CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Fremont Hydrogen Station

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

January 2022 | CEC-600-2022-030

California Energy Commission

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ACKNOWLEDGEMENTS

The construction of the Fremont hydrogen refueling station has only been possible because of the substantial efforts and funds provided by a number of stakeholders. FirstElement Fuel, Inc. graciously thanks Toyota and Honda for their vision and fortitude, Air Products and Chemicals Inc., and Black & Veatch, 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, Commissioner 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. 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 for high performance retail 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

Per the terms of funding agreement ARV-14-013 between the CEC and FirstElement Fuel, Inc., FirstElement Fuel, Inc. designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station located at 41700 Grimmer Blvd., Fremont, CA 94538. FirstElement Fuel, Inc. plans to own and operate the hydrogen refueling station until at least 2027. 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 vehicle drivers.

Keywords: California Energy Commission, FirstElement Fuel, Inc., hydrogen refueling station, hydrogen infrastructure, fuel cell vehicles, Fremont.

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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 Zero Emission Vehicle Regulation and the Governor's Zero Emission Vehicle Mandate. More specific actions to bring FCEVs to California markets are 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 fuel cell electric vehicle 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 fuel cell electric vehicles. 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 Assembly Bill 118 funding program (Núñez, Chapter 750, Statutes of 2007) and created new legal requirements for the CEC's Clean Transportation Program. The bill directs the Energy Commission 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]).

The CEC contributed $1,451,000 of the total $2,577,595.99 cost to design, engineer, permit, construct, and commission the station.

The site selected for this project was 41700 Grimmer Blvd., Fremont, California. A hydrogen refueling station at this location will serve as a core station in northern California for at least the next 10 years. FirstElement Fuel, Inc. accomplished this goal through the steps outlined below.

The owner at Fremont was excited to bring a clean, alternative fuel to his station. Lease terms were negotiated and a lease was executed between FirstElement Fuel and the Fremont owner on December 22, 2015.

The site configuration and design were developed by FirstElement Fuel and detailed engineering design was performed by Black & Veatch. The zoning process in was ministerial and approval was garnered October 10, 2016.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were finalized on October 10, 2016.

Hydrogen refueling station equipment was purchased from Air Products and Chemicals and the remainder of materials were sourced from a variety of general and specialty vendors. FirstElement acted as general contractor for the project because of the difficulty in finding a qualified, timely bid for the station project. Construction began on February 3, 2017 and was complete on July 31, 2017.

Commissioning began on June 19, 2017 and was complete on July 20, 2017. The FirstElement 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

Project Timeline

There were many steps required to bring the Fremont hydrogen refueling station project to completion. The following synopsis highlights the most critical items, provides detail on each one, and states the timing required for each step for this particular project.

Site Acquisition (Fall 2013 – 12/22/2015)

Beginning in the Fall of 2013, First Element Fuel, Inc. (FirstElement or FE) took steps to identify and acquire appropriate sites for the station. FE worked with historic vehicle sales data, academic publications, automakers, and the Energy Commission's Station Location Areas to select desired market locations. FE 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, FE contacted station owners and operators to negotiate lease opportunities. A Letter of Intent was executed with the property owner at 41700 Grimmer Blvd., Fremont, CA 94538 on January 27, 2014. A binding 10 year lease was later executed on December 22, 2015.

Equipment Procurement (September 16, 2014- May 16, 2017)

FE 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 PON application. A contract was executed with Air Products for the equipment on September 16, 2014 and equipment was delivered to the site on May 16, 2017.

Site Design and Engineering (5/19/2016 – 3/3/2017)

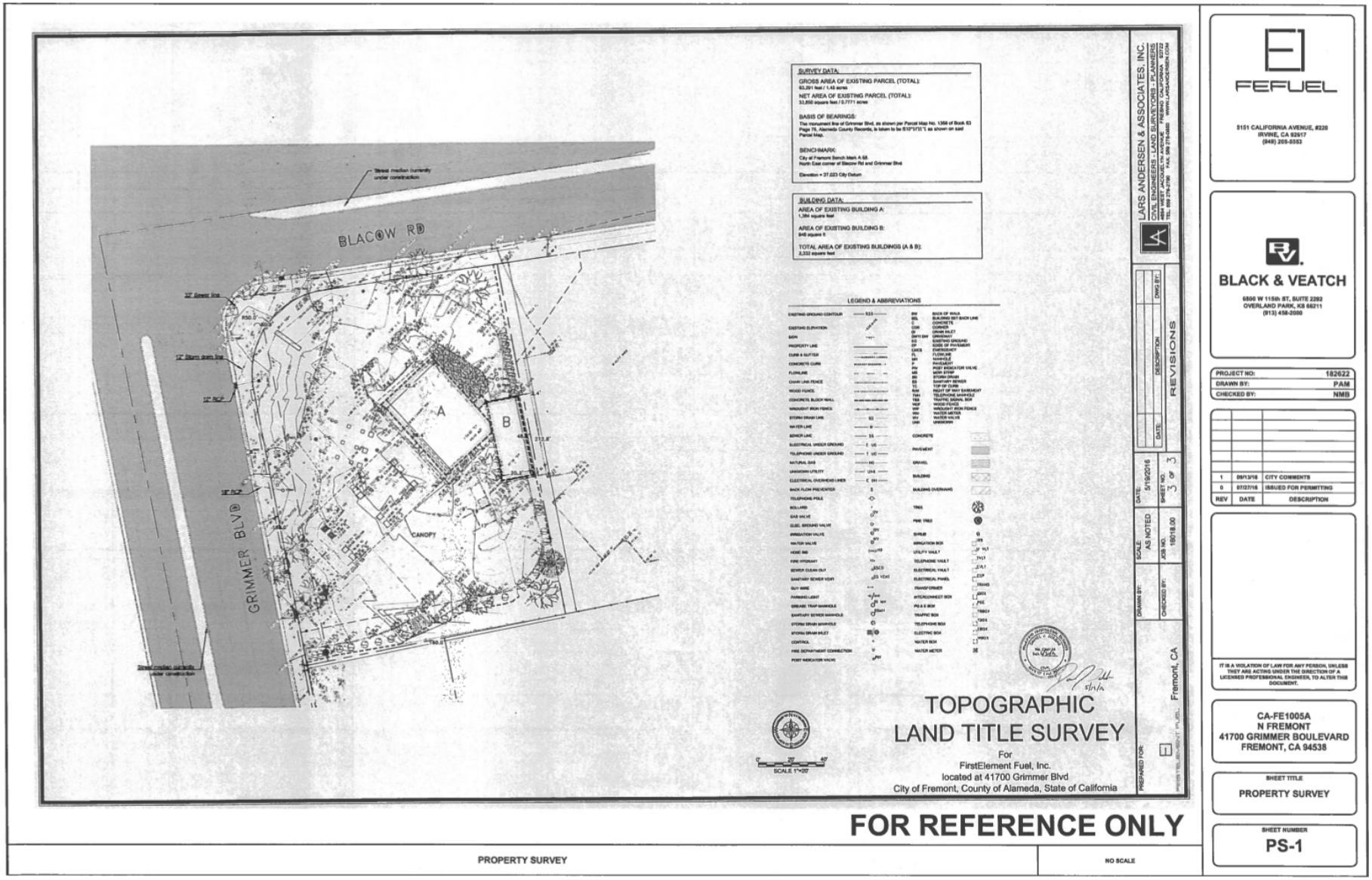
FE and Black & Veatch conducted a preliminary site survey to begin the site layout process on. Because the Fremont station started late due to a site location change, the normal initial engineering drawing step ("CD30s") was bypassed for speed.

On May 19, 2016, a detailed engineering survey for the Fremont station site was subsequently performed by Lars Anderson & Associates as shown in Figure 1.

On May 20, 2016, 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 their accuracy and completeness. The equipment compound page of the zoning drawings is shown in Figure 2.

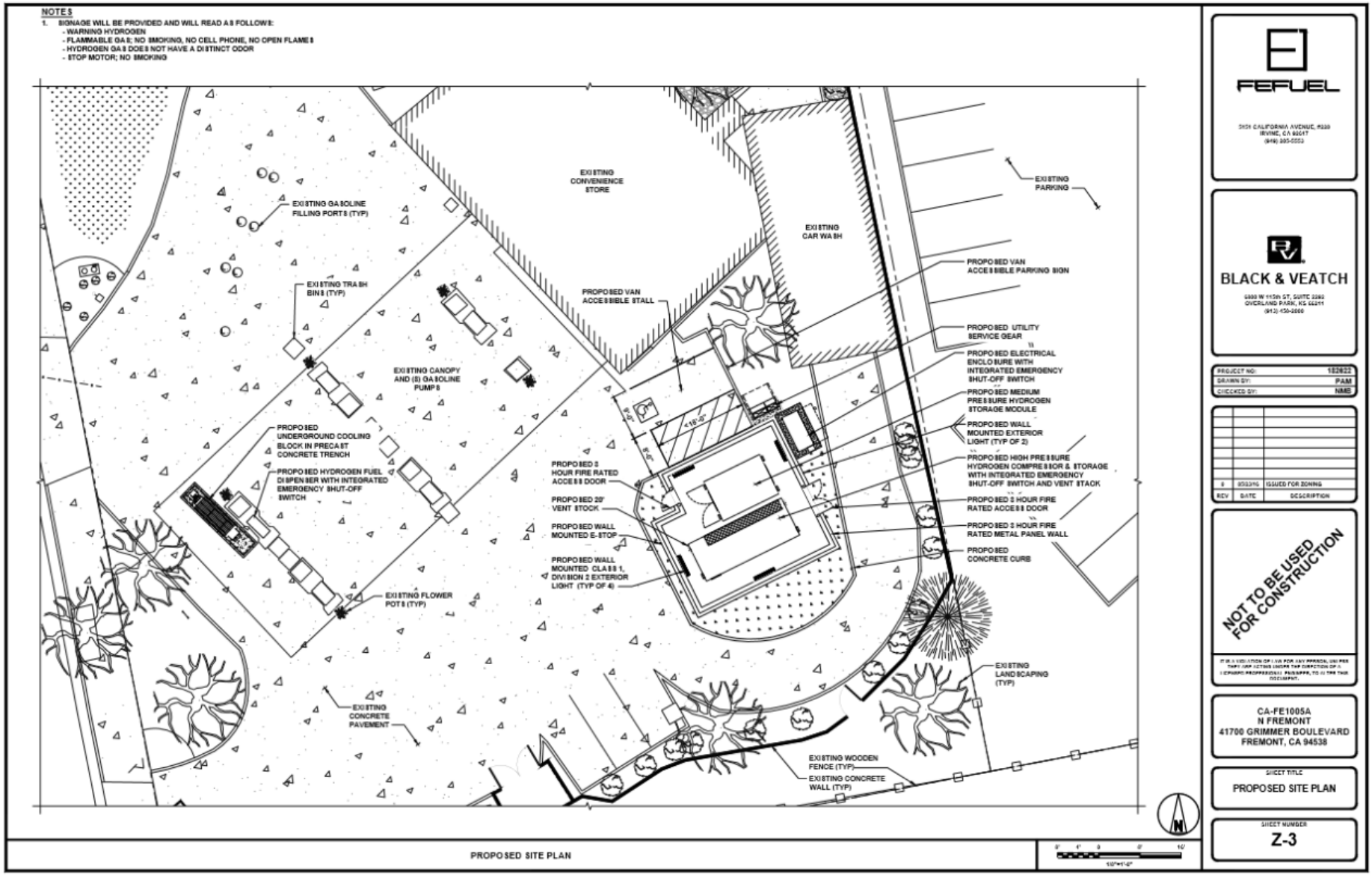
On December 2, 2016, draft final construction drawings (or "CD 90s") were completed that depict all of the minute detailed required for both construction and the permit review process. Final construction drawings (or "CD 100s") were completed with 60 pages that depict all of the minute detailed required for both construction and the permit review process on March 3, 2017. These drawings are similarly signed and sealed by the professional engineer of record to ensure their accuracy and completeness. The equipment compound page of the CD100 Drawings is shown in Figure 3.

Figure 1: Survey of Fremont Hydrogen Station Location



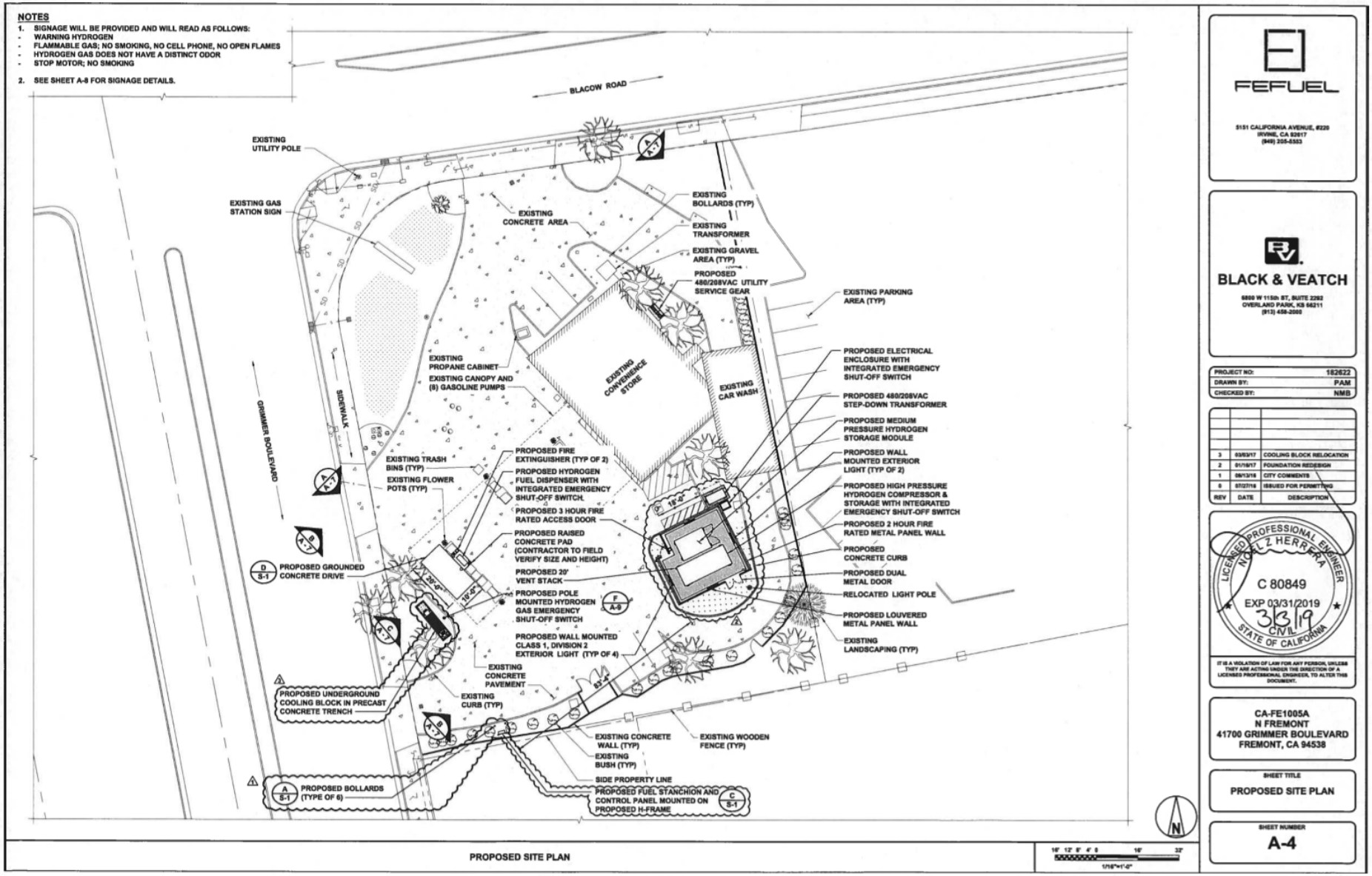
Source: FirstElement Fuel, Inc.

Figure 2: Detail of Equipment Compound from Zoning Drawing Set Showing More Detail and Accuracy than CD30



Source: FirstElement Fuel, Inc.

Figure 3: Detail of Equipment Compound from CD100 Drawing Set Showing Complete Detail for Permitting and Construction



Source: FirstElement Fuel, Inc.

Entitlement Process (5/31/2016 – 10/10/2016)

The zoning application was submitted to the appropriate jurisdiction on May 31, 2016. 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 on October 10, 2016.

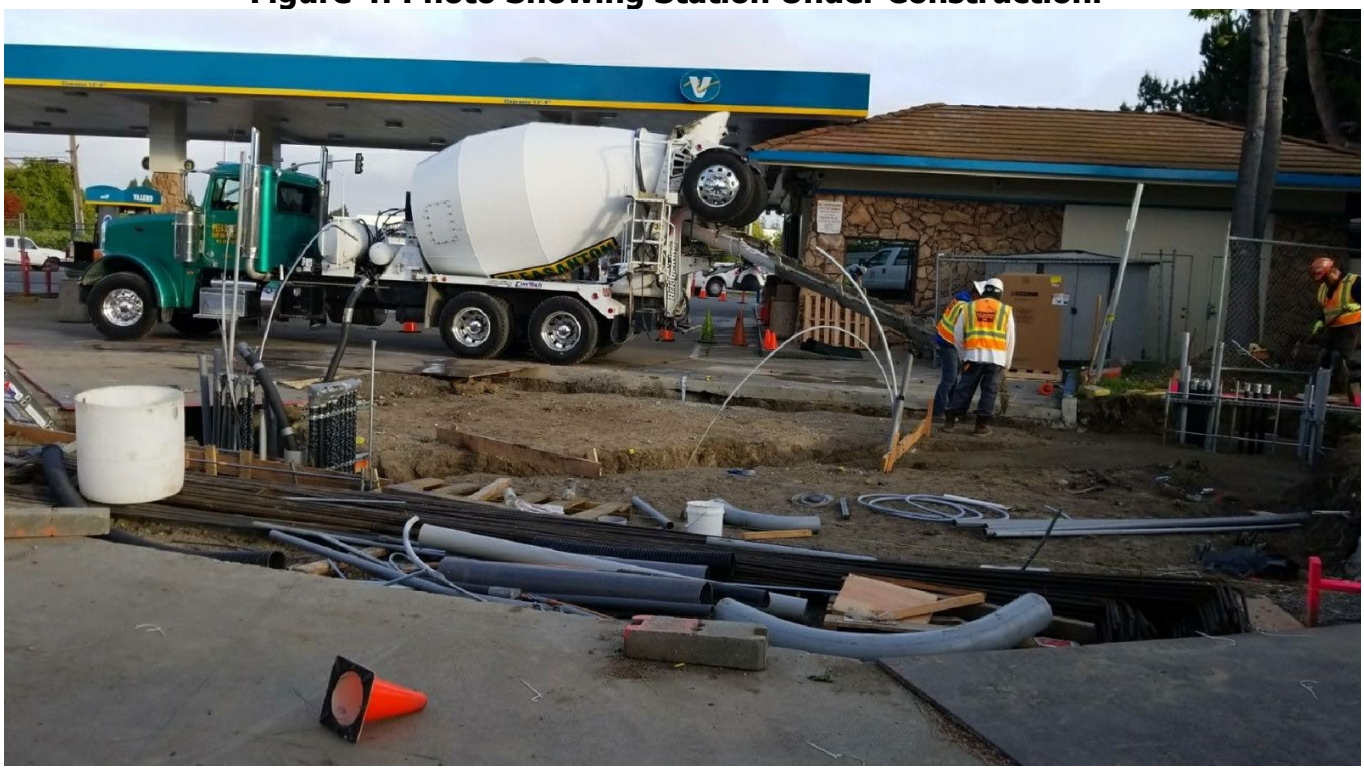
Permit Process (7/29/2016 – 10/10/2016)

All building permit applications were submitted on July 29, 2016, and approved on October 10, 2016.

Construction Process (2/3/2017 – 7/31/2017)

FE and Black & Veatch submitted a detailed bid package to contractors in the Fall of 2016. However, due to a number of factors including the Northern California location, requirement for prevailing wages, and low number of bids, all of the quotes received were extremely high compared to past projects. Consequently, FE chose to act as our own general contractor. Construction started February 3, 2017. Figure 4 shows the station under construction. Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site on May 16, 2017, as shown in Figure 5 show the station under construction. Construction was completed on July 31, 2017.

Figure 4: Photo Showing Station Under Construction.



Source: FirstElement Fuel, Inc.

Figure 5: Crane Lifting Hydrogen Equipment in Fremont

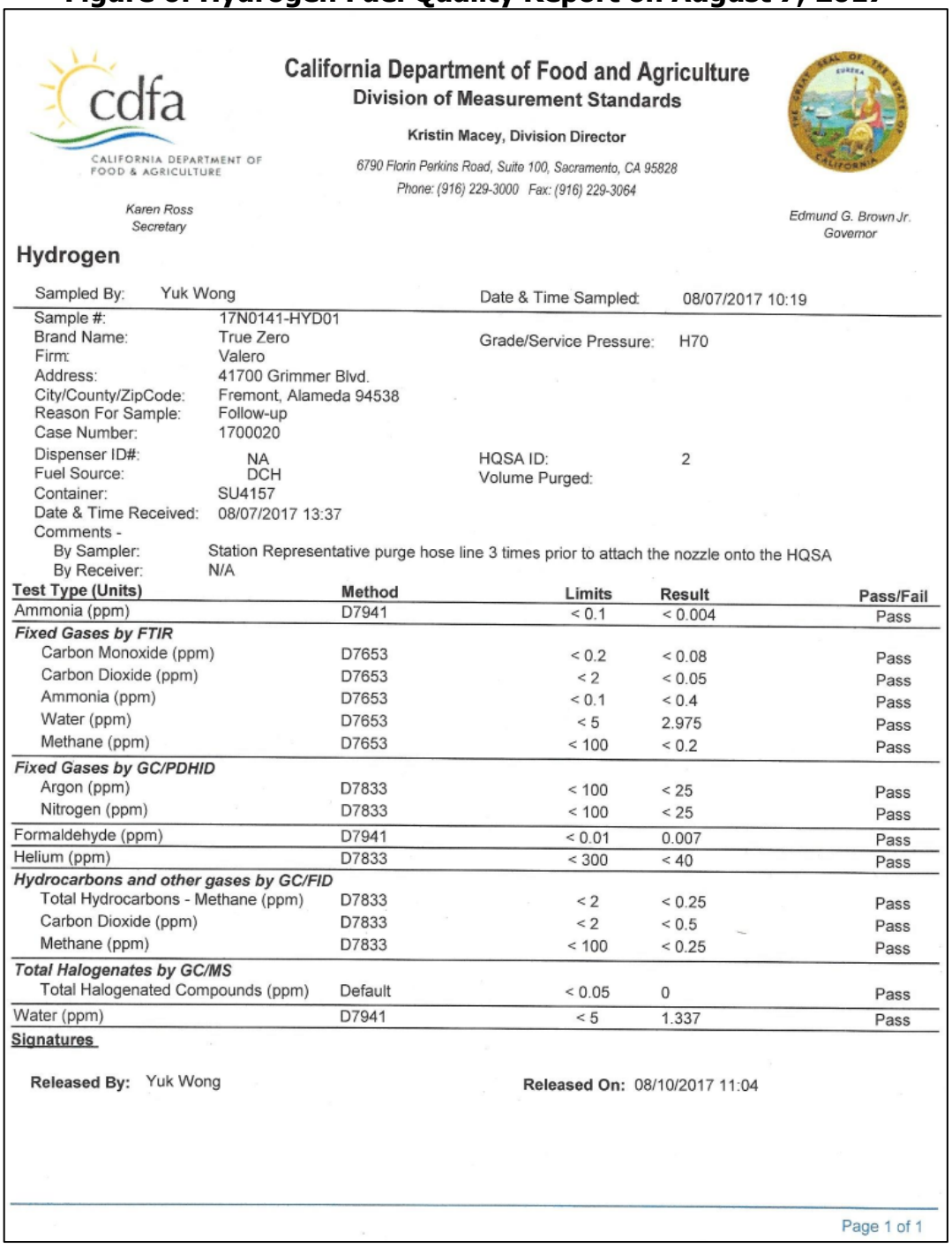
Source: FirstElement Fuel, Inc.

The commissioning of the Fremont hydrogen station included the cleaning and purging of lines, pressure testing, and hydrogen sampling. Figure 6 shows the hydrogen purity analysis following the commissioning process.

Station Declared Operational (7/20/2017)

The Fremont hydrogen station met the Energy Commission's definition of operational by completing installation of all station/dispenser components, obtaining all of the required permits from the local jurisdiction, filling the station's storage tubes with pressurized hydrogen gas, successfully passing a hydrogen quality test, successfully fueled one fuel cell vehicle with hydrogen, and becoming open to the public.

Figure 6: Hydrogen Fuel Quality Report on August 7, 2017



cdfa
CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

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Karen Ross
Secretary

Edmund G. Brown Jr.
Governor

Hydrogen

Sampled By:	Yuk Wong	Date & Time Sampled:	08/07/2017 10:19
Sample #:	17N0141-HYD01		
Brand Name:	True Zero	Grade/Service Pressure:	H70
Firm:	Valero		
Address:	41700 Grimmer Blvd.		
City/County/ZipCode:	Fremont, Alameda 94538		
Reason For Sample:	Follow-up		
Case Number:	1700020		
Dispenser ID#:	NA	HQSA ID:	2
Fuel Source:	DCH	Volume Purged:	
Container:	SU4157		
Date & Time Received:	08/07/2017 13:37		
Comments -			
By Sampler:	Station Representative purge hose line 3 times prior to attach the nozzle onto the HQSA		
By Receiver:	N/A		

Test Type (Units)	Method	Limits	Result	Pass/Fail
Ammonia (ppm)	D7941	< 0.1	< 0.004	Pass
Fixed Gases by FTIR				
Carbon Monoxide (ppm)	D7653	< 0.2	< 0.08	Pass
Carbon Dioxide (ppm)	D7653	< 2	< 0.05	Pass
Ammonia (ppm)	D7653	< 0.1	< 0.4	Pass
Water (ppm)	D7653	< 5	2.975	Pass
Methane (ppm)	D7653	< 100	< 0.2	Pass
Fixed Gases by GC/PDHID				
Argon (ppm)	D7833	< 100	< 25	Pass
Nitrogen (ppm)	D7833	< 100	< 25	Pass
Formaldehyde (ppm)	D7941	< 0.01	0.007	Pass
Helium (ppm)	D7833	< 300	< 40	Pass
Hydrocarbons and other gases by GC/FID				
Total Hydrocarbons - Methane (ppm)	D7833	< 2	< 0.25	Pass
Carbon Dioxide (ppm)	D7833	< 2	< 0.5	Pass
Methane (ppm)	D7833	< 100	< 0.25	Pass
Total Halogenates by GC/MS				
Total Halogenated Compounds (ppm)	Default	< 0.05	0	Pass
Water (ppm)	D7941	< 5	1.337	Pass

Signatures

Released By: Yuk Wong **Released On:** 08/10/2017 11:04

Page 1 of 1

Source: FirstElement Fuel, Inc.

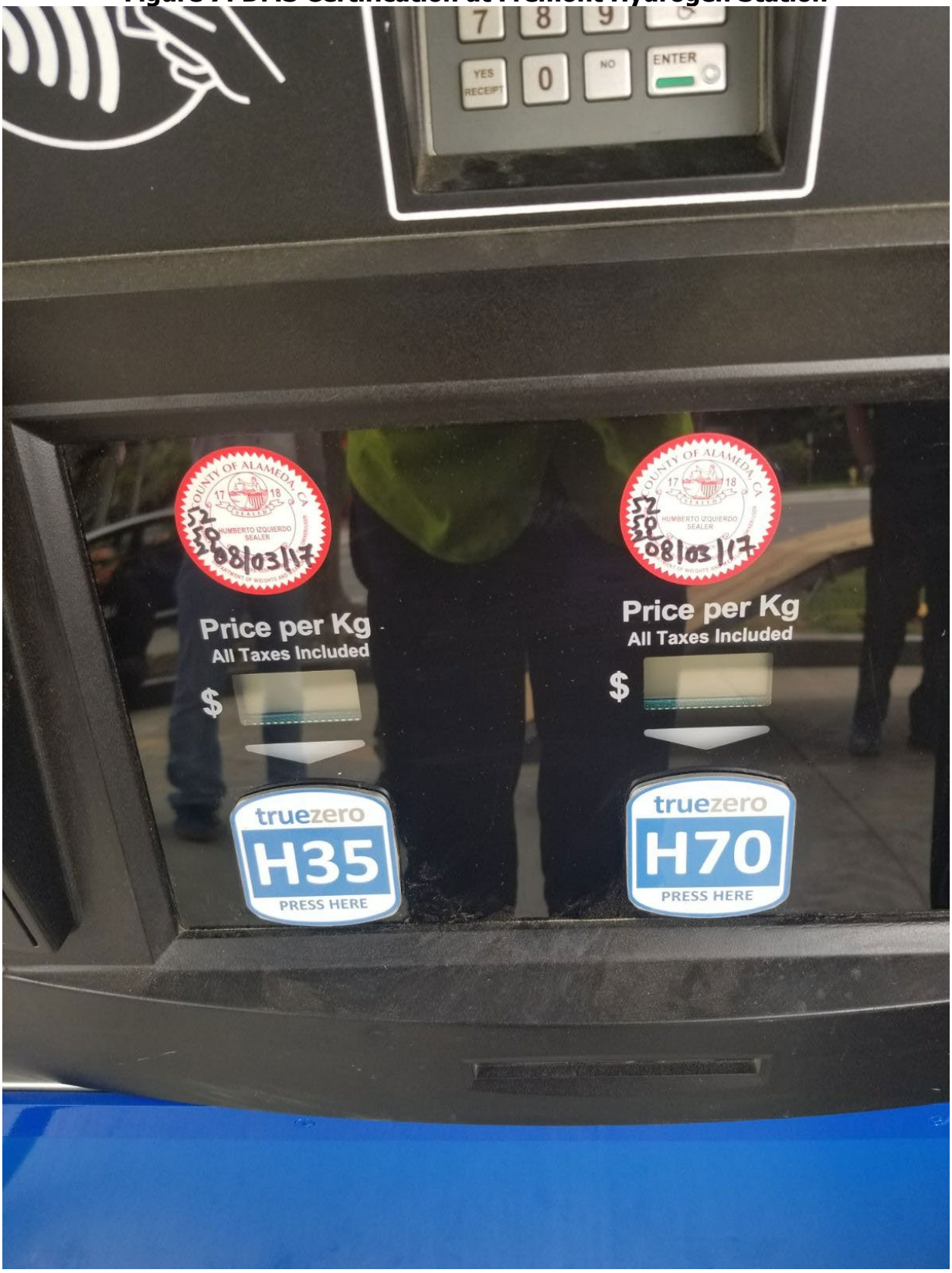
Automaker testing was performed at the Fremont hydrogen station to verify correct operation per Society of Automtive Engineers J2601.

Division of Measurement Standards (DMS) Certification (8/3/2017)

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

Acting as a Registered Service Agent and working with the local County Weights and Measures Officer as a witness, FirstElement successfully put the dispenser into service as shown in Figure 7.

Figure 7: DMS Certification at Fremont Hydrogen Station



Source: FirstElement Fuel, Inc.

Customer Usage (7/20/2017-Present)

The first public customer filled their Hyundai Tucson at the Fremont station on July 20, 2017 (Figure 8) and the station has been used regularly since then. The Fremont station dispensed 85 kilograms (kg) of hydrogen in August 2017 and 867 kgs in September 2017.

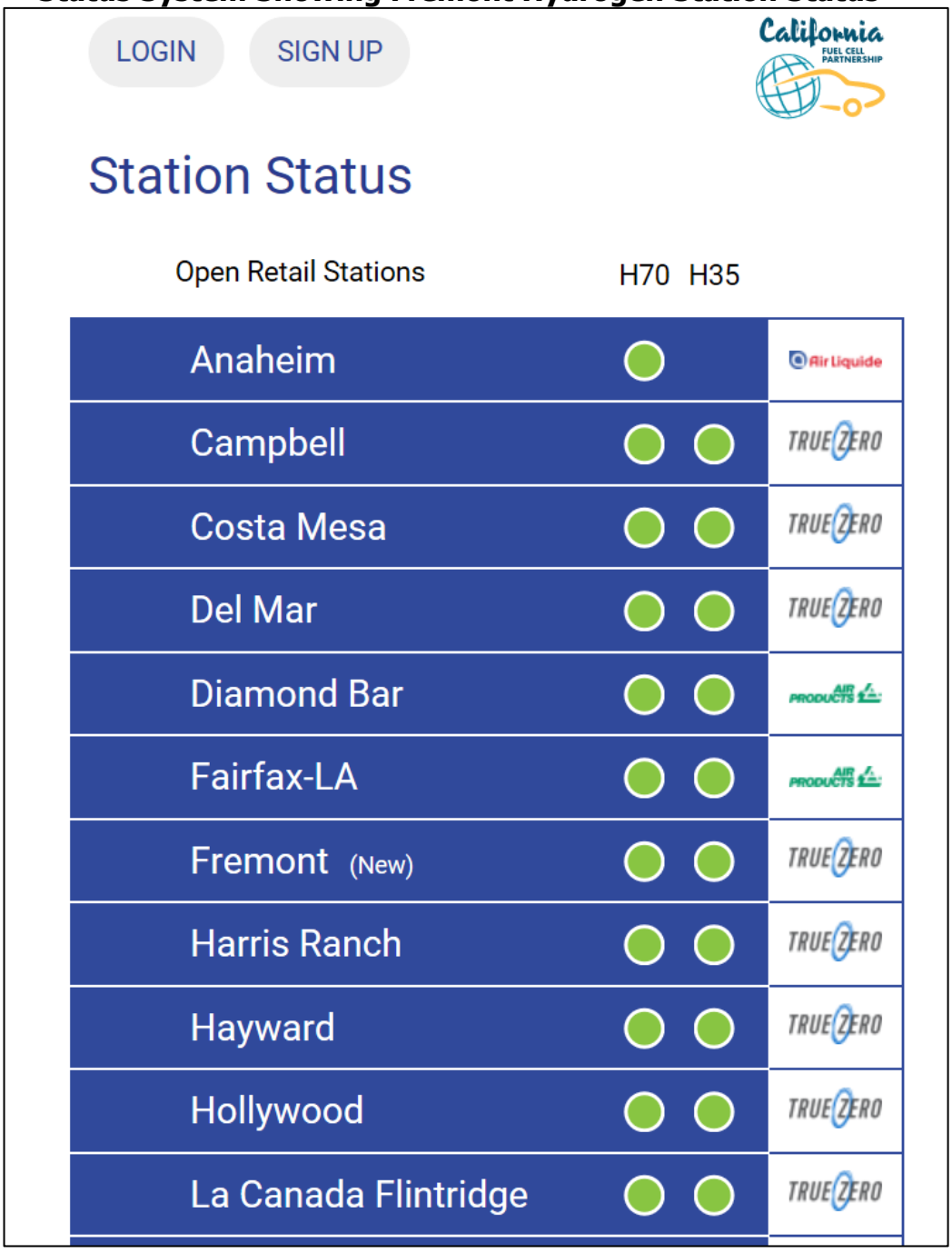
Figure 8: Photo of First Customer Using the Fremont Hydrogen Station on July 20, 2017

Source: FirstElement Fuel, Inc.

Station Operational Status System Activated (9/7/2017)

The California Fuel Cell Partnership Station Operational Status System provides regularly updated station status information to fuel cell vehicle drivers. FirstElement developed software in-house that provides the required updates to the Station Operational Status System system. The Fremont hydrogen station began sending regular status updates to Station Operational Status System on 9/7/2017 as shown in Figure 9.

Figure 9: Screenshot of The California Fuel Cell Partnership Station Operational Status System Showing Fremont Hydrogen Station Status



Source: FirstElement, Inc.

The station is open and active as shown in Figure 10.

Figure 10: Fremont Hydrogen Station

Source: FirstElement Fuel, Inc.

Hydrogen will be stored as a compressed gas in an above ground tank concealed behind a wall at this facility. Hydrogen is non-toxic, colorless, and odorless so hydrogen station equipment is outfitted with appropriate sensors to provide immediate notification in the case that a leak ever occurs. No solid or liquid waste will be produced at this site.

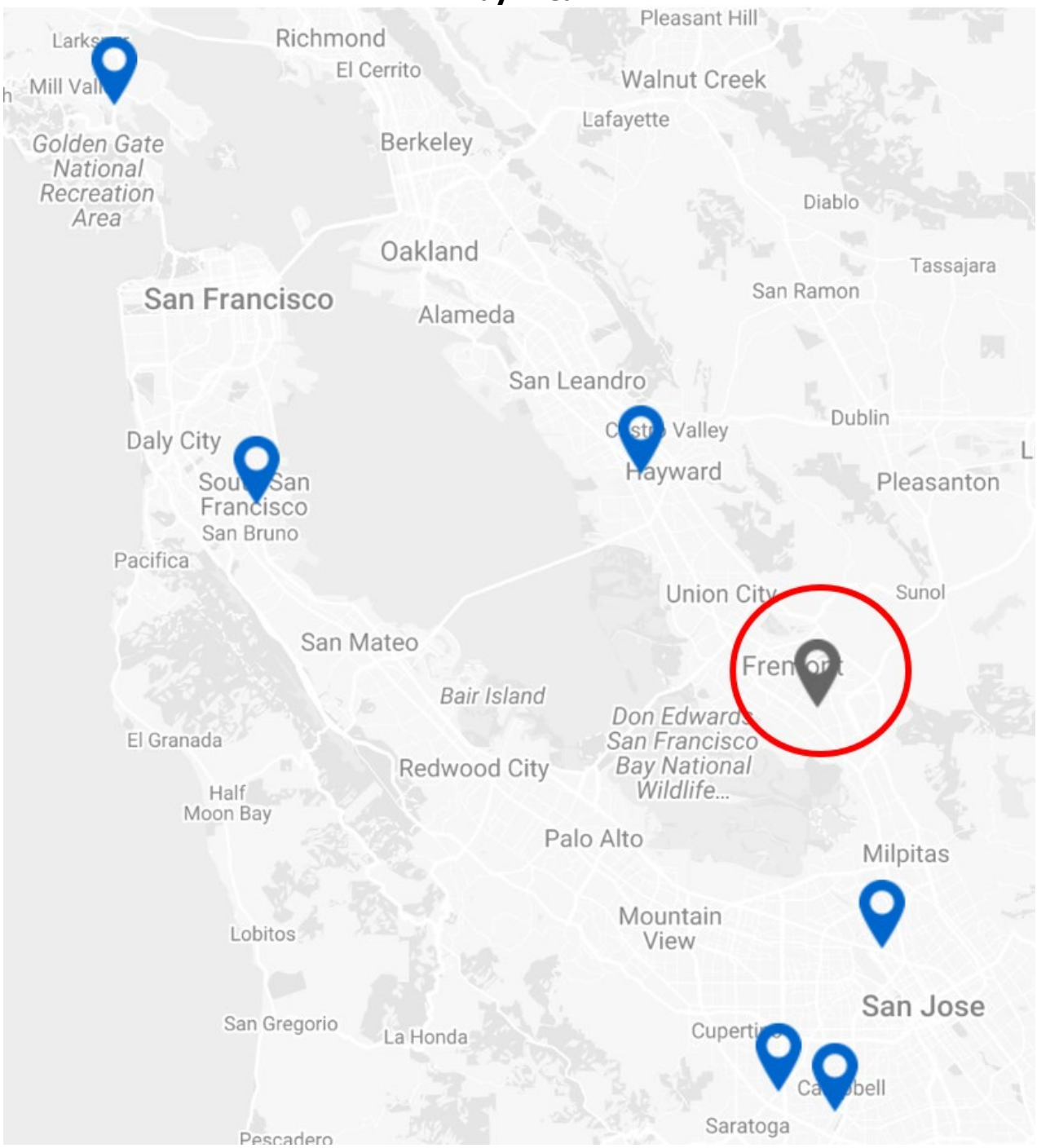
Minimal was consumed for this project. There was no additional landscaping added for the construction of the hydrogen refueling station and therefore no additional irrigation water will be consumed.

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 aid in evening fueling.

Fremont Station in the Network

Figure 11 shows the location of the Fremont hydrogen station at 41700 Grimmer Blvd., Fremont as a primary station in the San Francisco Bay Area.

Figure 11: The Fremont Hydrogen Station is a Primary Station in the San Francisco Bay Area

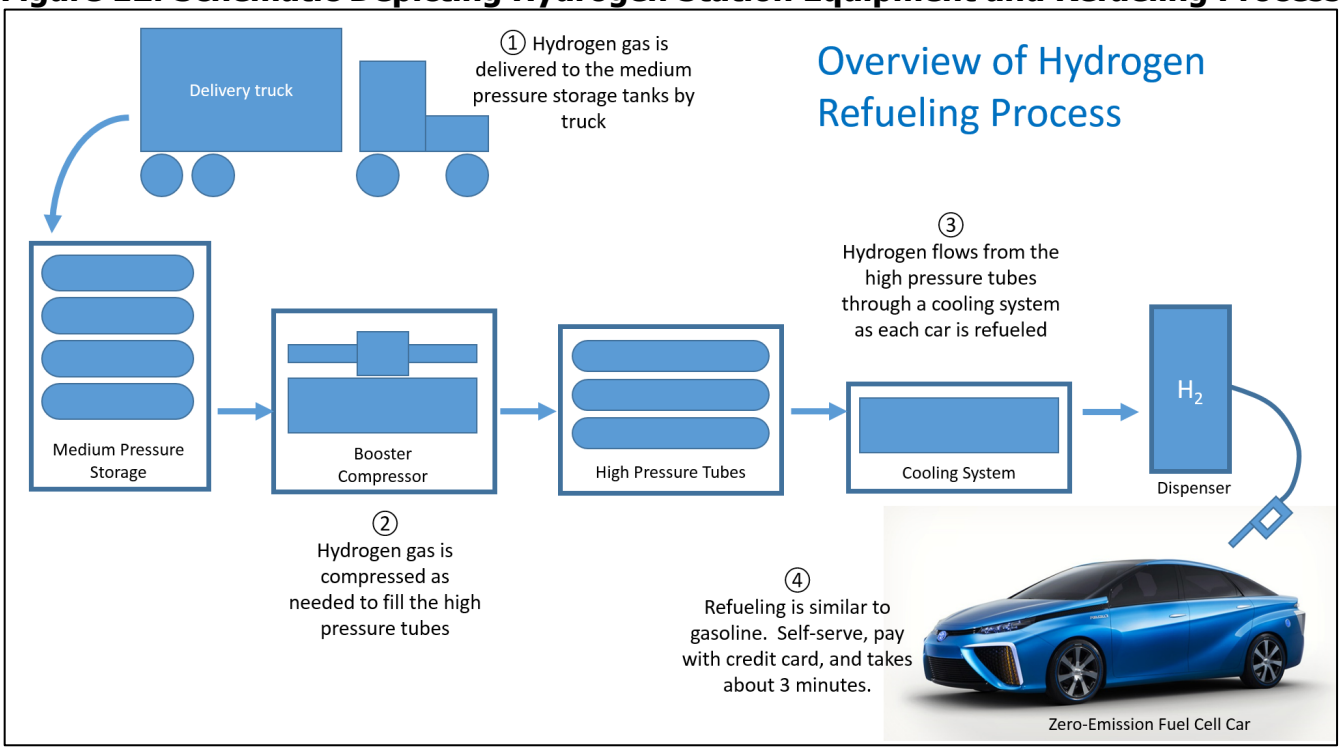


Source: FirstElement Fuel, Inc.

Schematic Layout of the Fremont Station

Figure 12 depicts an overview of the Fremont hydrogen station components and the steps involved in the refueling process.

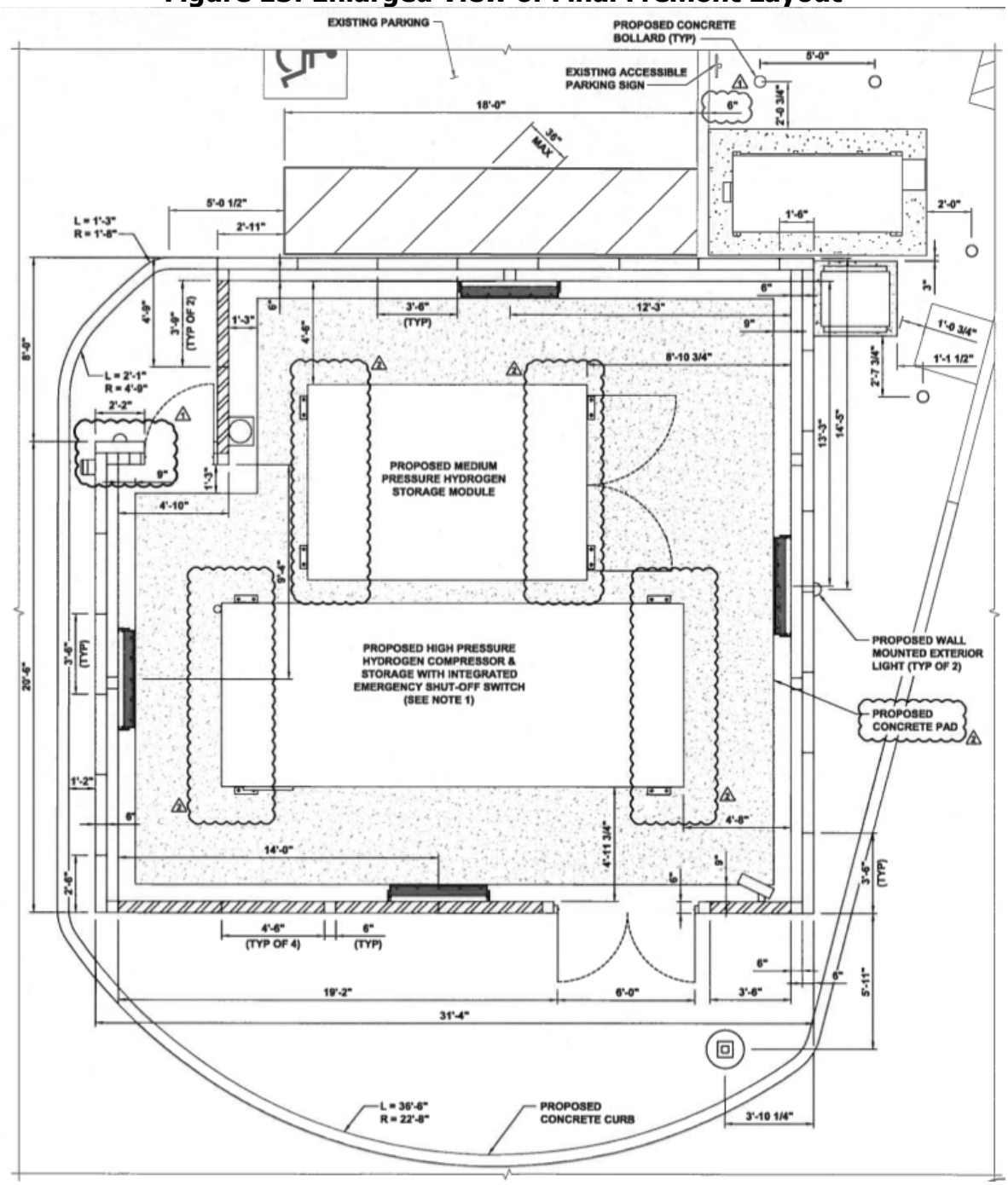
Figure 12: Schematic Depicting Hydrogen Station Equipment and Refueling Process



Source: FirstElement Fuel, Inc.

Figure 13 shows a detailed view of the actual final, as-built configuration of the Fremont station.

Figure 13: Enlarged View of Final Fremont Layout



Source: FirstElement Fuel, Inc.

Table 1 shows a list of subcontractors and their budgets for the Fremont Station project.

Table 1: List of Subcontractors and Budget

Air Products and Chemicals, Inc., Allentown , PA	
H2 station equipment	$1,483,691.18
Black & Veatch, Overland Park, KS	
Construction	$825,439.00
Engineering	$53,641.08
Permitting	$21,779.77
Project Management	$20,897.90
Various Vendors	
Construction Materials (tubing, wire, etc.)	$110,354.46
Fixtures (doors, lights, etc.)	$41,943.88
MSI Tech, Irvine CA	
Data Collection Tool	$2,353.56
Karen Calhoun, Newport Beach, CA	
Legal services	$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	$4,345.13
Total Vendor Costs	$2,577,595.99
CEC Grant	$1,451,000.00
Remaining cash provided by FE	$1,126,595.99
Total CEC cost share (w/o FE internal costs)	56.3%

Source: FirstElement, Inc.

CHAPTER 2:
Data Collection and Energy Analysis

The Fremont hydrogen refueling station is supplied by hydrogen generated via the Steam Methane Reformation process that converts methane (CH_4) and water (H_2O) to hydrogen (H_2) and carbon dioxide (CO_2):

$$CH_4 + 2H_20 \rightarrow 4H_2 + CO_2$$

Per California Senate Bill 1505, Environmental Standards for Hydrogen Production, at least one third of the hydrogen sold by FirstElement'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, CA. 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 (sources of biogas shown in Figure 14). Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

Air Products currently has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1); documentation is provided in Figure 15. Although California has a substantial amount of biogas resources, local supply cannot be injected into California pipelines because of CA Health & Safety Cost Section 25420. Air Products' biogas supply for this project is being sourced outside of California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council region that delivers gas into California.

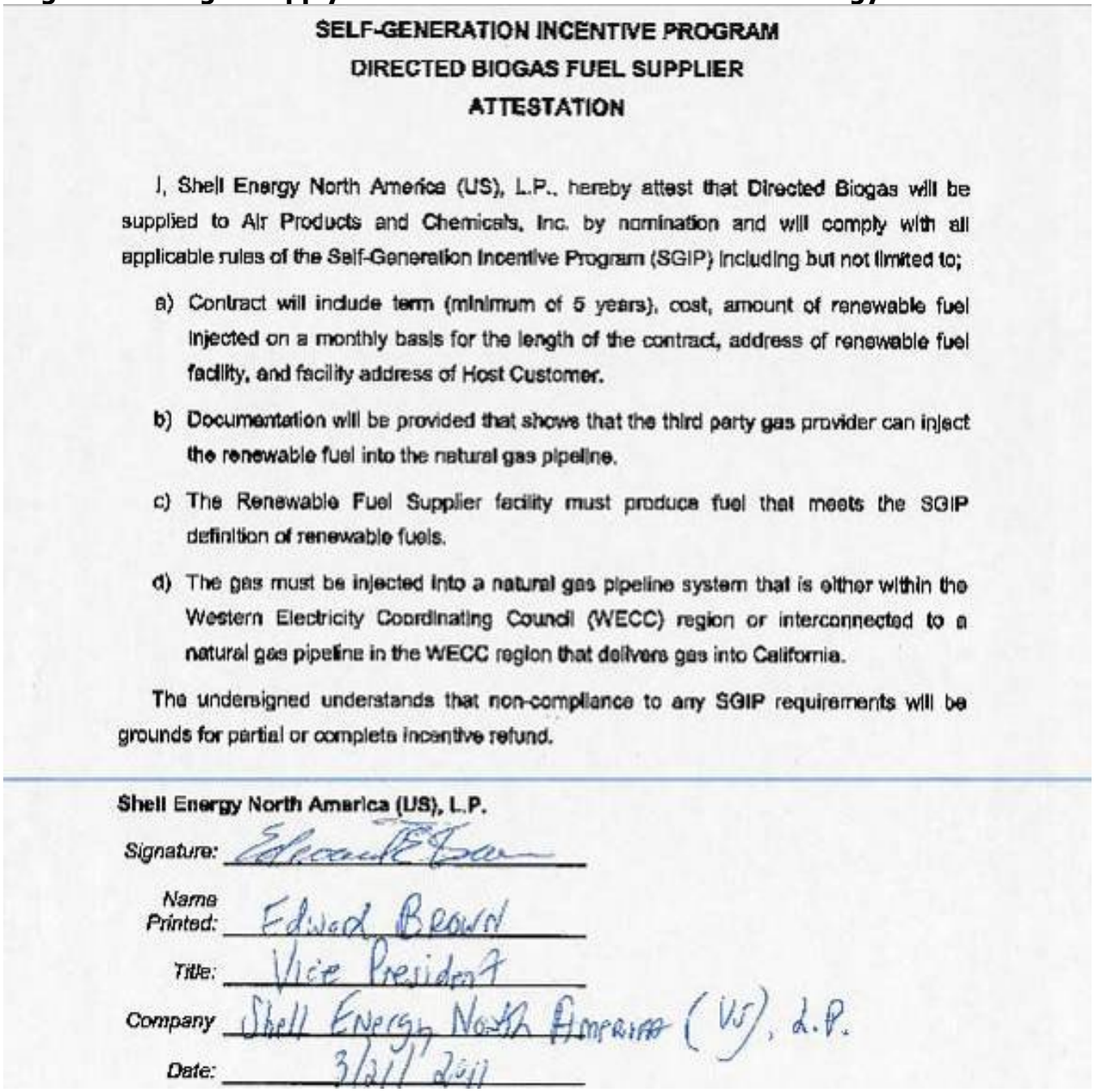
Figure 14: Biogas Sources

Exhibit A
RB Supply Sources
Shell Energy North America (US), L.P.

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

Source: FirstElement, Inc.

Figure 15: Biogas Supply Contract Between APCI and Shell Energy North America



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, Inc.

Hydrogen is delivered to all FE stations (including Fremont) 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 and greenhouse gas emissions data presented in Table 2. As shown, 1/3 of the energy feedstock is renewable, nearly zero petroleum is used, and the only tailpipe emissions are water compared to the myriad pollutants emitted by combustion of gasoline. Also, the entire well-to-wheels greenhouse gas emissions are 58 percent lower than similar usage for a typical California gasoline vehicle.

Table 2: Percentage of Energy Sources and Well-to-Wheel Greenhouse Gas Emissions for FirstElement Hydrogen Compared to Average California Gasoline.

Energy Sources	Fuel Cell Vehicle fueled at FirstElement station	Average California internal combustion car fueled by gasoline
Coal	1.7%	0.4%
Petroleum	0.3%	78.6%
Natural Gas	64.7%	13.9%
Renewable	33.3%	7.1%
Total Greenhouse Gasses	178 grams/mile	428 grams/mile
Tailpipe Emissions	Pure Water	VOC, CO, NO_x, PM10, PM2.5, SOx, CH_4, N_2O, and toxins

Source: FirstElement, Inc.

The Fremont hydrogen station is capable of dispensing 180 kg/day. Assuming that FCEVs average 52 mile/kg (taken from Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model), and consumption of 180 kg/day for the next 10 years, the station will offset 8,384 metric tons of total greenhouse gasses compared to equivalent gasoline vehicles. Also, the Fremont hydrogen station will eliminate over 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon[1].

Data on the operation of the station will be collected and reported to the Energy Commission throughout the term of an associated operations and maintenance grant through the Clean Transportation Program. Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the project's actual performance to proposed expectations.

[1] Department of Transportation, Bureau of Transportation Statistics; Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles; https://www.bts.gov/archive/publications/national_transportation_statistics/table_04_23

CHAPTER 3:
Statement of Future Intent

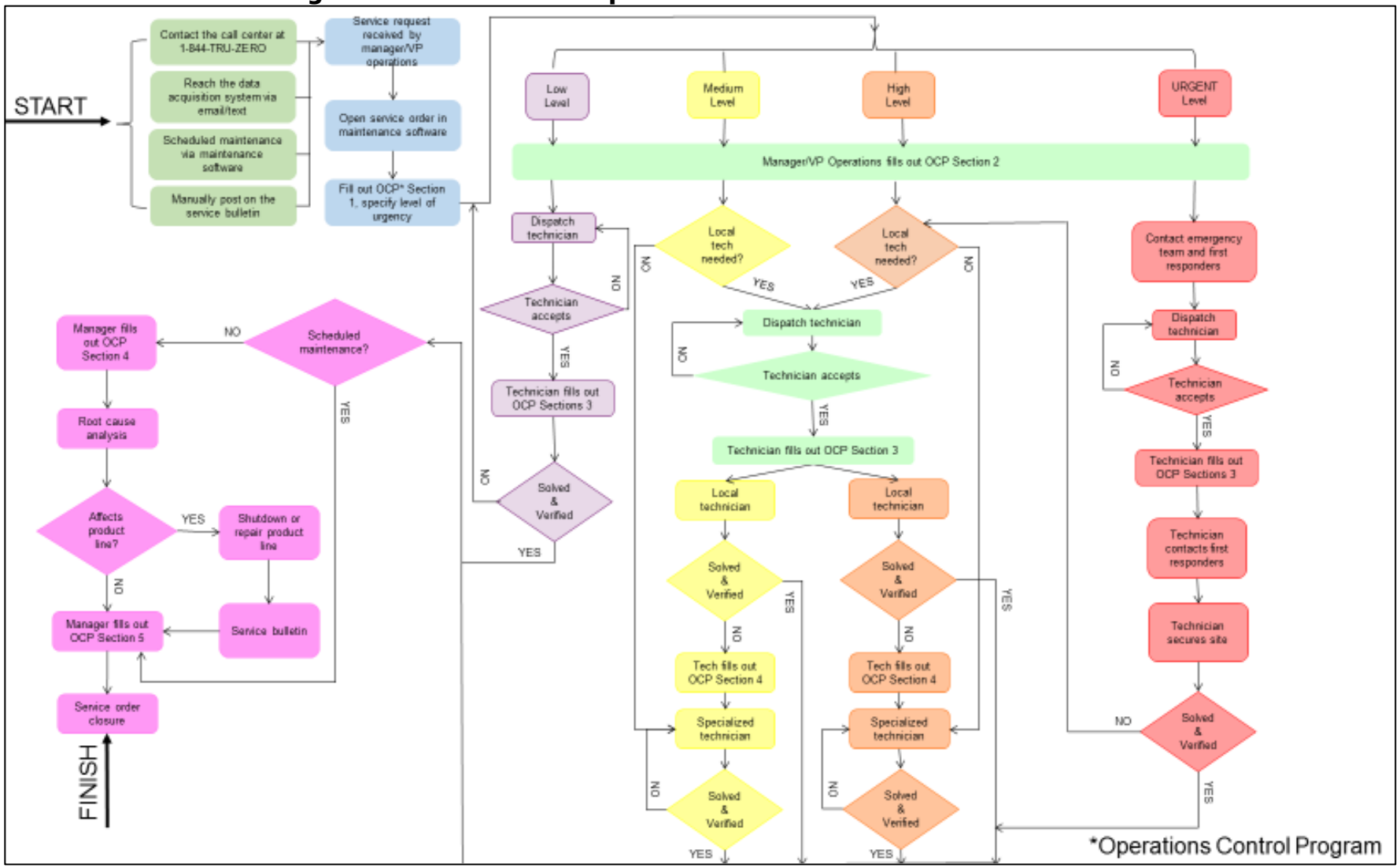
FE intends to own and operate the refueling station at 41700 Grimmer Blvd., Fremont, CA for at least 10 years. FE has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FE has executed an initial 10 year lease with the landowner with the possibility for extension.

In addition, FE 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 16 shows a flow diagram for response from the Operations and Maintenance team.

To augment onsite personnel across the FE network, a comprehensive data collection and monitoring system has been implemented. Figure 17 shows a screenshot of one page of the system. FE 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.

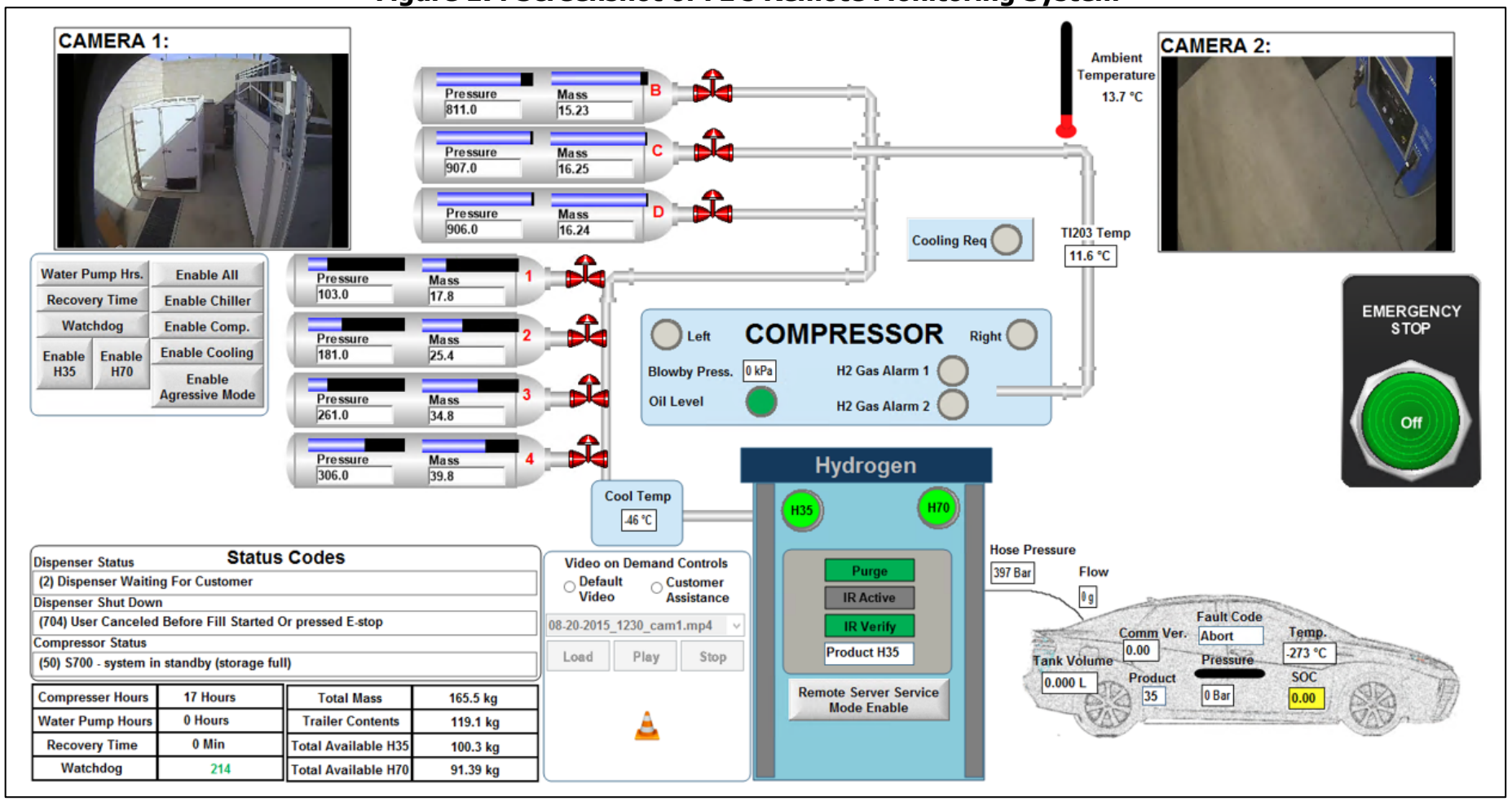
In addition to remote monitoring, FE has implemented rigorous Computerized Maintenance Management Systems and Enterprise Asset Management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and repair activities. This will help to maximize station up-time and enable tracking of key performance indicators.

Figure 16: FirstElement Operations and Maintenance Control Plan



Source: FirstElement Fuel, Inc

Figure 17: Screenshot of FE's Remote Monitoring System



Source: FirstElement Fuel, Inc.

CHAPTER 4:
Findings, Conclusions, and Recommendations

The following is a list of important findings from the Fremont hydrogen station project:

- Because of high construction bids, FirstElement acted directly as general contractor for the construction of the Fremont hydrogen station. In the end, this did not substantially improve the construction costs, but it did provide valuable first-hand experience that can be applied to the design and construction of future stations.
- The Fremont hydrogen station was the first location where FirstElement placed a hydrogen dispenser under an existing gasoline fueling canopy. The hydrogen portion went smoothly, but removing and replacing a gasoline/diesel dispenser required more effort and more cost than anticipated.
- National Fire Protection Agency 2: Hydrogen Technologies Code is a critical tool for working with permit agencies. The code clearly defines fire safety guidelines that enable local jurisdictions and builders to reach common ground, while also ensuring safety via the rigorous National Fire Protection Agency code writing process. The key is for both station builders and station permit agencies to fully understand, and appreciate, the content of National Fire Protection Agency 2.

GLOSSARY

CALIFORNIA DIVISION OF MEASUREMENT STANDARDS (DMS)—Enforcer of California weights and measures laws and regulations. The Division works closely with county sealers of weights and measures who, under the supervision and direction of the Secretary of Food and Agriculture, carry out the vast majority of weights and measures enforcement activities at the local level. Ensuring fair competition for industry and accurate value comparison for consumers are the primary functions of the county/state programs.

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.

CARBON DIOXIDE (CO2)—A colorless, odorless, nonpoisonous 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).

FIRSTELEMENT FUEL, INC. (FE)—FirstElement Fuel, Inc. is committed to making safe, reliable, retail hydrogen available for the world's next-generation of vehicles powered by fuel cells.[2]

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.

KILOGRAM (kg)—The base unit of mass in the International System of Units that is equal to the mass of a prototype agreed upon by international convention and that is nearly equal to the mass of 1,000 cubic centimeters of water at the temperature of its maximum density.

[2] FirstElement Fuel, Inc. About webpage https://www.firstelementfuel.com/about-firstelement-fuel

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 and enteric fermentation in animals, and is one of the greenhouse gases.

WATER (H2O)—Water is an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of Earth's hydrosphere and the fluids of all known living organisms. Its chemical formula is H2O, meaning that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds.[3]

[3] Wikipedia Water https://en.wikipedia.org/wiki/Water