CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

**FINAL PROJECT REPORT**

# Mill Valley Hydrogen Station

**Prepared for: California Energy Commission**

**Prepared by: FirstElement Fuel, Inc.**

**Gavin Newsom, Governor**

**November 2019 | CEC-600-2019-050**

# California Energy Commission

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**Agreement Number: ARV-14-013**

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# ACKNOWLEDGEMENTS

The construction of the Mill Valley hydrogen refueling station has been possible only because of the substantial efforts and funds provided by a number of stakeholders.

FirstElement Fuel, Inc. graciously thanks Toyota for its vision and fortitude; Air Products and Chemicals Inc., Black & Veatch, and E-Tech for bringing the project together; Tyson Eckerle for helping push the lease over the goal line; and, of course, Jean Baronas, Sarah Williams, Jim McKinney, Vice Chair Janea Scott, and many others at the California Energy Commission for tremendous, sustained confidence in clean, alternative transportation.

# PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). 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-13-607 to provide funding opportunities under the Clean Transportation Program for hydrogen refueling stations. In response to PON-13-607, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards May 1, 2014 and the agreement was executed as ARV-14-013 on July 22, 2014.

# ABSTRACT

FirstElement Fuel, Inc. designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station at 574 Redwood Hwy., Mill Valley (Marin County). FirstElement Fuel, Inc. plans to own and operate the hydrogen refueling station until at least 2025. The station consists of a concrete reinforced block compound that encloses hydrogen storage, compression, and cooling equipment; a dispenser with two fueling hoses; a customer payment interface; a canopy; and a dedicated concrete fueling position for fuel cell electric vehicle drivers.

**Keywords**: FirstElement Fuel, Inc., hydrogen refueling station, hydrogen infrastructure, fuel cell electric vehicles.

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# EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles (FCEVs) and hydrogen refueling stations are expected to play key roles in California as the State transitions to lower-carbon and zero-emission vehicle technologies for light-duty passenger vehicles, transit buses, and truck transport fleets. Numerous government regulations and policy actions identify FCEVs as a vehicle technology that will be available to meet the California Air Resources Board's zero emission vehicle regulation and the specific actions to bring the vehicles to California markets specified in the Governor's Zero Emission Vehicle Action Plan.

Hydrogen fuel cell electric drive technology offers tremendous potential for the light-duty passenger vehicle market and medium- and heavy-duty truck and bus markets. FCEV passenger vehicles can drive more than 300 miles on a tank of hydrogen and can be refueled in 3 to 4 minutes the way gasoline passenger vehicles are fueled. They have zero tailpipe emissions, while the carbon footprint of these vehicles is nearly the same as plug-in electric vehicles. The technology can be readily scaled up for sport utility vehicles, family passenger vans, pick-up trucks, urban package and beverage delivery trucks, and even heavy-duty trucks and buses. Most auto industry analysts and agencies view fuel cell electric drive technology as a complement to battery electric drive technologies, rather than as a competing technology. Both battery and FCEV technologies will be needed in California to achieve the zero-emission vehicle deployment goals.

In contrast to battery electric and plug-in hybrid electric vehicles that can be charged in home settings, FCEVs require a new network of refueling stations that dispense pressurized hydrogen for consumer use. This has meant that the auto industry and station development industry have had to co-develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen FCEVs. FCEVs cannot be widely marketed and sold to consumers without a minimum network of refueling stations available.

Assembly Bill 8 (AB 8, Perea, Chapter 401, Statutes of 2013) reauthorized the original AB 118 funding program (Núñez, Chapter 750, Statutes of 2007) and created new legal requirements for the CEC's Alternative and Renewable Fuel and Vehicle Technology Program. The bill directs the CEC to allocate up to $20 million per year, or up to 20 percent of each fiscal year's available funding, for the development of hydrogen refueling stations "until there are at least 100 publicly available hydrogen-fueling stations in operation in California" (Health and Safety Code 43018.9[e][1]).

In response to PON-13-607 issued by the CEC, FirstElement Fuel, Inc. was awarded funding for 19 stations. The CEC contributed $1,451,000 of the total $2,314,463.63 cost to design, engineer, permit, construct, and commission the Hollywood station.

FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and the CEC's Station Location Areas to select desired market locations. FirstElement Fuel, Inc. then analyzed specific properties within the target locations to find sites that could meet the space requirements for hydrogen fueling equipment. The site ultimately selected for this project was 574 Redwood Hwy., Mill Valley (Marin County). A hydrogen

refueling station at this location will serve as a core station in Northern California for at least the next 10 years.

The owner at Mill Valley was excited to bring a clean, alternative fuel to his station. FirstElement Fuel, Inc. and the Mill Valley owner executed a lease on February 2, 2015.

FirstElement Fuel, Inc. developed the site configuration and design and Black & Veatch performed the detailed engineering design. The zoning process in Mill Valley required a public hearing and several community design review approvals with final approval received July 15, 2015.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were filed December 29, 2014 and were finalized September 8, 2015. Because the Mill Valley station is located close to a wetland area and floodplain, the equipment foundation had to be raised several feet and part of the hydrogen refrigeration system, normally placed underground, had to be placed above grade. The permitting process from application to finalization took a total of 190 days.

FirstElement Fuel, Inc. purchased hydrogen refueling station equipment from Air Products and Chemicals, and the remainder of materials were sourced from a variety of general and specialty vendors. E-Tech from Concord, California was selected as the contractor for the project because of its relatively low bid, excellent safety record, good standing with Black & Veatch, and willingness to work with FirstElement Fuel, Inc. on multiple projects. Construction began October 28, 2015, and was complete on April 15, 2016.

The process of making the station operational began on March 16, 2016, and was complete on April 8, 2016. The FirstElement Fuel, Inc. team performed the bulk of the commissioning tasks including cleaning, purging, and pressure testing with Air Products performing final start-up.

# CHAPTER 1:
# Station Design and Construction

There were many steps required to bring the Mill Valley 33 percent renewable hydrogen refueling station project to completion. The following synopsis highlights the most critical items.

## Site Acquisition - Construction (Fall 2013 – April 2016)

Beginning in the fall of 2013, FirstElement Fuel, Inc. took steps to identify and acquire appropriate sites for the station. FirstElement Fuel, Inc. worked with historical vehicle sales data, academic publications, automakers, and the CEC's Station Location Areas to select desired market locations. FirstElement Fuel, Inc. then analyzed specific properties within the target locations to find sites that could meet the space requirements for hydrogen fueling equipment.

After selecting general locations and specific sites, FirstElement Fuel, Inc. contacted station owners and operators to negotiate lease opportunities. FirstElement Fuel, Inc. executed a letter of intent was executed with the property owner on January 14, 2014. A binding 10-year lease was later executed on February 2, 2015.

FirstElement Fuel, Inc. selected Air Products equipment because of the cost, capacity, reliability, and more mature supply chain as compared to other suppliers as detail in the FirstElement Fuel, Inc. grant application. FirstElement Fuel, Inc. executed a contract with Air Products for the equipment on September 16, 2014, and equipment was delivered to the site on March 8, 2015.

FirstElement Fuel, Inc. and Black & Veatch surveyed the site to begin the site layout on August 12, 2014. They generated initial engineering drawings on December 2, 2014. These drawings are referred to as "construction drawing 30s" because they represent 30 percent complete construction drawings and contain only two pages. Figure 1 shows the equipment compound drawing from the construction drawing 30 set. As shown, the drawing lacks specific detail and serves only to outline the site plan.

On October 30, 2014, Clark Survey performed a detailed engineering survey for the Mill Valley station site, as shown in Figure 2.

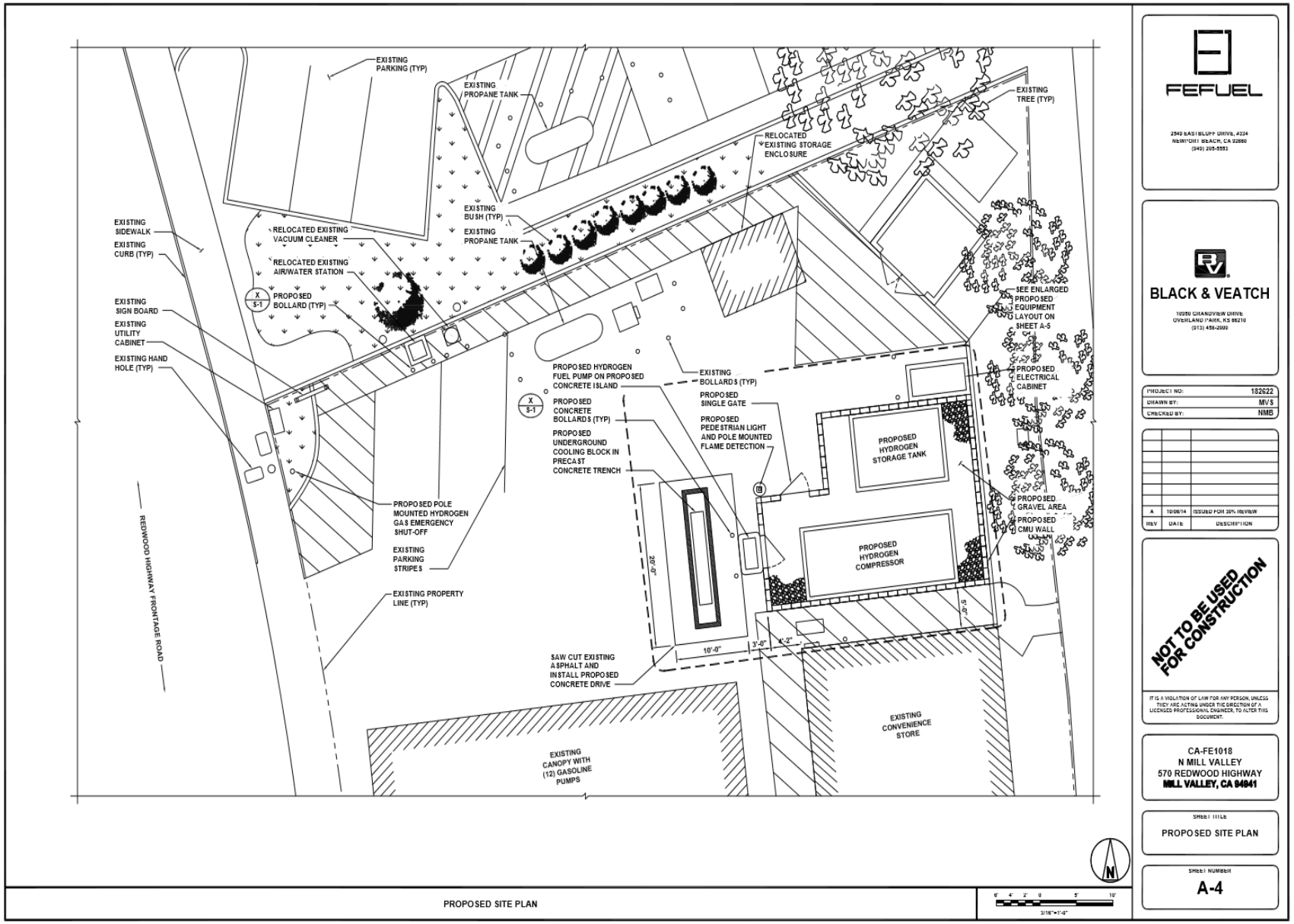
FirstElement Fuel, Inc. and Black & Veatch submitted the zoning application to the appropriate jurisdiction on December 29, 2014. The local planning department must verify that the project meets the zoning requirements of the proposed location and approve any aesthetic, landscaping or other details that are important to the community. Approval was received through public hearing process on July 15, 2015.

On April 2, 2015, zoning drawings were generated that provide an accurate but relatively high-level depiction of the project for review by planners at the jurisdiction. These drawings are signed and sealed by the professional engineer of record to ensure accuracy and completeness. The equipment compound page of the zoning drawings is shown in Figure 3.

On June 5, 2015, draft final construction drawings (or "construction drawing 90s") were completed that depict all the details required for both construction and the permit review. Final construction drawings (or "construction drawing 100s") were completed, with 60 pages that depict all the details required for both construction and the permit review on June 12, 2015. These drawings are similarly signed and sealed by the professional engineer of record to ensure accuracy and completeness. The equipment compound page of the construction drawing 100 set is shown in Figure 4.

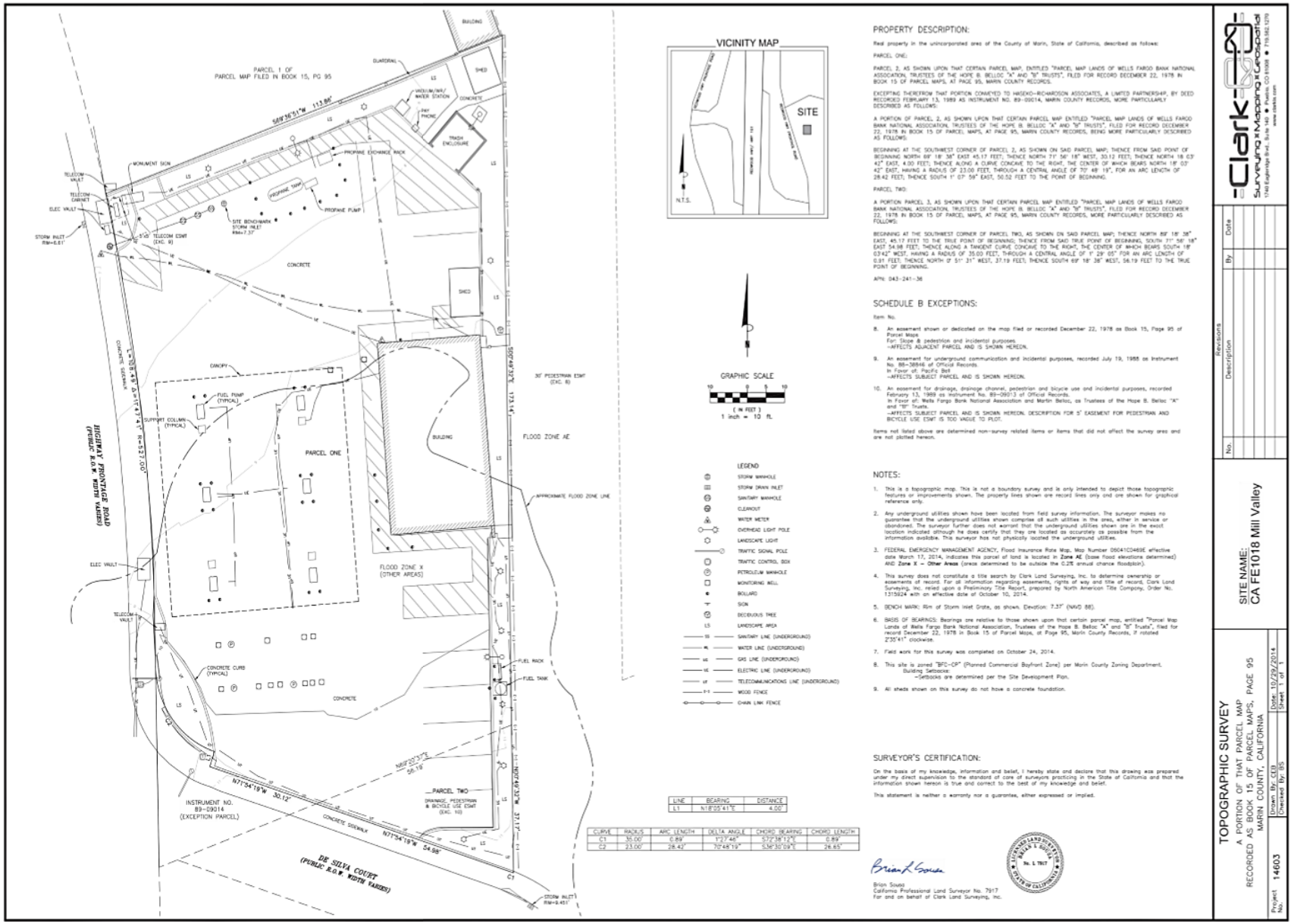
Because the Mill Valley hydrogen station is located on a floodplain near a protected wetlands area, construction could only occur during a certain portion of the year due to a nesting bird population. Also, equipment height above grade had to be changed compared to FirstElement Fuel, Inc.'s normal design, and a water pumping and cleanup system had to be employed during construction.

**Figure 1: Coarse Detail of Equipment Compound From Construction Drawing 30 Set**



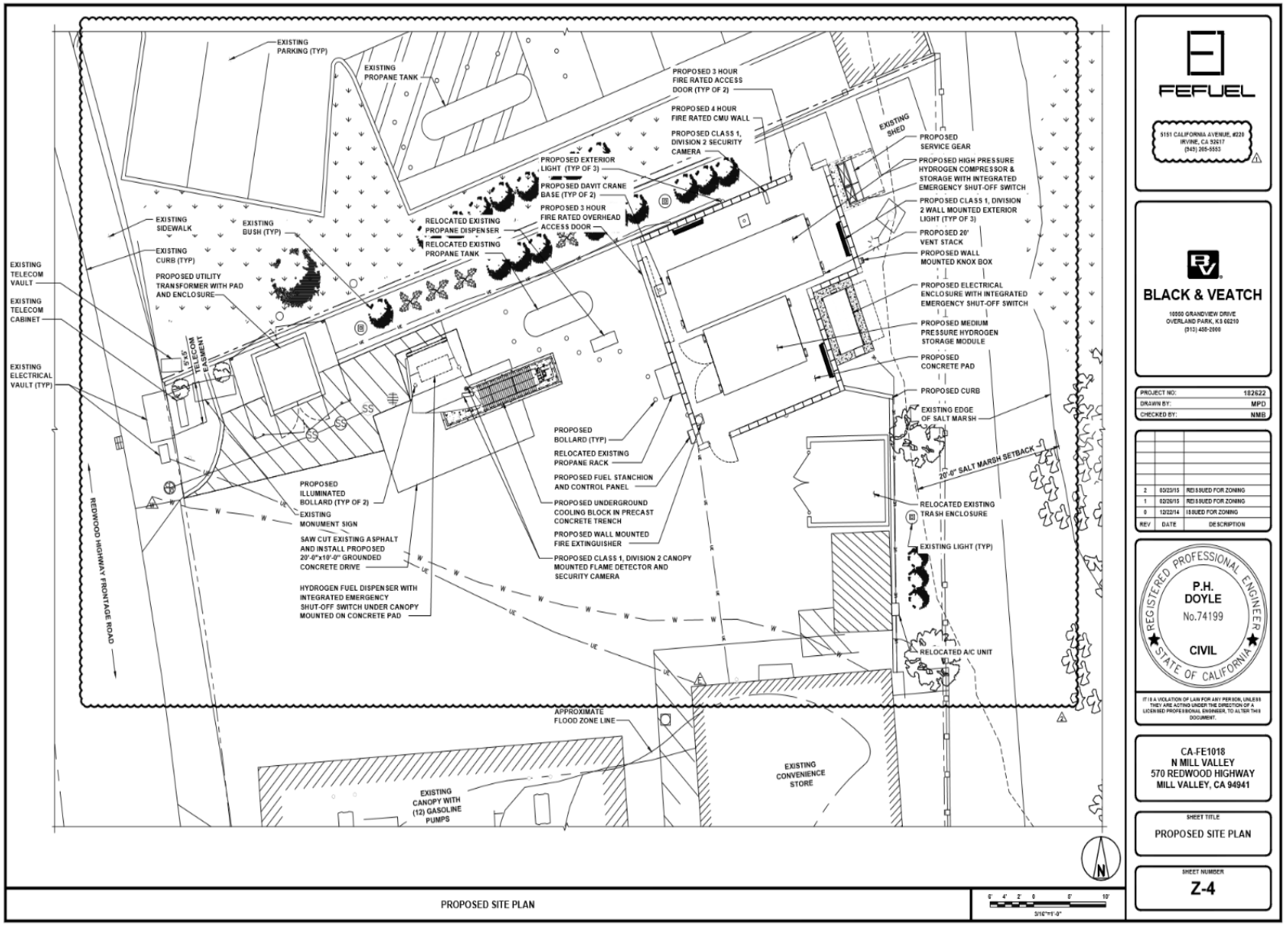

Source: FirstElement Fuel, Inc. Original figure is higher resolution.

## Figure 2: Survey of Mill Valley Hydrogen Station Location



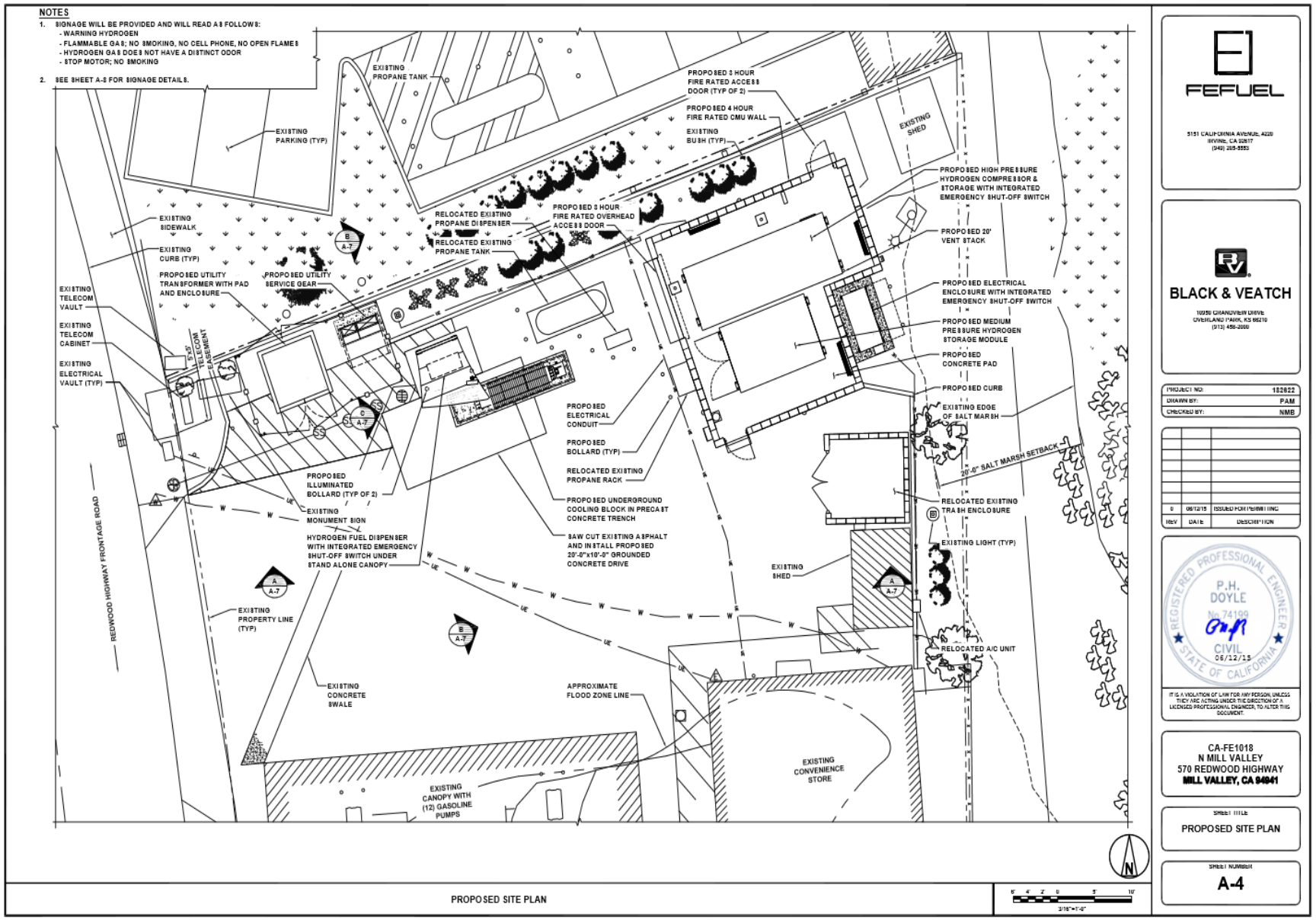

Source: FirstElement Fuel, Inc. Original figure is higher resolution.

## Figure 3: Equipment Compound From Zoning Drawing Set




Source: FirstElement Fuel, Inc. Original figure is higher resolution.

## Figure 4: Equipment Compound From Construction Drawing 100 Set




Source: FirstElement Fuel, Inc. Original figure is higher resolution.

All building permit applications were submitted on June 16, 2015, and approved on September 8, 2015.

FirstElement Fuel, Inc. and Black & Veatch submitted a detailed bid package to contractors on September 28, 2015. The contract was awarded to E-Tech on October 8, 2015. The bulk of E-Tech's construction experience lies in cell towers. Cell towers are roughly similar to hydrogen stations in size, have similar foundations and block walls, and have similar electrical requirements. E-Tech provided a reasonable bid, had a desire to get involved with hydrogen projects, and had a willingness to work in northern California. Construction started October 28, 2015. Figure 5 shows the equipment compound before completion. Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site March 8, 2016, as shown in Figure 6. Construction was completed April 15, 2016. Construction progressed smoothly, in part because of the time spent throughout the project to gain a common understanding of project requirements, especially those listed in the National Fire Protection Association hydrogen technologies code.

**Figure 5: Concrete Formwork in Progress**

Source: FirstElement Fuel, Inc.

**Figure 6: Crane Lifting Hydrogen Compression Unit**


Source: FirstElement Fuel, Inc.

## Making the Station Operational Process (March 16, 2016 – April 8, 2016)

The commissioning of the Mill Valley hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling.

Figure 7 shows a refrigeration system check in progress.

### Station Declared Operational (April 22, 2016)

The Mill Valley hydrogen station met the definition of operational in PON-13-607 by completing installation of all station/dispenser components, obtaining all the required permits from the local jurisdiction, filling the station's storage tubes with pressurized hydrogen gas, successfully passing a hydrogen quality test, as shown in Figure 8, successfully fueling one fuel cell electric vehicle with hydrogen, and opening to the public. FirstElement Fuel Inc. declared the station operational on April 22, 2016.

**Figure 7: Refrigeration System Checks During Commissioning**

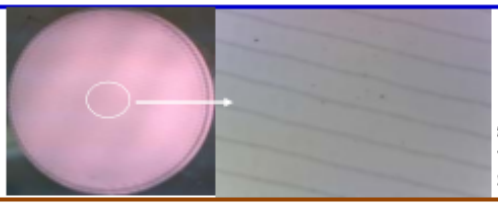
Source: FirstElement Fuel, Inc.

**Figure 8: Hydrogen Fuel Quality Report on April 21, 2016**

www.SmartChemistry.com

FIRST ELEMENT FUEL — MILL VALLEY HYDROGEN STATION

| SAE J2719 | SAE J2719 Limits (µmol/mol) | Smart Chemistry Detection Limits (µmol/mol) | H70 H2 @Nozzle sampled on 04/21/2016 Concentration (µmol/mol) | Analytical Method |
|---|---|---|---|---|
| **Water** | 5 | 0.5 | **0.77** | |
| **Total Hydrocarbons ($C_1$ Basis)** | 2 | 1 | **0.123** | ASTM D7892 |
| Methane | | | 0.12 | |
| Acetone | | | 0.0039 | |
| Ethanol | | | 0.0020 | |
| **Oxygen** | 5 | 1 | < 1 | ASTM D7649 |
| **Helium** | 300 | 10 | < 10 | ASTM D1946 |
| **Nitrogen, Argon** | 100 | | | |
| Nitrogen | | 2 | < 2 | ASTM D7649 |
| Argon | | 0.4 | < 0.4 | ASTM D7649 |
| **Carbon Dioxide** | 2 | 0.5 | < 0.5 | ASTM D7649 |
| **Carbon Monoxide** | 0.2 | 0.0005 | **0.0039** | ASTM D5466 |
| **Total Sulfur** | 0.004 | 0.000001 | **0.000038** | ASTM D7652 |
| Hydrogen Sulfide | | 0.000001 | 0.0000094 | ASTM D7652 |
| Carbonyl Sulfide | | 0.000001 | 0.000018 | ASTM D7652 |
| Methyl Mercaptan (MTM) | | 0.00001 | < 0.00001 | ASTM D7652 |
| Ethyl Mercaptan (ETM) | | 0.00001 | < 0.00001 | ASTM D7652 |
| Dimethyl Sulfide (DMS) | | 0.00001 | < 0.00001 | ASTM D7652 |
| Carbon Disulfide | | 0.00001 | 0.000011 | ASTM D7652 |
| Isopropyl Mercaptan (IPM) | | 0.00001 | < 0.00001 | ASTM D7652 |
| Tert-Butyl Mercaptan (TBM) | | 0.00001 | < 0.00001 | ASTM D7652 |
| n-Propyl Mercaptan | | 0.00001 | < 0.00001 | ASTM D7652 |
| n-Butyl Mercaptan | | 0.00001 | < 0.00001 | ASTM D7652 |
| Tetrahydrothiophene (THT) | | 0.00001 | < 0.00001 | ASTM D7652 |
| **Formaldehyde** | 0.01 | 0.001 | < 0.001 | ASTM D7892 |
| **Formic Acid** | 0.2 | 0.001 | < 0.001 | ASTM D5466 |
| **Ammonia** | 0.1 | 0.005 | < 0.005 | ASTM D5466 |
| **Total halogenates** | 0.05 | | **0.0021** | |
| Hydrogen Bromide | | 0.003 | < 0.003 | ASTM D5466 |
| Hydrogen Chloride | | 0.002 | < 0.002 | ASTM D5466 |
| Chlorine | | 0.0008 | < 0.0008 | ASTM D5466 |
| **Organic Halides (32 compounds in red and bold listed in "Other Hydrocarbons").** Both Smart Chemistry and method limits is for each individual organic halide. | | 0.001 | 0.0021 | ASTM D7892 |
| Tetrachloro-hexafluorobutanes | | | 0.0021 | |
| **Particulate Concentration** | | | **0.061 mg/kg** | ASTM D7651 |
| **Particulates Found & Size** | | | **23 Particulates found with sizes in µm: 104, 102, 78, 58 (2), 54 (4), 52, 50, 47, 46, 43, 40, 36 (2), 35, 32, 30, 27 (2) & 21.** | ASTM D7834 |
| **Hydrogen Fuel Index** The hydrogen fuel index is the value obtained when the amount of aggregate impurities, as, expressed as percent (µmole/µmole), is subtracted from 100%. (Section 3.5 of SAE J2719) | | | **99.99991%** | |



Source: FirstElement Fuel, Inc. Original figure is higher resolution.

Automaker testing was performed at the Mill Valley hydrogen station to verify correct operation per *SAE J2601 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles.*

## Certification (April 28, 2016)

The California Department of Food and Agriculture's Division of Measurement Standards is responsible for enforcing California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California.

FirstElement Fuel, Inc. achieved certification by acting as the registered service agent, dispensing a measured amount of fuel, and confirming the quantity dispensed is accurately reflected by the dispenser in accordance with examination procedures (EPO NO. 40-A)[1] as witnessed by the local county weights and measures officer as shown in Figure 9.

**Figure 9: Certification at Mill Valley Hydrogen Station**

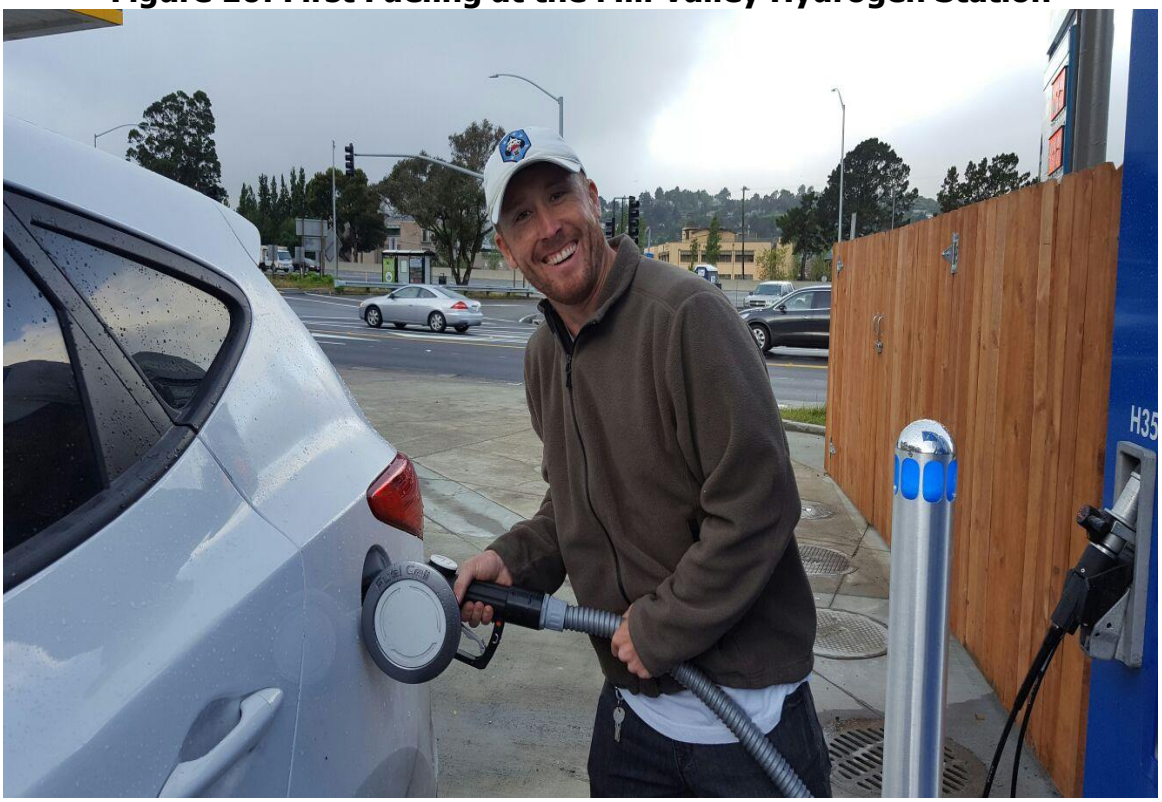

Source: FirstElement Fuel, Inc.

## Station Use (April 22, 2016 - Present)

Figure 10 shows the first vehicle filled was a Hyundai Tucson on April 22, 2016 and the station has been used regularly since then. The Mill Valley station dispensed 54.5 kilograms of hydrogen in May 2016.

1 California Department of Food and Agriculture. https://www.cdfa.ca.gov/dms/programs/devices/Hydrogen_Gas-Measuring_Devices_EPO-40.pdf

**Figure 10: First Fueling at the Mill Valley Hydrogen Station**



Source: FirstElement Fuel, Inc.

## Station Operational Status System

The California Fuel Cell Partnership, Station Operational Status System is a website portal[2] designed to provide hydrogen station status for motorist use. This system is important to FCEV drivers during the development phase of the hydrogen refueling station network because it lets drivers know that the hydrogen station they intend to use is operational before they depart. The Mill Valley hydrogen station began sending automated updates (FirstElement Fuel, Inc. software) on a regular basis, to Station Operational Status System on June 17, 2016.

## Environmental Impacts

Hydrogen will be stored as a compressed gas in an above ground tank concealed behind a wall at this station. In accordance with the funding agreement with the CEC, 33.3 percent of the hydrogen sold at the Mill Valley hydrogen refueling station will be produced from renewable sources including biogas. Hydrogen is non-toxic, colorless, and odorless so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in case a leak occurs. No solid or liquid waste will be produced at this site.

Minimal water was consumed for this project. There was no additional landscaping added for the construction of the hydrogen refueling station, and, therefore, no additional irrigation water will be consumed.

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2 California Fuel Cell Partnership https://m.cafcp.org/

The use will not cause any unsightly appearances, such as noise, glare, dust, or odor. The facility is a modern addition to an existing gasoline station. No outdoor sound amplification systems were installed; however, lighting was installed at the facility to enhance evening fueling.

## Mill Valley Station in the Network

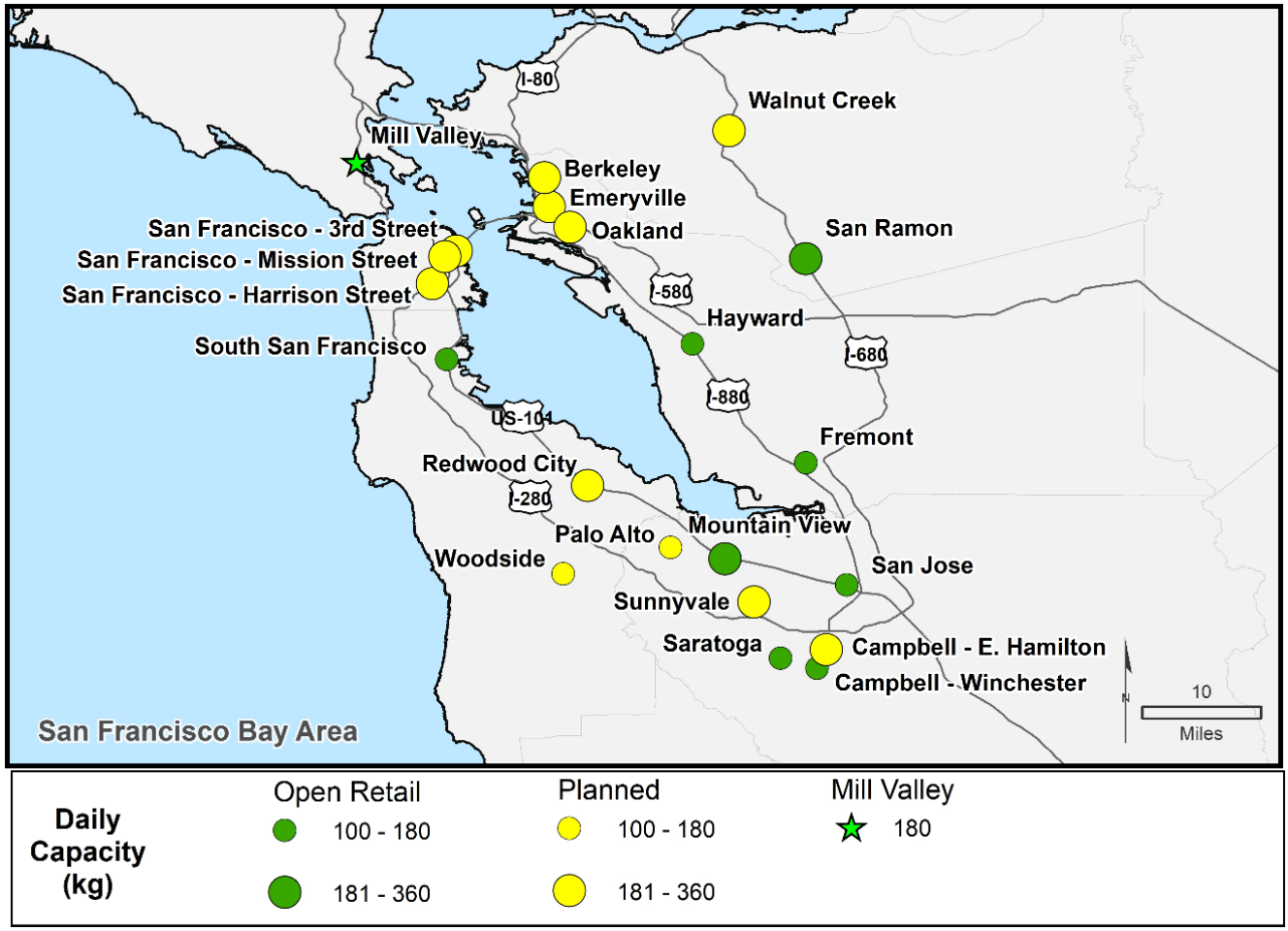
The station is open and ready for use as shown in Figure 11.

**Figure 11: Mill Valley Hydrogen Station**

Source: FirstElement Fuel, Inc.

Figure 12 shows the greater San Francisco area map which indicates where the Mill Valley station is situated in relationship to other facilities in the northern part of the state. The Mill Valley Station is located next to Highway 101, between the Muir Woods National Monument (west) and Richardson Bay (east).

**Figure 12: Hydrogen Stations: Open retail as planned in the San Francisco Bay Area**

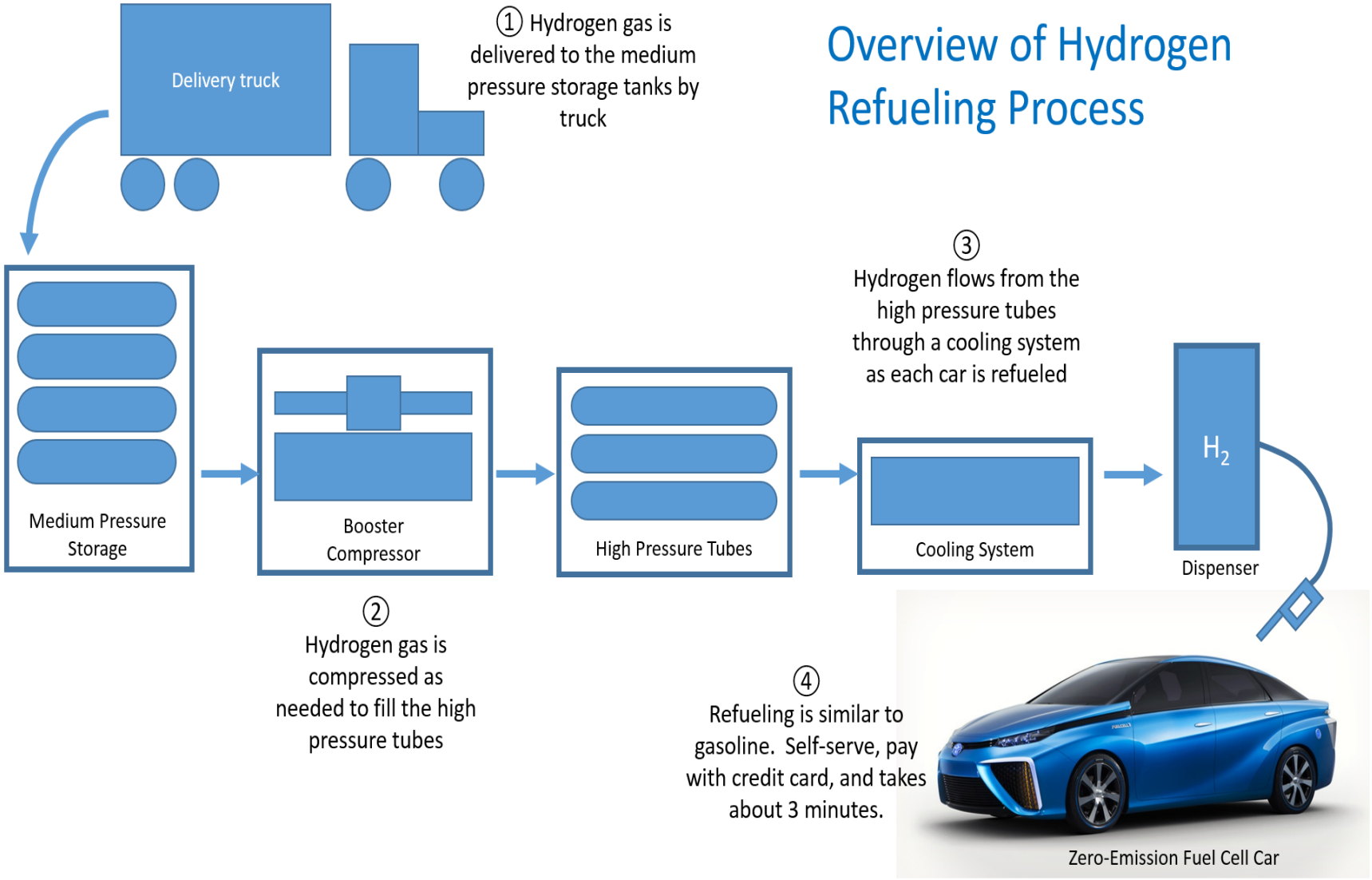



Source: California Energy Commission Staff

## Schematic Layout of the Mill Valley Station

Figure 13 depicts an overview of the Mill Valley hydrogen station components and the steps in the refueling process.

**Figure 13: Hydrogen Station Equipment and Refueling Process**

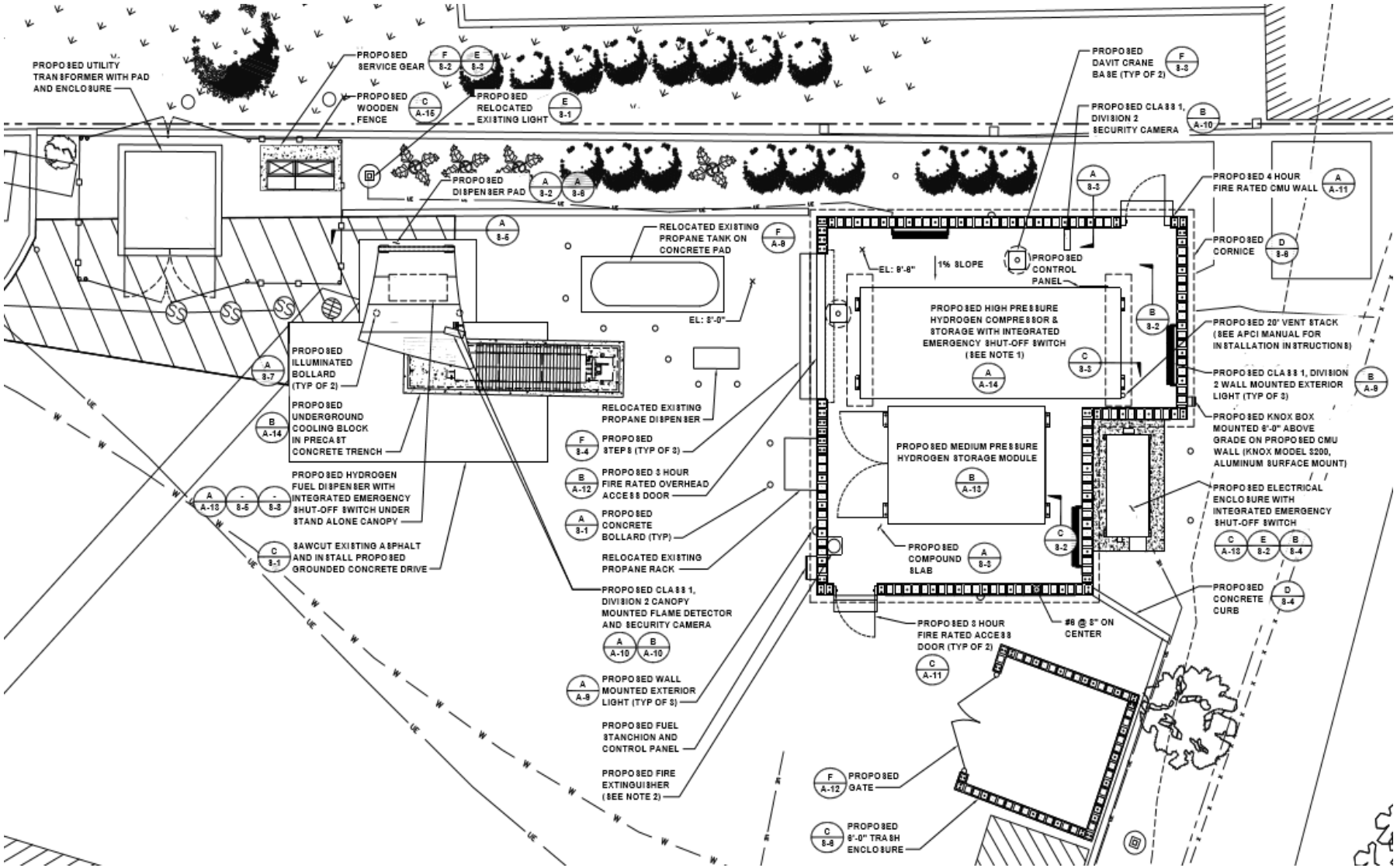



Source: FirstElement Fuel, Inc.

## Final Configuration and Budget

Figure 14 shows a detailed view of the final, as-built configuration of the Mill Valley station.

**Figure 14: Enlarged View of Final Mill Valley Layout**




Source: FirstElement Fuel, Inc. Original figure is higher resolution.

Figure 15 shows a detailed view of the budget to construct the Mill Valley hydrogen station.

**Figure 15: The Project Grant Funding and Match Funding**

| | |
|---|---|
| **Air Products and Chemicals, Inc., Allentown , PA** | |
| H2 station equipment | $1,479,873.55 |
| **Black & Veatch, Overland Park, KS** | |
| Construction | $683,593.60 |
| Engineering | $43,802.40 |
| Permitting | $57,218.57 |
| Project Management | $18,197.53 |
| **Various Vendors** | |
| Construction Materials (tubing, wire, etc.) | $18,874.46 |
| Fixtures (doors, lights, etc.) | $60,462.80 |
| **MSI Tech, Irvine CA** | |
| Data Collection Tool | $3,416.38 |
| **Karen Calhoun, Newport Beach, CA** | |
| Legal services | $13,150.03 |
| **Vertical Advisors LLP, Newport Beach, CA** | |
| Financial services | $4,345.13 |
| **Total Project Costs** | $2,382,934.45 |
| | |
| **California Energy Commission Grant** | $1,451,000.00 |
| **Remaining match funding provided by FirstElement Fuel, Inc.** | $931,934.45 |
| **Total California Energy Commission cost share** | 60.9% |

Source: FirstElement Fuel, Inc.

# CHAPTER 2:
# Energy Analysis

The Mill Valley hydrogen refueling station is supplied by hydrogen generated via steam methane reformation that converts methane ($CH_4$) and water ($H_2O$) to hydrogen ($H_2$) and carbon dioxide ($CO_2$):

$$CH_4 + 2H_2O \rightarrow 4H_2 + CO_2$$

Per California Senate Bill 1505 (Lowenthal, Chapter 877, Statutes of 2006), Environmental Standards for Hydrogen Production, at least one-third of the hydrogen sold by FirstElement Fuel, Inc.'s state funded hydrogen refueling stations will be produced from renewable sources. Hydrogen is supplied to the hydrogen fueling stations from Air Products' hydrogen production facilities in Wilmington/Carson, California. Renewable biogas will be procured as feedstock for the facilities, resulting in delivered hydrogen product that meets the requirements of this PON and the 33.3 percent renewable hydrogen requirements of California Senate Bill 1505, as shown in Table 1. The table lists out two renewable biomethane supply sources from Shell Energy North America (U.S.), L.P. Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

**Table 1: Documentation of Biogas Sources**

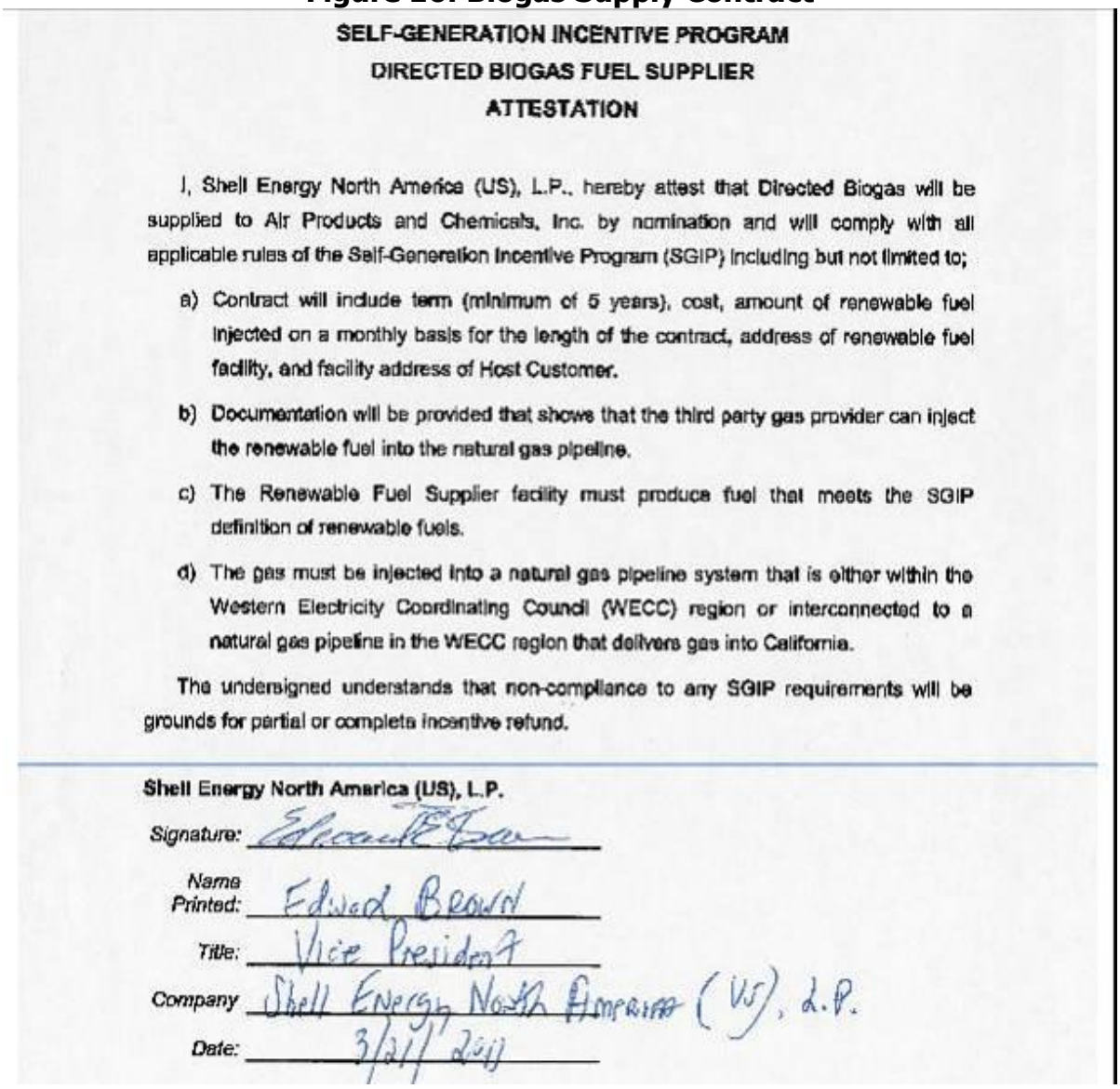
| Supply Source | Address | Pipeline/LDC | Receipt | Delivery |
|---|---|---|---|---|
| Greentree Landfill | 635 Toby Road<br>Kersey, PA 15846 | National Fuels Gas<br>TETCO<br>NGPL<br>EPNG<br>Socal Gas FAR | Landfill meter<br>Nat Fuel-Bristoria<br>Tetco-Sweet Lake 3825<br>EPNG Jal 3083<br>Topock | Bristoria<br>NGPL-Sweet Lake<br>EPNG Jal 3083<br>Topock<br>Socal Citygate |
| Imperial Landfill | 11 Boggs Road<br>Imperial, PA 15126 | National Fuels Gas<br>TETCO<br>NGPL<br>EPNG<br>Socal Gas FAR | Landfill meter<br>Nat Fuel-Bristoria<br>Tetco-Sweet Lake 3825<br>EPNG Jal 3083<br>Topock | Bristoria<br>NGPL-Sweet Lake<br>EPNG Jal 3083<br>Topock<br>Socal Citygate |

Source: FirstElement Fuel, Inc.

Air Products has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1); documentation is provided in Figure 16. Although California has a substantial amount of biogas, local supply cannot be injected into California pipelines under California Health and Safety Code Section 25420. Air Products' biogas supply for this project is being sourced outside California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council[3] region that delivers gas into California.

3 Western Electricity Coordinating Council. https://www.wecc.biz/Pages/AboutWECC.aspx

**Figure 16: Biogas Supply Contract**



**SELF-GENERATION INCENTIVE PROGRAM**

**DIRECTED BIOGAS FUEL SUPPLIER**

**ATTESTATION**

I, Shell Energy North America (US), L.P., hereby attest that Directed Biogas will be supplied to Air Products and Chemicals, Inc. by nomination and will comply with all applicable rules of the Self-Generation Incentive Program (SGIP) including but not limited to;

a) Contract will include term (minimum of 5 years), cost, amount of renewable fuel injected on a monthly basis for the length of the contract, address of renewable fuel facility, and facility address of Host Customer.

b) Documentation will be provided that shows that the third party gas provider can inject the renewable fuel into the natural gas pipeline.

c) The Renewable Fuel Supplier facility must produce fuel that meets the SGIP definition of renewable fuels.

d) The gas must be injected into a natural gas pipeline system that is either within the Western Electricity Coordinating Council (WECC) region or interconnected to a natural gas pipeline in the WECC region that delivers gas into California.

The undersigned understands that non-compliance to any SGIP requirements will be grounds for partial or complete incentive refund.

**Shell Energy North America (US), L.P.**

*Signature:* Edward E Beard

*Name Printed:* Edward Beard

*Title:* Vice President

*Company* Shell Energy North America (US), L.P.

*Date:* 3/21/2011

Source: FirstElement Fuel, Inc.

Hydrogen is delivered to all FirstElement Fuel, Inc. stations (including Mill Valley) by a Department of Transportation-certified high-pressure delivery trailer.

The *Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model* produced by Argonne National Laboratory was used to determine the energy sources

The Mill Valley hydrogen station can dispense 180 kilograms per day, or enough to support up to 260 FCEVs, although this number can vary depending on actual FCEV geographical deployment relative to other open retail station locations and FCEV driver habits. Assuming that FCEVs average 52 miles per 1 kilograms of hydrogen, see *The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model*[4], and consumption of 180

4 GREET® Model https://greet.es.anl.gov/

kilograms per day for the next 10 years, the station will offset 8,400 metric tons of total greenhouse gas compared to equivalent gasoline vehicles. Furthermore, the Mill Valley hydrogen station will eliminate more than 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon[5].

As part of a separate grant agreement (ARV-17-030) for operations and maintenance funding through the CEC, data on the operation of the station will be collected and reported quarterly for three years (March 1, 2018 to February 28, 2021). Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the actual performance of the project to proposed expectations.

5 U.S. Department of Transportation, Bureau of Transportation Statistics (Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles)
http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html.

# CHAPTER 3:
# Future Activities

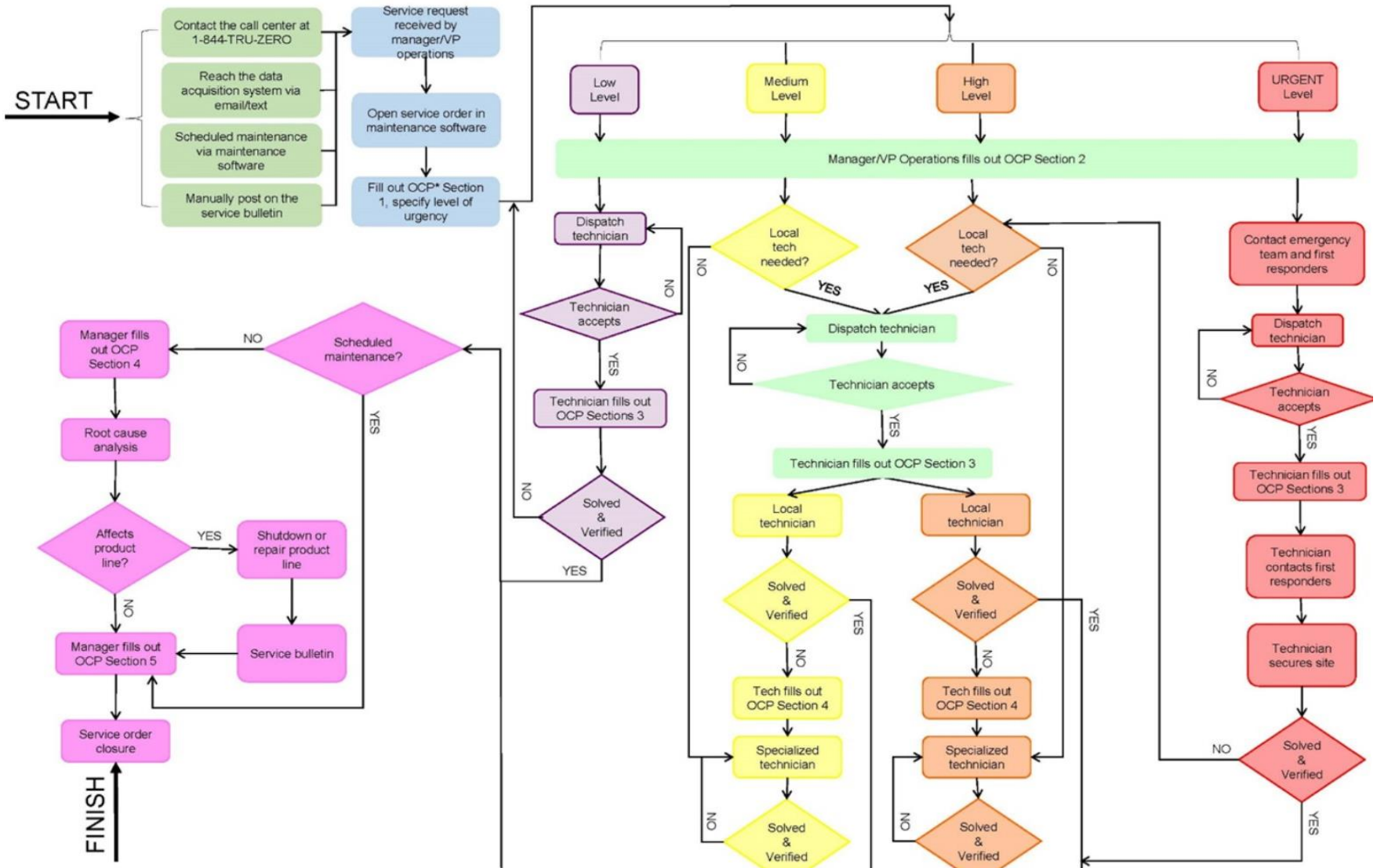
FirstElement Fuel, Inc. intends to own and operate the Mill Valley refueling station for at least 10 years. FirstElement Fuel, Inc. has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FirstElement Fuel, Inc. has executed an initial 10-year lease with the landowner with the possibility for extension.

In addition, FirstElement Fuel, Inc. is building an in-house maintenance team that will have the personnel and equipment resources to maintain and repair any of our stations as quickly as possible throughout California. Figure 17 shows a flow diagram for response from the Operations and Maintenance team.

To augment onsite personnel across the FirstElement Fuel, Inc. network, a comprehensive data collection and monitoring system has been implemented. Figure 18 shows a screenshot of one page of the system. FirstElement Fuel, Inc. maintenance personal can access a breadth of real-time performance and sensor data, live video feeds, and historic usage data, and can control some features of the station remotely, 24 hours a day.

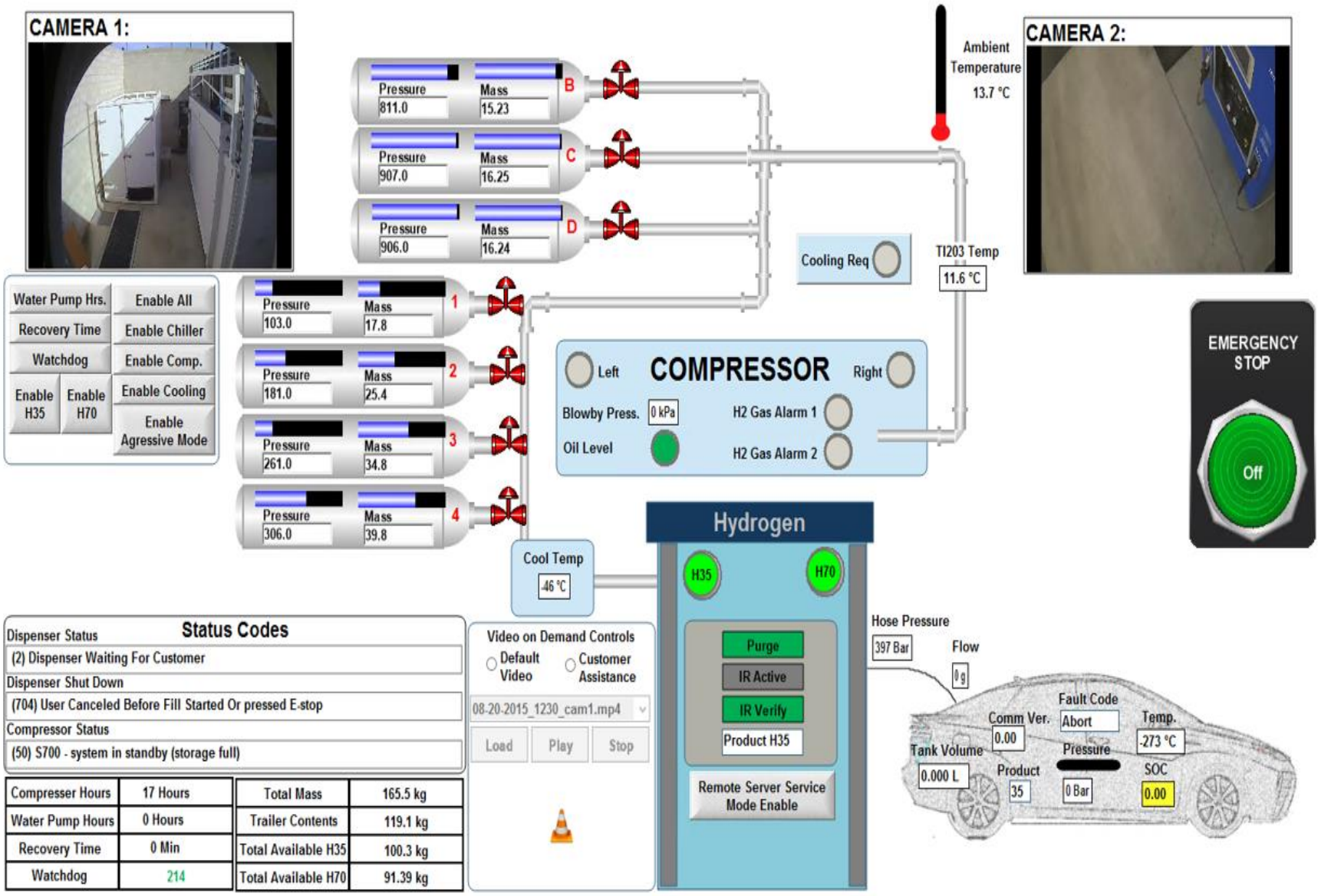
In addition to remote monitoring, FirstElement Fuel, Inc. has implemented rigorous computerized maintenance management systems and enterprise asset management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and repair activities. This will help to maximize station up-time and enable tracking of key performance indicators.

**Figure 17: FirstElement Fuel, Inc. Response Flow Chart**




Source: FirstElement Fuel, Inc.

**Figure 18: FirstElement Fuel, Inc.'s Remote Monitoring System**




Source: FirstElement Fuel, Inc.

# CHAPTER 4:
# Conclusions

The following considers findings from the 33 percent renewable hydrogen Mill Valley hydrogen refueling station project.

Because the Mill Valley hydrogen station is located on a floodplain near a protected wetlands area, several special considerations had to be accounted for. For example, construction could only occur during a certain portion of the year due to a nesting bird population. Also, equipment height above grade had to be changed compared to FirstElement Fuel, Inc.'s normal design, and a water pumping and cleanup system had to be employed during construction.

Like many of the projects that FirstElement Fuel, Inc. has undertaken, the jurisdiction in Mill Valley was primarily concerned with mundane development issues like traffic circulation and building aesthetics. In most jurisdictions, the unique hydrogen aspects of the projects have not been major issues.

National Fire Protection Association hydrogen technologies code is a critical tool for technical projects of this nature. The code clearly defines fire guidelines that enable local jurisdictions and contractors to uniformly construct hydrogen facilities and ensure safety. The key is for both station builders and station permit agencies to fully understand and appreciate the content of National Fire Protection Association hydrogen technologies code.

# 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 Energy Commission's five major areas of responsibilities are:

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

CARBON DIOXIDE (CO2) - A colorless, odorless, non-poisonous gas that is a normal part of the air. Carbon dioxide is exhaled by humans and animals and is absorbed by green growing things and by the sea. CO2 is the greenhouse gas whose concentration is being most affected directly by human activities. CO2 also serves as the reference to compare all other greenhouse gases (see carbon dioxide equivalent). The major source of CO2 emissions is fossil fuel combustion. CO2 emissions are also a product of forest clearing, biomass burning, and non-energy production processes such as cement production. Atmospheric concentrations of CO2 have been increasing at a rate of about 0.5 percent per year and are now about 30 pecent above preindustrial levels. (EPA)

FUEL CELL ELECTRIC VEHICLE (FCEV) - A zero-emission vehicle that runs on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle.

HYDROGEN (H2) - A colorless, odorless, highly flammable gas, the chemical element of atomic number 1.

METHANE (CH4) - A light hydrocarbon that is the main component of natural gas and marsh gas. It is the product of the anaerobic decomposition of organic matter, enteric fermentation in animals and is one of the greenhouse gases. Chemical formula is CH4.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) - SAE International, formerly the Society of Automotive Engineers, is a U.S.-based, globally active professional association and standards organization for engineering professionals in various industries.

WATER (H2O) - A colorless, transparent, odorless, tasteless liquid compound of hydrogen and oxygen. The liquid form of steam and ice. Fresh water at atmospheric pressure is used as a standard for describing the relative density of liquids, the standard for liquid capacity, and the standard for fluid flow. The melting and boiling points of water are the basis for the Celsius temperature system. Water is the only byproduct of the combination of hydrogen and oxygen and is produced during the burning of any hydrocarbon. Water is the only substance that expands on freezing as well as by heating and has a maximum density at 4°C.