States Department of Energy – Plug-in Electric Vehicle Handbook for Fleet Managers
- Questions and Answers
    - Questions and answers were submitted directly to the County of Sonoma Fleet Manager after the webinar concluded. Unfortunately, the webinar software program does not log the questions and they have not been retained.

The presentation included educational information on current locations, how to choose a site for new locations, what equipment choices are available for charging, handicap accessibility, pricing for use of chargers by public, and costs associated with electric vehicle charging. Both webinars were well attended with forty-four participants attending the first one on January 3, 2018. The second webinar on January 18, 2018 featuring the same content was attended by approximately fifty-four participants.

4.2 Other Outreach Conducted by the County of Sonoma

Continued outreach by the County of Sonoma's Fleet Manager, Mr. David Worthington, takes the form of Mr. Worthington's participation at EV conference panel discussions. The last expo Mr. Worthington attended was the Fifth Annual Bay Area ALTCAR expo at the Oakland, California City Hall on March 21, 2018. Topics covered at the Expo included:

- Synergies between Electric and Shared / Automated Vehicles
- Future of Sustainable Transportation and How to Get There
- Progress and Opportunities (Environmental Issues)
- Update on Hydrogen in the Bay Area and Beyond

Mr. Worthington attends and speaks at one or two of these events a year.

CHAPTER 5:
EV Charging Station Technology, Observations, Conclusions, and Recommendations

5.1 EV Charging Station Technology

Electric vehicle charging pedestal manufacturers continue to upgrade the pedestal abilities. Data collection and use tracking are evolving which will inform decision making about adding chargers to a network. County of Sonoma charging pedestals currently offer Level One (120-volt) and Level Two (240-volt). Level Three (400-600-volt – direct current) "fast-charge" pedestals are available from manufacturers. The County of Sonoma is unlikely to install level three chargers due to the high cost of electrical system upgrades required to power the pedestals. Development of pricing structure and methods for public charging use are evolving from per hour use pricing to kilo-watt hour pricing. Rather than pricing that measures how long a period of time an EV is charging, the pricing will measure how much electricity was used in an EV charging session. Charging for electricity used aligns with how public utilities charge for electricity.

Management of the charger pedestals by both the County of Sonoma and the manufacturer utilize a built-in wireless system. A real-time look at charger use and availability provided by the wireless reporting service enhances data gathering. The data can then be used to determine growth, maintenance and forecasting for expansion of the charging network.

For the EV driver, there are mobile phone "apps" that can direct the driver to the nearest available charger and also provide specifics about the location and charging level available at a location. Car manufacturer in-vehicle navigation systems are starting to add EV charging station locations included in the navigation software.

Research and development of wireless EV charging by car manufactures is on-going. BMW, for example, is starting to promote this enhancement with the idea that charging will be simpler with no charging cords to be connected by the driver.

Experts in the field expect that the next trend will be the availability of "ultra-fast" charging stations. These charging stations will be designed to deliver a charge to an EV quicker that even a Level Three charging pedestal. Future autonomous vehicles will include EVs and benefit from new technologies. Wireless inductive charging stations, much like current gas stations are being discussed. The autonomous vehicle when experiencing low battery levels will direct itself to a wireless, inductive charging location. If there is a passenger in the EV they will not have to leave the vehicle to connect a cord. The passenger will simply wait a few minutes for the EV to charge and then be on their way to the destination.

5.2 Observations

Electric vehicle manufactures continue to expand the range of the EV in each successive year. Once there is widespread perception that finding a charging station is of little to no concern, adoption of EVs will likely accelerate. If gasoline costs continue to climb, it will make EVs that much more attractive. As more EVs are purchased, data and trends determining how the public uses their EVs will likely be easier to obtain and use in forecasting. The data will inform decision making around where to locate charging stations, how many pedestals at each location are needed and what level of charging is desirable.

At the County of Sonoma, we have noticed that more and more employees purchase EVs for personal use who have driven one of the 383 County of Sonoma's Fleet EVs for their job. Employees who use a fleet EV and thus road test the EVs in a "real-world" experience gain familiarity with EVs that cannot be gained in a short dealer test drive. A number of these employees have purchased EVs for their personal car as a result of EV use at their jobs. Employees driving EVs for the first few times are impressed by the torque/acceleration and the general handling. As staff grows more comfortable with the EVs, trips of greater and greater lengths are being taken. The employee's ability to experience an extended test drive of an EV informs perceptions and mitigates risks involved in the significant purchase cost of an EV.

Fleet personnel have noted that concerns about battery replacement and disposal are less of an issue now due to market and technological advancements. First, a robust secondary market for lithium batteries has developed. Recycling the batteries into other non EV uses grows greater every year. Second, the batteries used in EVs are increasingly more efficient and long-lived resulting in longer periods of use between replacements.

The County of Sonoma noted that within days of the two new EV charging stations opening to the public, they had been discovered and were in use by the public. Web search results yield a half dozen sites that list EV charging locations.

5.3 Conclusions

Greater public use of EVs is largely driven by the growth of the charging network and the perceptions of the vehicles themselves. Growing the charging network will likely result in more EVs on the road in a largely rural area like Sonoma County. As the number of charging stations grows and are dispersed around Sonoma County, the scarcity concern regarding where an EV can be charged is reduced.

Acceptance of EVs in mainstream auto culture grows every year. All of the major automotive manufactures now have some version of an EV. The high-profile boutique manufacturer, Tesla, offers only EVs. The larger, international auto shows held each year now feature electric vehicles as a regular attraction. As more and more EVs appear on the roads and in media, adoption by a greater portion of the motoring public will likely increase.

The total project cost during the grant program for the County of Sonoma to build an accessible charging site at an existing public facility, where none existed before, is approximately $139,000. Total project cost includes management, design, permitting, construction and contract close-out phases. Economical installation of a new EV charging station is dependent on the availability of electrical service that has capacity for the new electrical load of EV charging sites. Standard development costs for an EV charging site include management, design, construction, and access compliance costs. Whether a charging site has one, two or three charging pedestals standard costs will not rise or fall significantly.

There are maintenance costs associated with providing a charging pedestal. The charging cords which experience the weather extremes of summer and winter and are coiled and uncoiled daily causes the performance to suffer over time. The County of Sonoma replaces the electrical cords that connect the charging pedestal to the EV every three years. The cost to replace one pedestal charging cord is approximately $2,000. Commercial service plans are available for one to five-year durations from the pedestal manufactures.

The pricing structure and rate to charge the public for charging an EV needs continued development to fund maintenance and life cycle costs. The County's goal is to make each installation self-sufficient in terms of annual maintenance costs.

When selecting a site for EV charging, convenience of use should be considered. Is the location available every day? Is the location available after business hours? Is it well lit, safe and easily found? Answers to these questions will inform site selection. Robust use of sites selected for EV charging depends on services available within walking distance to the charging station. Public uses such as shopping, services and government centers will likely increase the use of an EV charging site by the public.

An EV charging station project has just a few steps that can increase the odds of a successful installation including:

- Select an appropriate site that is close to destinations used by the public
- Determine that there is sufficient available electrical service capacity to power the charging pedestals
- Engage professional designers, engineers and contractors
- Design the site for access compliance building codes
- Prepare a realistic budget and schedule with contingencies funding and time.

Two critical points need to be addressed prior to commencing a project that adds electric vehicle charging stations to a new/existing facility/location. One – verify that there is sufficient existing electrical service at the location. If there is not, a costly upgrade to the main electrical service will be necessary. This could take the form of adding a new transformer, electrical panel and/or work by the local electrical utility. Two – address the requirements of the Americans with Disabilities building code elements in the new installations. The new vehicle charging stalls need to meet slope and clearance requirements, as well as being located on a designated path of travel to a facility front door or public way.

Insight into what level of charging to make available at a charging location is growing as more electric vehicles are on the road. Ideally, charging at a workplace where electric vehicles can charge for four to eight hours is preferable as a level one charger can be used. The level one charger, at 120 volts, are economical to install as the electrical service load on the existing electrical system is less and more manageable.

With these two critical concerns addressed, a project to add electric vehicle charging stations to a location is a straight-forward construction project when managed and designed by professionals utilizing competent contractors.

Keys to reducing the cost to install EV charging stations include locating the charging stations as close to the point of existing electrical service as possible. This reduces the lineal feet of trenching required for underground installation of electrical service to the charging pedestals. Survey the site location to ensure that an Americans with Disabilities code compliant path of travel to a public facility front door or public way exists. If an existing compliant path is not available, the cost to design and install one can be considerable. In addition, survey the proposed location for underground utilities to ensure that there will be no obstacles for the installation of underground electrical service to the new charging pedestals.

Use of the EV charging stations by the public requires time management to create charging access for multiple users. Signage and enforcement can be utilized to see that the charging

stations are used as fueling stalls rather than parking stalls. Each charging station stall created in the grant projects has signage indicating that "Charging is limited to 4 hours per car between peak hours of 7:00 a.m. to 6:00 p.m." and "No Parking Except for Vehicle Charging".

The County of Sonoma allows the utilization of EV charging stations for use by disabled persons with placards or license plates when they have been designed as accessible and located at a public facility. Signage indicates that use of electric vehicle charging stations by disabled persons is permitted without restrictions if all of the adjacent accessible parking stalls are occupied. The signage at each charging station for disabled use reads: "Designed for Disabled Access – Use Last". This accommodation is specific to a site and is posted at the Cloverdale and Guerneville locations, but not at the airport location.

An early draft of the California Building Code for electric vehicle charging (11B-208.1) defines EV charging stations as fueling stations, not as parking stalls. This definition currently excludes the fueling stations for charging EVs from compliance with accessibility. However, the (11B-202.4) Advisory EVG-250 from the Governor's Office of Planning and Research dating from 2013 states that "A reasonable portion of Electric Vehicle Charging Stations are required to be accessible." The County of Sonoma adopted one of the earliest approaches in the State in regard to providing EV charging stations that also serve the disabled community. At least one of the charging stations is required to be access compliant for both a car and a van.

The County of Sonoma's goals for this project were met, if not exceeded, as measured by the use of the charging stations. During site visits at project close out, the public was already charging at the new locations. The County of Sonoma had not posted the sites on-line yet so demand in these new locations already existed. The County of Sonoma's decision to include access compliance as a part of each project, though no regulations required it at the time, has proven to be foretelling. Access compliance is a litigious environment, and it is likely that the County has avoided issues by providing access compliant charging stations.

5.4 Recommendations

Choose the site carefully when selecting new locations for charging pedestals. To increase use, sites should be close to services needed or desired by the public. This includes shopping areas, government services, and recreational sites to name just a few. When designing a new facility, plan for the electrical service load of EV charging, which can be substantial. EV charging pedestal charging levels are largely driven by the existing and available electrical service at the location selected for new EV charging sites. These two evaluations, availability of public services and existing electrical capacity are both necessary to create a charging site that draws the public and is economical to install.

To determine the pedestal charging level at any location, assess the amount of time the public may spend at the charging site location. At a government center where the public may spend an hour or two obtaining services, a faster charge requiring a more robust electrical service may be more desirable. At a location where the public may spend several hours, more economical charging levels may be acceptable.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

ELECTRIC VEHICLE (EV)—A broad category that includes all vehicles that are fully powered by electricity or an electric motor.