CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Kings Canyon Unified School District

Canyon Air Repair Project

Prepared for: California Energy Commission

Prepared by: Kings Canyon Unified School District

Gavin Newsom, Governor
January 2020 | CEC-600-2020-017

California Energy Commission

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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-14-608 to support the installation of new natural gas fueling infrastructure and upgrades to existing natural gas fueling infrastructure. In response to PON-14-608, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 12, 2015, and the agreement was executed as ARV-15-020 on January 25, 2016.

ABSTRACT

Kings Canyon Unified School District is a Kindergarten-to-12th grade school system that serves students from a 600 square-mile area in California. The district serves Reedley, Orange Cove, and the foothill and mountain communities of Navelencia, Squaw Valley, Dunlap and Miramonte. The district employs approximately 1,500 staff members and has a student population of about 10,000.

Kings Canyon Unified School District operates a school bus fleet of 74 vehicles, with 37 compressed natural gas buses, and 31 diesel powered buses with diesel particulate filters to meet the California Air Resources Board's Truck and Bus Regulation.

An important aspect of natural gas vehicle deployment in California is developing supporting infrastructure. There is limited access to natural gas infrastructure in the surrounding regions of the district, which deters the use or expansion of natural gas technologies by central valley school bus fleets. As a result, the district sought to expand compressed natural gas fuel use and availability through the creation of the Central Valley Transportation Center. The Central Valley Transportation Center will provide Reedley and surrounding communities with green jobs, clean and low carbon energy and green education training. The Central Valley Transportation Center will also be the home of the districts fleet of school buses and service vehicle with alternative fuel dispensing and service center located on site.

Keywords: Compressed natural gas, liquefied natural gas, liquefied to compressed natural gas

Please use the following citation for this report:

Kings Canyon Unified School District. 2020. *Canyon Air Repair Project*. Energy Commission. Publication Number: CEC-600-2020-017.

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EXECUTIVE SUMMARY

The Kings Canyon Unified School District continues to work toward the reduction of pollution in the San Joaquin Valley. The district has spearheaded these efforts through the replacement of diesel-powered buses with buses and vehicles using engines that produce less pollution. The district has 37 compressed natural gas powered buses and five compressed natural gas powered service vehicles. The district constructed a compressed natural gas fueling station in 1996 and the compressed natural gas station is open to the public during all district-operating houses, five days per week. The station is also on call during the weekend.

The Kings Canyon Unified School District's progressive project, the Central Valley Transportation Center, is the first of its kind in the local rural community. The Central Valley Transportation Center seeks to provide Reedley and surrounding communities with "good jobs, clean energy and green education." In order to fulfil the Central Valley Transportation Center's and the Kings Canyon Unified School District district's mission of providing residents and students with green energy choices and sustainable transportation, the district needs to place alternative fueling infrastructures on the site. However, because of substantial financial hardships, the district must seek grant funding for its Canyon Air Repair project. This funding will allow the district, which services a predominately low-income Hispanic/Latino student population, to continue to keep the compressed natural gas station in operation.

The funding received through the California Energy Commission will allow The Kings Canyon Unified School District, through its Canyon Air Repair project, to continue providing clean burning fuel for the transportation fleet and other communities that use the fueling stations. Reedley is also a largely disadvantaged community of Latino/Hispanic residents where economic development is scarce. In addition, according to the California Environmental Protection Agency's CalEnviroScreen 2.0, Reedley is a severely disadvantaged community, ranking among the "highest population characteristics scores of 91-100 percent."

The American Lung Association continues to rank the Central Valley as one of the worst air pollution regions in the State. The Kings Canyon Unified School District seeks to better provide healthy living for its students and surrounding community members through the Central Valley Transportation Center and especially with the replacement of fueling infrastructure on the site.

CHAPTER 1:
Project Background, Objectives, and Project Approach

1.1: Project Background and Objectives

1.1.1: About the District

Kings Canyon Unified School District (KCUSD) is a preschool through 12th grade public school system that serves students from a 600 square-mile area and is geographically one of the largest school districts in California.

Diverse in geography and culture, KCUSD serves Reedley, Orange Cove and the foothill and mountain communities of Navelencia, Squaw Valley, Dunlap and Miramonte. The District employs approximately 1,500 staff members and has a student population of about 10,000.

KCUSD operates 22 school campuses in configurations that include Kindergarten-to-5th-grade, Kindergarten-to-8th-grade, middle school, and high school education. KCUSD also offers a robust selection of programs that include preschool education, adult education, alternative education, vocational education, and special education. A middle college and an online academy for high school students are also available to meet a broad spectrum of student needs. Students enjoy stimulating and innovative curricula that align with state standards and effectively target student needs and interests.

1.1.2: Current Fleet

The KCUSD school bus fleet currently consists of 74 vehicles, which includes 37 compressed natural gas (CNG) powered buses and 31 diesel powered buses equipped with diesel particulate filters to meet the California Air Resources Board's Truck and Bus Regulation.[1] The KCUSD school bus fleet runs cleanly and meets all strict California emissions standards. The transportation department fleet also has light-duty Ford Transit Connect support vehicles powered by natural gas, in addition to four electric vehicles. This includes an all-electric warehouse box truck for deliveries.

It is in the best interest of KCUSD to have a compressed natural gas (CNG) fueling station that would have the ability to provide fuel for its fleet of CNG school buses and five support vehicles. The fueling station would also be a backup fueling station for those public entities that have natural gas powered vehicles in the area if ever their fueling station went out of service, such as Sanger Unified, Parlier Unified, Dinuba Unified and Dinuba Rural Transit and Immanuel. Table 1 shows fleets supported by the KCUSD station.

1 ARB Website: http://www.arb.ca.gov/msprog/truckstop/tb/schoolbus.htm

Table 1: KCUSD Supported Fleets

Fleet Owner	Fleet Description	# Vehicles	Miles per Day	Miles per Gallon in Gasoline Gallon Equivalent	Gas Gallon Equivalent / Day / Vehicle	Rollout Days / year	Est. DGEs / Fleet / year
Dinuba USD	40' CNG school buses (current)	2	45	5.5	8.2	200	2871
Dinuba USD	40' CNG school buses (future)	16	45	5.5	8.2	200	2296
Reedley	CNG refuse trucks	7	70	3.0	23.3	312	44701
PG&E	1-ton Service body	3	40	10.0	4.0	250	26312
Fresno Rural Transit	35' CNG paratransit buses	12	80	5.0	16.0	250	42105
Orange Cove Transit	35' CNG paratransit buses	4	80	5.0	16.0	250	14035
Clay USD	40' CNG school buses	1	55	5.5	10.0	175	1535
Immanuel High School (private)	40' CNG school buses	4	55	5.5	10.0	180	6316
AT&T	Service Support Vans	10	50	12.0	4.2	250	9138

Source: KCUSD

KCUSD met the goals of this project with the installation of its Central Valley Transportation Center (CVTC) CNG station by:

- Placing new natural gas fueling infrastructure on site at the district's CVTC,
- Encouraging the expansion of CNG use by providing publicly accessible CNG fueling to interested area fleets and residents,
- Reducing emission of NOx, particulate matter, (PM) and GHGs within Reedley and Fresno County,
- Increasing the knowledge of CNG among CVTC staff, Reedley citizens, and local public and private company fleets and encouraging CNG use.

1.1.3: Project Approach

KCUSD brought on board an engineering company, Integrated Designs by SOMAM, Inc., and shared information regarding the construction of a new fueling station for its school bus fleet. Reb Guthrie of Fuel Solutions, Inc., the engineering consultant, drew up the CNG portion of the drawings and gave the district a cost estimate for the construction of this project.

KCUSD partnered with Reb Guthrie of Fuel Solutions, Inc. to help with the specification writing, bid proposal and walk, inspection and technical expertise in the area of CNG and CNG facilities. The project was formally bid for installation and procurement of new compressors and fast-fill dispenser. Bid opening was October 14, 2015 and awarded to EFS West. EFS West used Jimco Sales and Manufacturing Lane Supply Inc. for the Canopy, Revolution CNG, Inc. for the CNG Mechanical and Equipment and Verduzco Electric as the Electrical Consultant.

The work to be performed under this contract included, in general, to provide and install mechanical equipment and their required functions for a complete CNG vehicle-fueling system. The base CNG equipment and related work includes two 325-standard-cubic-feet-per-minute CNG compressor skids with electric motor prime mover, 650-standard-cubic-feet-per-minute-rated gas dryer, (two) two-hose fast fill dispensers, 43 one-hose post type time slow-fill dispensers, CNG storage vessels, canopy, backup generator, miscellaneous concrete, and other components required for a new CNG fueling system at 1600 S. Apple Avenue (northeast corner of S. Apple Ave and E. Huntsman Ave), Reedley, CA 93654.

Removal of existing CNG equipment (CNG Bauer C23.2 Compressor Unit, three CNG Storage Sphere Vessels) currently located at the KCUSD Bus Yard, 675 W. Manning Avenue, Reedley, CA 93654, and relocated and installed at the CVTC, 1600 S. Apple Avenue, Reedley, CA 93654.

The base bid came in just above $1.2 million dollars, with additional expenses adding to the initial first phase of the project bringing the total to approximately $2.1 million dollars. Final payments total $1.6 million dollars.

In December 2015, the California Energy Commission (Energy Commission) awarded KCUSD $500,000 in grant funding. With this funding available, KCUSD was able to move forward with the construction of the new CNG fueling station for their fleet.

1.1.4: Central Valley Transportation Center

On Friday October 28, 2016, KCUSD unveiled to the public the new CVTC, which is a joint effort with Reedley to relocate the old transportation center and the Public Works Department and associated vehicle maintenance yard to the new CVTC. The new facility will combine the current daily operations of the KCUSD transportation facility and the City Public Works Department into one facility.

The event was opened by Superintendent Juan Garza, who thank Reedley and their continued support. Dr. John Quinto, Assistant Superintendent/Chief Business Official, thank all who helped in the build and funding of the CVTC. Afterward there were venders available to provide additional information for those who took a tour about the inner workings of all the equipment as well as the new offices.

CHAPTER 2:
Scope of Work

The scope of work for KCUSD under contract ARV-15-020 included the design, installation, operation, and reporting of this CNG refueling station. Revolution CNG, Inc., was responsible for constructing the CNG refueling station with new equipment.

All equipment meets all applicable American Petroleum Institute, American Society of Mechanical Engineers, International Society of Automation, American Gas Association, National Electric Code, and National Fire Protection Association requirements. The station also included the installation of utility tie-ins, start-up, debugging and stabilizing the refueling station, along with design, engineering, permitting, project management, and purchasing. KCUSD's work included fire protection, fire detection, methane detection, and all necessary safety elements identified with hazardous operations process safety.

KCUSD completed several technical tasks in order to complete the CNG station in an orderly and efficient manner. In particular, KCUSD completed the below technical tasks under this project:

2.1: Task 2: Engineering, Design, and Equipment Procurement

2.1.1: Specifications and Bid Documents

The goal of this task was to engineer and design adequate CNG fueling infrastructure for the CVTC. After KCUSD completed the design plan, the district finalized the specifications for the construction of a new fueling station and prepared bid documents.

KCUSD took an approach to find out how much gas flow would be needed for the new fueling station. KCUSD consulted Pacific Gas & Electric (PG&E) to ensure the project would have the necessary amount of gas flow needed for the equipment. After requests were granted, KCUSD then made the requests to build and obtain permits from Reedley, which were granted. Receiving notification from both PG&E and Reedley, construction drawings were completed, approved, and finalized.

2.1.2: Engineering

The goal of this task is to prepare engineering drawings for permitting and construction.

After receiving approval from Reedley and PG&E for gas flow needed, drawings and permits to construct to begin construction was approved.

2.1.3: Order Equipment for Project

The goal of this task is to purchase the equipment needed for construction of the new fueling station.

KCUSD bid the project out. The equipment specified in the bid documents was Bauer equipment that the district had used on a previous project. KCUSD found Bauer products to

meet expectations and were comfortable listing the equipment as the basis to award. Not only does KCUSD feel the product meets the needs of the district, it also proved to be the most cost efficient option.

1.1.3.1: Equipment

Installed equipment consists of the following:

- Two Bauer X-fill C26.12 compressors
- An Intelli-Flo™ Programmable-Logic-Computer (PLC) Controlled Fully-Electronic Priority-Fill Panel
- Remote Control with the BAUER Remote HMI™
- Six Wilco 4' storage vessels
- Two Tulsa Technologies fast fill dual fill stations
- 32 Tulsa Technologies slow fill stations

2.2: Task 3: Equipment Installation and Operations

The goal of this task was to receive and install the new equipment procured in Task 2. Once installation of CNG was complete, a startup and commission phase was conducted to test the functionality of the CNG fueling station in place.

2.2.1: Site Preparation

The goal of this task was to prepare the site for the new CNG fueling station. The approach for this task was to plan preparation of the site while bus activity was low. The time frame was 240 days and from start to finish and the site was completed on time. The district operated the bus fleet at the old transportation yard located at 675 W. Manning Ave. during construction. No down occurred as this was an offsite build.

2.2.2: Equipment Installation

The goal of this task was to install the new CNG fueling station at the new location at the CVTC.

The new CNG fueling station installed 30 single hose and one dual hose time-fill poles. The time-fill fueling poles are used to fuel the buses typically when not in use over a five to 14-hour period. The fueling dispensers automatically shut off when the buses are full. For safety precautions, operators can also manually stop the dispensers with manual shutoff valves installed at the dispensers. Portable fire extinguishers are also located near the dispensers if needed in case of emergency.

Bollards were also installed around the new fueling poles to provide protection.

2.2.3: Commissioning and Operations

The goal of this task was to commission the new fueling station.

After the final inspection of the new station, Transportation staff communicated with Revolution CNG in regards to the pre-test of fast fill and time fill stations. Table 2 reflects the data from CNG time-fill and fast-fill pressure test results.

Table 2: CNG Time-fill & Fast-fill Pressure Test Results

CVTC Time Fill Pressure Test Results	**-**	**-**	**-**
Date	Average Pressure	Average Temp C	Interval, Second
10/7/2016	5542	23	60
CVTC Fast Fill Pressure Test Results	**-**	**-**	**-**
Date	Average Pressure	Average Temp C	Interval, Second
10/8/2016	5719	25	60

Source: KCUSD

2.3: Task 4: Data Collection and Analysis

The goal of this task was to collect operational data form the project, and to analyze that data for economic and environmental impacts.

2.3.1: Number of Vehicles Fueled

The District has a total of 37 CNG buses which slow-fill overnight and fast-fill during the day. In addition to KCUSD vehicles, Reedley city transit buses has five CNG vehicles. Furthermore, Immanuel Schools (private) have four buses; AT&T vans can fuel 10 vehicles; Orange Cove Transit fuels four transit buses; Fresno Rural Transit fuels 12 buses; and Dinuba Unified occasionally fuels their 18 buses.

2.3.2: Maximum Capacity of the New Fueling System

The new station has a capacity of 33,000 pounds per square inch (PSI) CNG storage. The Bauer C23 X-Series model C26.12 has the capability to handle a total capacity of 350 cfm each, nearly doubling our output from the old location from 14,500 to 33,000 PSI. Table 3 shows test results from the Bauer C23 X-Series model C26.12. We are producing more cfm utilizing two (2) 150 horsepower compressors.

- Number of vehicles fueled per day per station:
    - About 35 vehicles
- Comparison of public vs. fleet transactions per day:
    - Public five percent vs. fleet 95 percent
- Number of days or hours per year that each station was inoperative:
    - No days in last six months
- Maximum capacity of the new fueling system:

- 120 inlet pressure of gas line to system
- Two Bauer X-Fill C26.12 units producing 350 cfm each
- 33,000 PSI (six storage vessels) doubling our storage capacity from our old
- Xebec STR20NGX SINGLE-VESSEL SUCTION-DESICCANT DRYER

Table 3: Bauer C23 X-Series Model C26.12 Test Results

Model	Inlet Pressure				Final Pressure		Capacity						Number of Stages	Running Speed	Motor	
	PSIG		BAR		PSIG	BAR										
	min	max	min	max	max	max	CFM	M³/H	DGE/H	DLE/H	GGE/H	GLE/H		RPM	hp	kW
C26.2	10	15	0.7	1	5000	345	200	340	86	325.5	100	378.5	4	1500	150	110
C26.10	45	65	3.1	4.5	5000	345	360	612	154	583	180	681.4	4	1500	175	132
C26.12	90	145	6.2	10	5000	345	425	722	182	689	213	806.3	4	1500	175	132
C26.13	150	215	10.3	15	5000	345	440	748	189	715.4	220	832.8	4	1500	175	132

Note: All capacities are based on pipeline quality natural gas supplied at the maximum allowable inlet pressure to the compressor and 3600 psig discharge pressure. For all models lower inlet pressure is possible but with reduced capacity and possibly reduced discharge pressure. Motor power is reference to maximum allowable inlet pressure and 4500 psig discharge pressure. Consult BAUER for performance at other conditions.

Source: KCUSD

- Gallons of diesel fuel displaced by using natural gas:
  - 94,026.69 gallons of diesel fuel displaced at approximately 334,800 miles driven.
- Expected air emissions reduction:
  - Non-methane hydrocarbons—Reduction of 55 percent
  - Oxides of nitrogen
  - Non-methane hydrocarbons plus oxides of nitrogen
  - Particulate Matter
  - Formaldehyde
- Duty cycle of the current fleet and the expected duty cycle of future vehicle acquisitions:
  - 10 more CNG buses and electric/hybrid vehicles are estimated for purchase over the next two years.
- Specific jobs and economic development resulting from this project:
  - None at this time.
- Identify any current and planned use of renewable energy at the facility:
  - Continued use of CNG
  - EV infrastructure
    - Clipper Creek Chargers—Level 2
    - Aerovironment Level 2 Chargers—2 stations
    - Nissan Charger Level 3—1 station
- Identify the source of the alternative fuel:

    - Natural gas
- Describe any energy efficiency measures used in the facility that may exceed Title 24 standards in Part 6 of the California Code Regulations
    - None at this time.
- Provide data on potential job creation, economic development, and increased state revenue as a result of expected future expansion:
    - Deduction in diesel use and reduced fuel costs
    - The District has finished its mechanics expansion housing all the bus and white fleet mechanics in one large shop where they were separated prior providing better efficiency. District mechanics service 74 buses and 100 vehicle/trailers/golf carts.
    - District has plans to build additional buildings such as training classrooms that the city and district can use for trainings. No green jobs at this time. Possibly in the future.
- Provide a quantified estimate of the project's carbon intensity values for life-cycle greenhouse gas emissions:
    - Fossil-based North American Natural Gas to California CNG with 97 percent

Table 4 shows the Gas Company's current cost of fossil natural gas as of August 7, 2017.

    compression efficiency, CNGF205, 79.46 gallons CO_2 equivalent per megajoule.
    - Displacement of Ultra-Low-Sulfur Diesel, ULSD001, 102.01 gallons CO_2 equivalent per megajoule.
    - 22 percent reduction in carbon intensity by using CNG over diesel.
- The CVTC did not encounter a lot of rain. Harris Construction was ahead of schedule. All parts and machinery came in on a timely manner to finish this project on schedule.

Table 4: CNG usage from October 2016 to October 2017

Period	Season	Therms Used	Dollar/Therm	Amount
Sep-16	Summer	0	0	$0.00
Oct-16	Summer	2,666	$0.613	$1,634.85
Nov-16	Summer	11,396	$0.568	$6,475.10
Dec-16	Winter	8,376	$0.603	$5,048.11
Jan-17	Winter	12,927	$0.174	$2,242.92
Feb-17	Winter	14,877	$0.168	$2,506.09
Mar-17	Winter	19,248	$0.168	$3,229.14
Apr-17	Summer	12,707	$0.168	$2,136.33
May-17	Summer	17,794	$0.169	$3,007.20
Jun-17	Summer	11,004	$0.169	$1,858.04
Jul-17	Summer	6,000	$0.169	$1,016.02
Aug-17	Summer	11,868	$0.168	$1,998.51
Sept-17	Summer	16,937	$0.167	$2,832.84
Oct-17	Summer	19,736	$0.168	$3,315.00
Total		165,536		$37,300.15

Source KCUSD

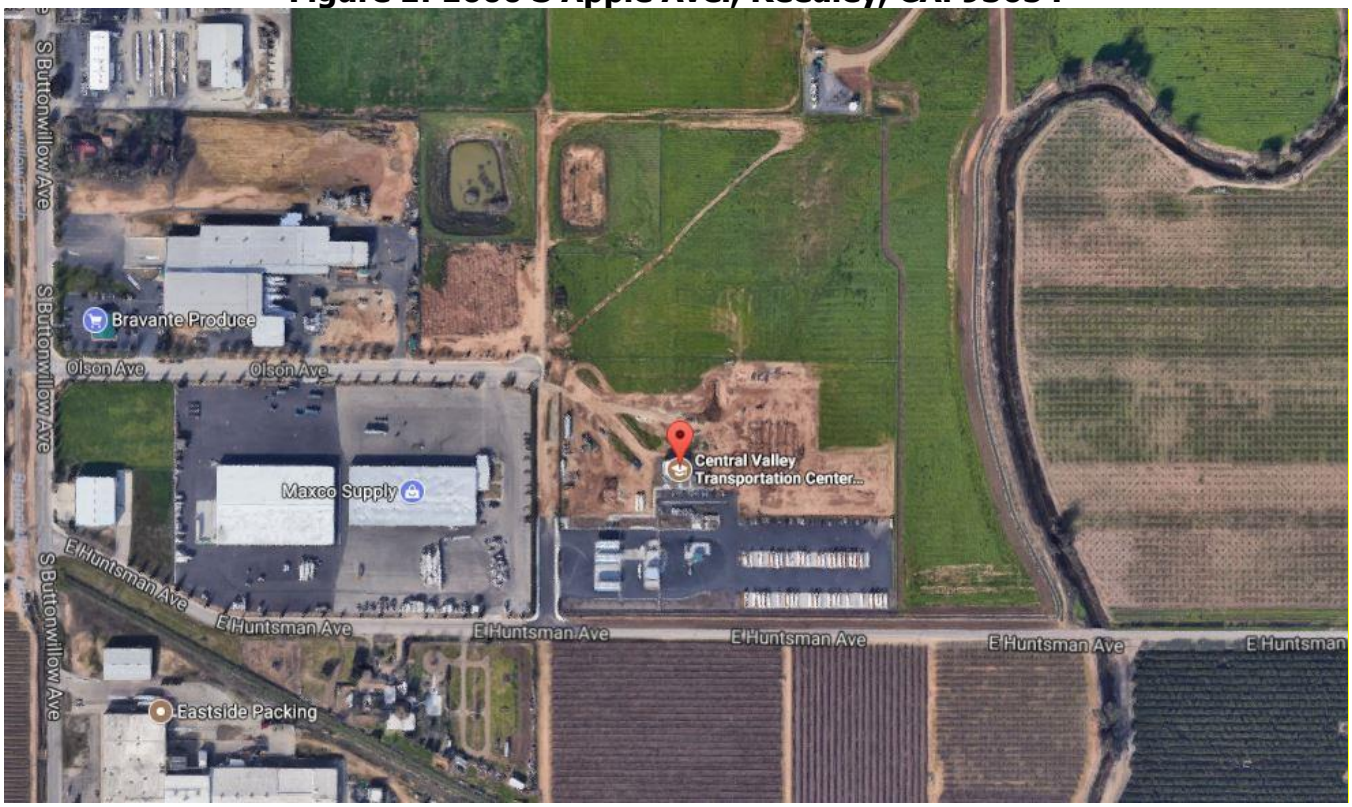
Gasoline Gallon Equivalent: 137,725
Diesel Gallon Equivalent: 120,785
Total Cost of CNG: $51,524.37

Diesel gallons used: 124,857 gallons at a cost of $2.07 per diesel gallon
Total Cost of Diesel: $258,453.67 for 31 diesel buses.
Cost Savings for using CNG: $206,929.30

2.4: Site Location

Figures 1 through Figure 12 show project progress on the Reedley CNG station from start to finish.

Figure 1: 1600 S Apple Ave., Reedley, CA. 93654



Source: KCUSD

Figure 2: Proposed Location for the CNG Compressors

Source: KCUSD

Figure 3: Proposed Location for the CNG Compressors, After Piping Installation

Source: KCUSD

Figure 4: Aerial view of Construction Phase of the CVTC

Source: KCUSD

Figure 5: Slow-fill CNG Refueling Infrastructure

Source: KCUSD

Figure 6: Parking Area for Slow-filled CNG Station

Source: KCUSD

Figure 7: Proposed Location for Electrical Vehicle Charging Stations

Source: KCUSD

Figure 8: Nissan Charger DC Fast Charger - One Station

Source: KCUSD

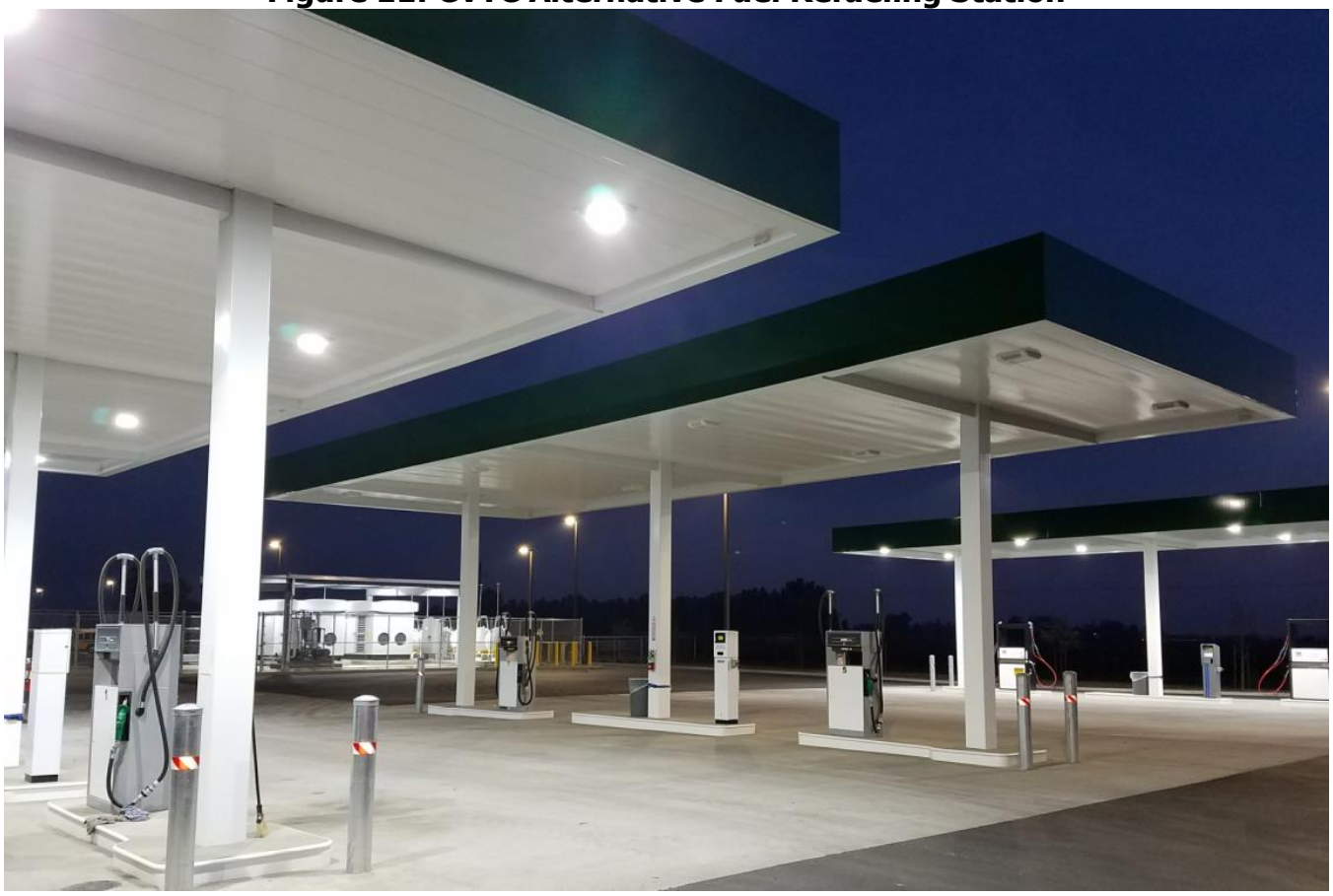
Figure 9: Aerovironment Level 2 Chargers – Two Stations

Source: KCUSD

Figure 10: Clipper Creek Chargers - Level 2

Source: KCUSD

Figure 11: CVTC Alternative Fuel Refueling Station



Source: KCUSD

Figure 12: CNG Compressors and Storage Tanks

Source: KCUSD

2.5: Fuel Throughput

There are 37 KCUSD school buses currently utilizing the CVTC CNG station. The station has been operational since October 2016. Annual fuel usage from October 1, 2016, to October 1, 2017, was approximately 165,536 CNG Therms, or 120,785 diesel gallon equivalents (DGE). As shown in Table 5, average monthly throughput is approximately 13,794 CNG Therms, or 10,065 DGE.

Table 5: Monthly and Annual Fuel Use Throughput

	CNG Therms	DGE
Monthly Average	13,794	10,065
Annual Average	165,536	120,785

Source: KCUSD

CHAPTER 3:
Conclusions

KCUSD has been aggressive in working to reduce air pollution in the central valley by replacing diesel powered buses with buses and support vehicles that are powered by engines that produce less pollution. This Energy Commission funding will make it possible to continue providing CNG for the District's transportation fleet and the various community organizations that utilize the fueling station.

By reviewing the districts problem statement, the district has addressed previous statements of building a new natural gas fueling infrastructure. This in turn encourages the expansion of CNG use by making the facility more accessible, thereby reducing emissions by replacing diesel buses with CNG buses and increasing local knowledge of availability of facility to public.

KCUSD has also increased its CNG bus fleet. The current fleet now stands at 37 CNG buses in use. In the last two years, the District has decommissioned 10 gross polluting diesel buses. Emission reductions of the 10 gross polluting diesel buses equate to about 192,000 diesel miles that the district has converted to CNG. On average, the district CNG fleet of 37 buses travels 481,000 miles per year. With diesel buses running at about seven miles to the gallon, KCUSD estimates avoiding 68,700 gallons of diesel fuel consumption due to the 37 bus fleet. The district has plans to purchase more buses this 2017-2018 school year and now with the added facility and capacity of the CVTC, the district can consider additional CNG fueled buses for further expansion. The district could not previously consider this option as slow fill lines were at capacity.

Also, with new technologies, rapid communication in the event of various issues or power outages is possible. This allows for rapid notification when problems arise; aids the district in the prompt handling of issues as they arise; and prevents the likelihood of employees arriving at the yard to find that no buses filled overnight.

As of October 2018, KCUSD is out to bid for two more CNG buses, which will increase the CNG bus fleet to 39 total. The district will save an additional 26,000 diesel miles approximately, while avoiding around 3,700 gallons of diesel fuel as the number of field trips increases 20 percent over the 2017-2018 school year.

Alternate fuel bus fleet will be increased to 58 percent (four electric, 39 CNG buses out of the 74 total bus fleet).

GLOSSARY

CARBON DIOXIDE (CO_2) - 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).

CENTRAL VALLEY TRANSPORTATION CENTER (CVTC) - A bus/transit yard for joint Kings Canyon Unified School District and Reedley use that will include solar covered parking, fueling station, vehicle wash facility, service bays, learning center, regeneration center, shops, and an office.

COMPRESSED NATURAL GAS (CNG) - natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

DIESEL GALLON-EQUIVALENT (DGE) - is the amount of alternative fuel it takes to equal the energy content of one liquid gallon of diesel gasoline.

GREENHOUSE GASES (GHG) – Any gas that absorbs infra-red radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

KINGS CANYON UNIFIED SCHOOL DISTRICT (KCUSD) - a preschool through 12th grade public school system located in the San Joaquin valley that serves students from a 600 square-mile area.

LOW CARBON FUEL STANDARD (LCFS) – A rule enacted to reduce carbon intensity in transportation fuels as compared to conventional petroleum fuels, such as gasoline and diesel.

NOx - Oxides of nitrogen that are a chief component of air pollution that can be produced by the burning of fossil fuels. Also called nitrogen oxides.

PARTICULATE MATTER (PM) - Unburned fuel particles that form smoke or soot and stick to lung tissue when inhaled. A chief component of exhaust emissions from heavy-duty diesel engines.

POUNDS PER SQUARE INCH (PSI) - a unit of pressure or of stress based on avoirdupois units. It is the pressure resulting from a force of one pound-force applied to an area of one square inch.

PROGRAMABLE LOGIC COMPUTER (PLC) - an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA) - an independent agency of the United States federal government for environmental protection.

APPENDIX A:
CNG Fueling Instructure Startup Test Data

CVTC Fast Fill Pressure Test Results

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 8:37	5656	PSI	14.7	60
10/8/2016 8:38	5656	PSI	14.7	60
10/8/2016 8:39	5658	PSI	14.9	60
10/8/2016 8:40	5659	PSI	15.1	60
10/8/2016 8:41	5660	PSI	15.2	60
10/8/2016 8:42	5661	PSI	15.4	60
10/8/2016 8:43	5661	PSI	15.5	60
10/8/2016 8:44	5662	PSI	15.6	60
10/8/2016 8:45	5662	PSI	15.8	60
10/8/2016 8:46	5662	PSI	15.8	60
10/8/2016 8:47	5662	PSI	15.9	60
10/8/2016 8:48	5662	PSI	16.1	60
10/8/2016 8:49	5662	PSI	16.1	60
10/8/2016 8:50	5662	PSI	16.1	60
10/8/2016 8:51	5663	PSI	16.2	60
10/8/2016 8:52	5663	PSI	16.3	60
10/8/2016 8:53	5664	PSI	16.3	60
10/8/2016 8:54	5665	PSI	16.4	60
10/8/2016 8:55	5666	PSI	16.5	60
10/8/2016 8:56	5667	PSI	16.7	60
10/8/2016 8:57	5669	PSI	16.8	60
10/8/2016 8:58	5670	PSI	16.9	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 8:59	5671	PSI	17.1	60
10/8/2016 9:00	5673	PSI	17.2	60
10/8/2016 9:01	5675	PSI	17.4	60
10/8/2016 9:02	5676	PSI	17.6	60
10/8/2016 9:03	5678	PSI	17.8	60
10/8/2016 9:04	5680	PSI	17.9	60
10/8/2016 9:05	5681	PSI	18.1	60
10/8/2016 9:06	5683	PSI	18.3	60
10/8/2016 9:07	5684	PSI	18.6	60
10/8/2016 9:08	5686	PSI	18.7	60
10/8/2016 9:09	5687	PSI	18.9	60
10/8/2016 9:10	5689	PSI	19.1	60
10/8/2016 9:11	5690	PSI	19.3	60
10/8/2016 9:12	5691	PSI	19.6	60
10/8/2016 9:13	5692	PSI	19.7	60
10/8/2016 9:14	5692	PSI	19.9	60
10/8/2016 9:15	5693	PSI	20.1	60
10/8/2016 9:16	5695	PSI	20.3	60
10/8/2016 9:17	5695	PSI	20.4	60
10/8/2016 9:18	5696	PSI	20.6	60
10/8/2016 9:19	5697	PSI	20.8	60
10/8/2016 9:20	5698	PSI	20.9	60
10/8/2016 9:21	5700	PSI	21.1	60
10/8/2016 9:22	5701	PSI	21.3	60
10/8/2016 9:23	5702	PSI	21.5	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 9:24	5703	PSI	21.7	60
10/8/2016 9:25	5704	PSI	21.8	60
10/8/2016 9:26	5705	PSI	21.9	60
10/8/2016 9:27	5705	PSI	22.1	60
10/8/2016 9:28	5706	PSI	22.3	60
10/8/2016 9:29	5705	PSI	22.4	60
10/8/2016 9:30	5706	PSI	22.6	60
10/8/2016 9:31	5706	PSI	22.7	60
10/8/2016 9:32	5707	PSI	22.8	60
10/8/2016 9:33	5708	PSI	22.9	60
10/8/2016 9:34	5708	PSI	23	60
10/8/2016 9:35	5709	PSI	23.2	60
10/8/2016 9:36	5709	PSI	23.3	60
10/8/2016 9:37	5710	PSI	23.4	60
10/8/2016 9:38	5711	PSI	23.5	60
10/8/2016 9:39	5712	PSI	23.7	60
10/8/2016 9:40	5713	PSI	23.8	60
10/8/2016 9:41	5714	PSI	23.9	60
10/8/2016 9:42	5715	PSI	24.1	60
10/8/2016 9:43	5715	PSI	24.2	60
10/8/2016 9:44	5716	PSI	24.4	60
10/8/2016 9:45	5717	PSI	24.5	60
10/8/2016 9:46	5718	PSI	24.6	60
10/8/2016 9:47	5718	PSI	24.8	60
10/8/2016 9:48	5719	PSI	24.9	60
10/8/2016 9:49	5720	PSI	25	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 9:50	5720	PSI	25.1	60
10/8/2016 9:51	5721	PSI	25.2	60
10/8/2016 9:52	5721	PSI	25.4	60
10/8/2016 9:53	5722	PSI	25.4	60
10/8/2016 9:54	5722	PSI	25.5	60
10/8/2016 9:55	5722	PSI	25.6	60
10/8/2016 9:56	5724	PSI	25.8	60
10/8/2016 9:57	5725	PSI	25.8	60
10/8/2016 9:58	5726	PSI	25.9	60
10/8/2016 9:59	5727	PSI	26	60
10/8/2016 10:00	5728	PSI	26.1	60
10/8/2016 10:01	5729	PSI	26.3	60
10/8/2016 10:02	5729	PSI	26.3	60
10/8/2016 10:03	5731	PSI	26.4	60
10/8/2016 10:04	5731	PSI	26.5	60
10/8/2016 10:05	5732	PSI	26.6	60
10/8/2016 10:06	5731	PSI	26.7	60
10/8/2016 10:07	5732	PSI	26.8	60
10/8/2016 10:08	5732	PSI	26.8	60
10/8/2016 10:09	5733	PSI	26.9	60
10/8/2016 10:10	5734	PSI	26.9	60
10/8/2016 10:11	5736	PSI	27.1	60
10/8/2016 10:12	5738	PSI	27.2	60
10/8/2016 10:13	5738	PSI	27.3	60
10/8/2016 10:14	5740	PSI	27.3	60
10/8/2016 10:15	5741	PSI	27.5	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 10:16	5742	PSI	27.6	60
10/8/2016 10:17	5743	PSI	27.8	60
10/8/2016 10:18	5743	PSI	27.9	60
10/8/2016 10:19	5743	PSI	28	60
10/8/2016 10:20	5744	PSI	28.1	60
10/8/2016 10:21	5743	PSI	28.2	60
10/8/2016 10:22	5742	PSI	28.3	60
10/8/2016 10:23	5741	PSI	28.3	60
10/8/2016 10:24	5740	PSI	28.3	60
10/8/2016 10:25	5740	PSI	28.3	60
10/8/2016 10:26	5740	PSI	28.3	60
10/8/2016 10:27	5741	PSI	28.4	60
10/8/2016 10:28	5742	PSI	28.4	60
10/8/2016 10:29	5742	PSI	28.5	60
10/8/2016 10:30	5744	PSI	28.6	60
10/8/2016 10:31	5745	PSI	28.7	60
10/8/2016 10:32	5746	PSI	28.8	60
10/8/2016 10:33	5747	PSI	28.9	60
10/8/2016 10:34	5748	PSI	29	60
10/8/2016 10:35	5748	PSI	29.1	60
10/8/2016 10:36	5749	PSI	29.1	60
10/8/2016 10:37	5750	PSI	29.2	60
10/8/2016 10:38	5751	PSI	29.3	60
10/8/2016 10:39	5752	PSI	29.4	60
10/8/2016 10:40	5753	PSI	29.4	60
10/8/2016 10:41	5755	PSI	29.6	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 10:42	5756	PSI	29.7	60
10/8/2016 10:43	5757	PSI	29.8	60
10/8/2016 10:44	5757	PSI	29.9	60
10/8/2016 10:45	5757	PSI	30	60
10/8/2016 10:46	5758	PSI	30.1	60
10/8/2016 10:47	5758	PSI	30.1	60
10/8/2016 10:48	5758	PSI	30.2	60
10/8/2016 10:49	5758	PSI	30.3	60
10/8/2016 10:50	5759	PSI	30.3	60
10/8/2016 10:51	5760	PSI	30.4	60
10/8/2016 10:52	5760	PSI	30.4	60
10/8/2016 10:53	5761	PSI	30.4	60
10/8/2016 10:54	5762	PSI	30.6	60
10/8/2016 10:55	5763	PSI	30.6	60
10/8/2016 10:56	5763	PSI	30.8	60
10/8/2016 10:57	5763	PSI	30.9	60
10/8/2016 10:58	5764	PSI	30.9	60
10/8/2016 10:59	5764	PSI	31	60
10/8/2016 11:00	5764	PSI	31.1	60
10/8/2016 11:01	5764	PSI	31.1	60
10/8/2016 11:02	5763	PSI	31.2	60
10/8/2016 11:03	5762	PSI	31.3	60
10/8/2016 11:04	5762	PSI	31.3	60
10/8/2016 11:05	5761	PSI	31.3	60
10/8/2016 11:06	5761	PSI	31.3	60
10/8/2016 11:07	5762	PSI	31.3	60

Date	Pressure	Units	Temp C	Interval (sec)
10/8/2016 11:08	5762	PSI	31.3	60
10/8/2016 11:09	5762	PSI	31.3	60
10/8/2016 11:10	5762	PSI	31.3	60
10/8/2016 11:11	5763	PSI	31.4	60
10/8/2016 11:12	5762	PSI	31.4	60
10/8/2016 11:13	5762	PSI	31.4	60

CVTC Time Fill Pressure Test Results

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 8:35	5511	PSI	15.3	60
10/7/2016 8:36	5511	PSI	15.3	60
10/7/2016 8:37	5511	PSI	15.4	60
10/7/2016 8:38	5512	PSI	15.5	60
10/7/2016 8:39	5512	PSI	15.6	60
10/7/2016 8:40	5513	PSI	15.7	60
10/7/2016 8:41	5513	PSI	15.9	60
10/7/2016 8:42	5513	PSI	16	60
10/7/2016 8:43	5514	PSI	16	60
10/7/2016 8:44	5514	PSI	16.1	60
10/7/2016 8:45	5515	PSI	16.2	60
10/7/2016 8:46	5515	PSI	16.3	60
10/7/2016 8:47	5515	PSI	16.4	60
10/7/2016 8:48	5515	PSI	16.4	60
10/7/2016 8:49	5516	PSI	16.5	60
10/7/2016 8:50	5516	PSI	16.6	60
10/7/2016 8:51	5517	PSI	16.6	60
10/7/2016 8:52	5517	PSI	16.8	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 8:53	5517	PSI	16.9	60
10/7/2016 8:54	5518	PSI	16.9	60
10/7/2016 8:55	5519	PSI	17.1	60
10/7/2016 8:56	5519	PSI	17.3	60
10/7/2016 8:57	5520	PSI	17.4	60
10/7/2016 8:58	5520	PSI	17.4	60
10/7/2016 8:59	5520	PSI	17.5	60
10/7/2016 9:00	5521	PSI	17.6	60
10/7/2016 9:01	5521	PSI	17.7	60
10/7/2016 9:02	5522	PSI	17.9	60
10/7/2016 9:03	5522	PSI	17.9	60
10/7/2016 9:04	5522	PSI	18.1	60
10/7/2016 9:05	5523	PSI	18.3	60
10/7/2016 9:06	5523	PSI	18.3	60
10/7/2016 9:07	5523	PSI	18.4	60
10/7/2016 9:08	5524	PSI	18.5	60
10/7/2016 9:09	5524	PSI	18.6	60
10/7/2016 9:10	5524	PSI	18.7	60
10/7/2016 9:11	5525	PSI	18.8	60
10/7/2016 9:12	5525	PSI	18.9	60
10/7/2016 9:13	5525	PSI	18.9	60
10/7/2016 9:14	5526	PSI	19	60
10/7/2016 9:15	5526	PSI	19.1	60
10/7/2016 9:16	5526	PSI	19.2	60
10/7/2016 9:17	5527	PSI	19.3	60
10/7/2016 9:18	5527	PSI	19.4	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 9:19	5527	PSI	19.4	60
10/7/2016 9:20	5527	PSI	19.4	60
10/7/2016 9:21	5527	PSI	19.5	60
10/7/2016 9:22	5528	PSI	19.5	60
10/7/2016 9:23	5528	PSI	19.6	60
10/7/2016 9:24	5528	PSI	19.8	60
10/7/2016 9:25	5529	PSI	19.8	60
10/7/2016 9:26	5529	PSI	19.9	60
10/7/2016 9:27	5530	PSI	20	60
10/7/2016 9:28	5531	PSI	20.1	60
10/7/2016 9:29	5531	PSI	20.3	60
10/7/2016 9:30	5532	PSI	20.4	60
10/7/2016 9:31	5532	PSI	20.5	60
10/7/2016 9:32	5533	PSI	20.7	60
10/7/2016 9:33	5533	PSI	20.7	60
10/7/2016 9:34	5534	PSI	20.9	60
10/7/2016 9:35	5535	PSI	21.1	60
10/7/2016 9:36	5536	PSI	21.1	60
10/7/2016 9:37	5537	PSI	21.3	60
10/7/2016 9:38	5537	PSI	21.4	60
10/7/2016 9:39	5538	PSI	21.6	60
10/7/2016 9:40	5538	PSI	21.6	60
10/7/2016 9:41	5538	PSI	21.8	60
10/7/2016 9:42	5539	PSI	21.9	60
10/7/2016 9:43	5539	PSI	21.9	60
10/7/2016 9:44	5539	PSI	22	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 9:45	5539	PSI	22.1	60
10/7/2016 9:46	5539	PSI	22.1	60
10/7/2016 9:47	5540	PSI	22.1	60
10/7/2016 9:48	5540	PSI	22.2	60
10/7/2016 9:49	5540	PSI	22.3	60
10/7/2016 9:50	5540	PSI	22.3	60
10/7/2016 9:51	5540	PSI	22.3	60
10/7/2016 9:52	5539	PSI	22.3	60
10/7/2016 9:53	5539	PSI	22.3	60
10/7/2016 9:54	5539	PSI	22.3	60
10/7/2016 9:55	5539	PSI	22.3	60
10/7/2016 9:56	5539	PSI	22.3	60
10/7/2016 9:57	5539	PSI	22.3	60
10/7/2016 9:58	5539	PSI	22.4	60
10/7/2016 9:59	5539	PSI	22.4	60
10/7/2016 10:00	5539	PSI	22.4	60
10/7/2016 10:01	5539	PSI	22.4	60
10/7/2016 10:02	5539	PSI	22.4	60
10/7/2016 10:03	5539	PSI	22.4	60
10/7/2016 10:04	5539	PSI	22.5	60
10/7/2016 10:05	5540	PSI	22.5	60
10/7/2016 10:06	5540	PSI	22.6	60
10/7/2016 10:07	5541	PSI	22.7	60
10/7/2016 10:08	5541	PSI	22.7	60
10/7/2016 10:09	5542	PSI	22.9	60
10/7/2016 10:10	5543	PSI	22.9	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 10:11	5543	PSI	23.1	60
10/7/2016 10:12	5544	PSI	23.1	60
10/7/2016 10:13	5545	PSI	23.3	60
10/7/2016 10:14	5546	PSI	23.4	60
10/7/2016 10:15	5546	PSI	23.5	60
10/7/2016 10:16	5546	PSI	23.5	60
10/7/2016 10:17	5546	PSI	23.6	60
10/7/2016 10:18	5547	PSI	23.6	60
10/7/2016 10:19	5547	PSI	23.6	60
10/7/2016 10:20	5547	PSI	23.7	60
10/7/2016 10:21	5547	PSI	23.7	60
10/7/2016 10:22	5547	PSI	23.8	60
10/7/2016 10:23	5548	PSI	23.8	60
10/7/2016 10:24	5548	PSI	23.8	60
10/7/2016 10:25	5548	PSI	23.8	60
10/7/2016 10:26	5548	PSI	23.9	60
10/7/2016 10:27	5548	PSI	23.9	60
10/7/2016 10:28	5548	PSI	24	60
10/7/2016 10:29	5549	PSI	24.1	60
10/7/2016 10:30	5549	PSI	24.2	60
10/7/2016 10:31	5549	PSI	24.3	60
10/7/2016 10:32	5550	PSI	24.3	60
10/7/2016 10:33	5551	PSI	24.4	60
10/7/2016 10:34	5552	PSI	24.6	60
10/7/2016 10:35	5553	PSI	24.7	60
10/7/2016 10:36	5553	PSI	24.9	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 10:37	5554	PSI	25	60
10/7/2016 10:38	5555	PSI	25.1	60
10/7/2016 10:39	5555	PSI	25.3	60
10/7/2016 10:40	5556	PSI	25.4	60
10/7/2016 10:41	5556	PSI	25.4	60
10/7/2016 10:42	5556	PSI	25.6	60
10/7/2016 10:43	5556	PSI	25.6	60
10/7/2016 10:44	5557	PSI	25.8	60
10/7/2016 10:45	5557	PSI	25.8	60
10/7/2016 10:46	5557	PSI	25.9	60
10/7/2016 10:47	5558	PSI	26	60
10/7/2016 10:48	5558	PSI	26.1	60
10/7/2016 10:49	5558	PSI	26.2	60
10/7/2016 10:50	5558	PSI	26.2	60
10/7/2016 10:51	5559	PSI	26.3	60
10/7/2016 10:52	5559	PSI	26.4	60
10/7/2016 10:53	5560	PSI	26.5	60
10/7/2016 10:54	5561	PSI	26.6	60
10/7/2016 10:55	5561	PSI	26.6	60
10/7/2016 10:56	5562	PSI	26.7	60
10/7/2016 10:57	5563	PSI	26.7	60
10/7/2016 10:58	5563	PSI	26.8	60
10/7/2016 10:59	5563	PSI	26.9	60
10/7/2016 11:00	5563	PSI	26.9	60
10/7/2016 11:01	5563	PSI	27	60
10/7/2016 11:02	5564	PSI	27	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 11:03	5565	PSI	27.1	60
10/7/2016 11:04	5566	PSI	27.3	60
10/7/2016 11:05	5566	PSI	27.3	60
10/7/2016 11:06	5567	PSI	27.4	60
10/7/2016 11:07	5568	PSI	27.5	60
10/7/2016 11:08	5568	PSI	27.6	60
10/7/2016 11:09	5569	PSI	27.6	60
10/7/2016 11:10	5569	PSI	27.7	60
10/7/2016 11:11	5569	PSI	27.8	60
10/7/2016 11:12	5569	PSI	27.8	60
10/7/2016 11:13	5569	PSI	27.9	60
10/7/2016 11:14	5569	PSI	27.8	60
10/7/2016 11:15	5570	PSI	27.9	60
10/7/2016 11:16	5570	PSI	27.9	60
10/7/2016 11:17	5570	PSI	27.9	60
10/7/2016 11:18	5571	PSI	27.9	60
10/7/2016 11:19	5571	PSI	28.1	60
10/7/2016 11:20	5571	PSI	28.1	60
10/7/2016 11:21	5571	PSI	28.1	60
10/7/2016 11:22	5572	PSI	28.1	60
10/7/2016 11:23	5572	PSI	28.1	60
10/7/2016 11:24	5572	PSI	28.1	60
10/7/2016 11:25	5572	PSI	28.1	60
10/7/2016 11:26	5572	PSI	28.1	60
10/7/2016 11:27	5572	PSI	28.1	60
10/7/2016 11:28	5573	PSI	28.3	60

Date	Pressure	Units	Temp C	Interval (sec.)
10/7/2016 11:29	5573	PSI	28.2	60
10/7/2016 11:30	5574	PSI	28.3	60
10/7/2016 11:31	5574	PSI	28.4	60
10/7/2016 11:32	5534	PSI	28.4	60
10/7/2016 11:33	5534	PSI	28.4	60
10/7/2016 11:34	5535	PSI	28.4	60
10/7/2016 11:35	5535	PSI	28.4	60
10/7/2016 11:36	5535	PSI	28.4	60
10/7/2016 11:37	5536	PSI	28.5	60
10/7/2016 11:38	5537	PSI	28.6	60
10/7/2016 11:39	5538	PSI	28.7	60
10/7/2016 11:40	5538	PSI	28.8	60
10/7/2016 11:41	5539	PSI	28.8	60
10/7/2016 11:42	5540	PSI	28.9	60
10/7/2016 11:43	5540	PSI	29	60
10/7/2016 11:44	5541	PSI	29.1	60
10/7/2016 11:45	5542	PSI	29.2	60
10/7/2016 11:46	5542	PSI	29.3	60
10/7/2016 11:47	5542	PSI	29.4	60
10/7/2016 11:48	5543	PSI	29.4	60