



**CALIFORNIA
ENERGY COMMISSION**



California Energy Commission
Clean Transportation Program

FINAL PROJECT REPORT

Kern Portable Compressed Natural Gas Refueling Program

Prepared for: California Energy Commission

Prepared by: Kern County Superintendent of Schools

**Gavin Newsom, Governor
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California Energy Commission

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, also known as the Alternative and Renewable Fuel and Vehicle Technology 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 non-road 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 *Investment Plan Update for the Clean Transportation Program*. The CEC issued solicitation PON-14-608 to provide funding opportunities under the Clean Transportation Program for projects to support 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 Energy Commission's Notice of Proposed Awards dated August 12, 2015, and the agreement was executed as ARV-15-019 on January 20, 2016.

ABSTRACT

The California Energy Commission's Clean Transportation Program awarded the Kern County Superintendent of Schools \$500,000 for the construction and equipment that were required to implement the Kern Portable CNG Refueling Program.

This final project report documents the planning, budget, specifications, and initial throughput for the alternative fueling method. The appendix provides photographs of construction of the high volume dispenser, the installed equipment, and the fueling trailer.

Keywords: California Energy Commission, Clean Transportation Program, Kern County Superintendent of Schools, KCSoS, Kern Portable CNG Refueling Program, natural gas fueling station, compressed natural gas

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EXECUTIVE SUMMARY

The Kern County Superintendent of Schools, in an effort to support California air quality and climate change goals, has committed to support the compressed natural gas fueling of school buses and other vehicles since 2005 with the original construction of its compressed natural gas fueling station and the subsequent replacement and expansion of this facility starting in 2014.

The California Energy Commission awarded a \$500,000 Clean Transportation Program grant to the Kern County Superintendent of Schools to construct and install the infrastructure and equipment needed to demonstrate the Kern Portable Compressed Natural Gas Refueling Program.

The new infrastructure included the construction and installation of a high-volume compressed natural gas dispenser. This piece of equipment fills the larger tank size that are on the tube trailers. In addition, funding supported the purchase of one portable refueling trailer. The intent of this demonstration project is to learn and develop best practices from this project.

Furthermore, the infrastructure will be available during business hours to other entities, both public and private, needing to obtain larger quantities of compressed natural gas for their large and small tube-type trailers. The Kern Portable Compressed Natural Gas Refueling Program will provide a new level of clean fueling infrastructure in California's Central Valley and will sustain and help promote the growth of alternative fuels.

Funding from this project has created greater access to cleaner burning fuels, which will help reduce Kern County Superintendent of Schools' carbon dioxide output by about 9,000 pounds. By leveraging local funds to expand infrastructure, this demonstration project was an effective approach that will provide greater access to affordable compressed natural gas fueling.

CHAPTER 1:

Problem Statement

Kern County, California, is about 8,163 square miles with a population of nearly 900,000 scattered around its 51 incorporated cities, towns, and communities, the largest city of which is Bakersfield, California.¹ The county is at the southernmost point of the California's Central Valley. It is cradled between the Coastal Range in the west and the Sierra Nevada Mountains in the east and is nestled at the foot of California's Transverse Ranges. This unique bowl-shaped geography, coupled with northerly prevailing winds that collect air pollutants from regions north and blow them south, has caused Kern County and Bakersfield to have some of the worst air quality in the United States.²

The Kern County Superintendent of Schools (KCSoS) is based in Bakersfield, California, and it serves and supports the 25 individual school districts within Kern County.³ In an effort to improve air quality, reduce greenhouse gases (GHGs) such as carbon dioxide (CO₂), and reduce costs, many Kern County school districts have considered purchasing compressed natural gas (CNG) school buses. Many districts, though, do not have access to a supply of natural gas and the KCSoS CNG fueling station is located in central Bakersfield. There is a need to provide CNG refueling options to the more rural locations that are located over 100 miles away.

Not all of the districts in Kern County can build fueling stations, though. One of the current barriers to school districts acquiring additional CNG school buses is limited fueling locations and cost, where even a small station can cost over \$3,000,000 to construct. Another barrier is that many rural districts do not have natural gas infrastructure extending to their locations and have instead utilize propane for their buildings. Additionally, when most of the smaller rural districts only use up to three buses, it is not economically or fiscally feasible to build a station and transport CNG; however, the cost of the CNG fueling trailer is around \$165,000 and provides a less expensive means of fueling the rural districts' buses.

1 [QuickFacts about Kern County](https://www.census.gov/quickfacts/kerncountycalifornia) (https://www.census.gov/quickfacts/kerncountycalifornia)

2 [American Lung Association](https://www.lung.org/) (https://www.lung.org/)

3 [Kern County Superintendent of Schools At a Glance](https://kern.org/wp-content/blogs.dir/4/files/sites/4/2018/09/KCSOS_Ataglance2018.pdf) (https://kern.org/wp-content/blogs.dir/4/files/sites/4/2018/09/KCSOS_Ataglance2018.pdf)

CHAPTER 2:

Goal of the Agreement

The goal of this agreement is to increase the availability of CNG fueling to the smaller and more remote school districts in Kern County by using a mobile refueling trailer to transport the CNG to those locations. To accomplish this, KCSoS expanded its existing CNG and electrical infrastructure, installed additional storage tanks and a dispenser at its fueling station, and purchased a trailer that can store and dispense 3,460 standard cubic feet (SCF) of CNG.

KCSoS also secured a commitment from Fruitvale Elementary School District to use the trailer for the demonstration. It is a small district with two CNG buses about six miles west of the KCSoS CNG fueling facility. The ultimate goal is to have those districts without access to CNG infrastructure purchase their own CNG trailers and fuel those trailers at the KCSoS fueling facility at 705 South Union Avenue, Bakersfield, California, 93307.

CHAPTER 3:

Project Planning Team

The KCSoS project planning team consisted of a combination of the KCSoS Facilities Department, Transportation, Maintenance, and Operations staff, and CNG consultants. The following is a list of each of the members, their primary roles, and reasons for selection. The Project Lead was William Black, a Project Engineer with AECOM. Bill has considerable experience in the engineering and design of CNG facilities throughout the United States. The project Construction Manager was George Carson, a KCSoS facilities specialist. George has many years of commercial construction management experience and managed Phase 1 of the KCSoS project. The project manager and liaison between the KCSoS and the CEC was Scott Fieber, manager of KCSoS's Emergency Preparedness and Utility Conservation Unit. Scott has been working with the KCSoS CNG station for seven years, with the ongoing maintenance and analysis of the existing facility, and has been involved in the planning of the new facility since its inception. KCSoS brought on industry expert Leo Thomason, who is the founder and owner of Natural Gas Vehicle Institute (NGVI). Leo has been involved with KCSoS for five years both in the analysis of the existing facility built in 2005 and in all aspects of the planning and design of the new facility. Leo provided training to the KCSoS CNG maintenance staff.

CHAPTER 4:

The New Fueling System

The project went smoothly overall, given its complexity, and had only a few software errors that were fixed after construction and installation was completed. The new ANGI-brand high-volume tube trailer dispenser, which can be towed by a three-quarter ton or larger truck, has a capacity 46,000 SCF, is equipped with a WEH-brand TK26 CNG Fueling Nozzle for buses and trucks, and is capable of delivering 3,600 pounds per square inch of CNG continuously through its one-inch hose. The dispenser with the infrastructure expansion cost \$310,017.00 and the fueling trailer cost around \$168,370 (Table 1).

Table 1: Project Budget

Item	Number	Unit Cost	Total
CNG Refueler Trailer	1	\$ 168,368.93	\$ 168,368.93
Tube Trailer CNG Dispenser	1	\$ 46,787.00	\$ 46,787.00
Storage Vessels	2	\$ 95,550.00	\$ 191,100.00
Equipment Shade Structure	1	\$ 36,410.00	\$ 36,410.00
Concrete Foundation Materials	1	\$ 15,380.00	\$ 15,380.00
Pipe / Tube Supports	1	\$ 10,780.00	\$ 10,780.00
Conduit / Piping / Tubing Materials	1	\$ 9,560.00	\$ 9,560.00
	Total		\$ 478,385.93

Source: Kern County Superintendent of Schools

CHAPTER 5:

Economic Benefits

This project occurred in an economically disadvantaged area. According to the Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0, the project area had score between 91-100 percent and supported up to 20 temporary construction jobs for about six months.

KCSoS currently pays taxes to the California Department of Tax and Fee Administration based on the following Vendor Use Tax formulas: taxable gallons sold was 441,000 diesel gallons equivalent (DGE) times \$1.2667 per gallon times a tax of 8.87 percent, which equals roughly \$49,550. This project resulted in increased taxes based on increased usage. The CNG refueling station also supported local commerce by ensuring access to the private and public sector, in addition to the surrounding school districts.

The KCSoS CNG fueling facility has been self-sustaining for over 12 years. The revenue from its operations covers the ongoing maintenance and operational costs. During the data collection phase, KCSoS had a profit of \$98,000 after factoring in all operational costs of the CNG facility. This profit went back into the KCSoS general fund and eventually into classrooms to support the students in Kern County. Future revenues could bring in up to \$1.7 million over a 10-year period. These funds will sustain the station and will continue to provide additional funds for students.

CHAPTER 6:

Station Usage

The KCSoS CNG fueling station expansion provided additional clean fueling infrastructure in the southern San Joaquin Valley to help promote the growth of alternative fuels. This provided greater access to affordable CNG, which helped reduce GHG emissions.

Including its own fleet of buses, the KCSoS CNG station typically provided an estimated 39,381 vehicle fuel fill-ups per year, varying daily from a low of 70 fill-ups per day to a high of 200 fill-ups. During the data collection period, the KCSoS CNG station operated almost continuously, closing for only a few hours on two separate days for minor repairs. This included the downtime that was associated with the programming and fine-tuning of the new dispenser. Using both time fills and fast fills, the CNG equipment at the KCSoS facility fueled its fleet of 68 CNG school buses and five service vehicles. The CNG station also fueled school bus fleet vehicles from the outlying areas of Kern County, 58 AT&T fleet vehicles, and other privately-owned CNG vehicles and fleets. It was the vehicles driven by the general public, however, that accounted for the largest number of vehicles fueled by the KCSoS CNG station.

Energy Commission funds also supported the purchase of one off-the-shelf portable refueling trailer. The intent of this demonstration project was to learn and identify best practices for deployment and then work with the remote districts on the purchase of additional CNG refueling trailers. This is a beneficial solution because school districts located in remote areas are apprehensive to purchase CNG school buses without convenient refueling options. The purchase of the CNG refueling trailer will allow those school districts to pilot their own refueling programs. During the data collection phase of this project, the trailer distributed around 2,600 pounds (lbs.) of CNG (Table 2, which is equivalent to nearly 430 gallons of diesel equivalent (DGE). With one gallon of diesel producing approximately 22 pounds of CO₂, the amount of CO₂ displaced was about 9,500 pounds (Tables 3 and 4).

Table 2: Trailer Use Log Sheet

Vehicle Number	District	Date	Trailer Fill DGE
Trailer	KCSOS	9/11/2018	310
Trailer	KCSOS	10/1/2018	81
Trailer	KCSOS	12/4/2018	40
Trailer	KCSOS	1/17/2019	159
Trailer	KCSOS	2/06/2019	246
Trailer Subtotals			836
Estimated Amount Left in Trailer			-370
Trailer Total			466

Source: Kern County Superintendent of Schools

Table 3: CNG Refueling Data

Location	FY	Pounds	DGE	Types of Vehicles Served	Number of Vehicles Served	Operational Days/Year
CNG Trailer	9/1/18 - 2/6/19	2,600	430	Fruitvale Buses	2 CNG Buses	365

Source: Kern County Superintendent of Schools CNG Station, Trailer and Vehicle Usage & Mileage Logs

Table 4: Calculation Explanation of CO₂ Reduction

Pounds of CNG Dispensed	Pounds of CNG per one DGE	Number of DGE (2,600/6.0)	Amount of CO ₂ per Combusted DGE	Amount of CO ₂ displaced (430 x 22 lbs.)
2,600 lbs.	6.0 lbs.	430 gallons	22 lbs.	9,500 pounds

Source: [Kern County Superintendent of Schools Staff Using US Department of Energy Calculations](https://afdc.energy.gov/laws/5840) (https://afdc.energy.gov/laws/5840)

CHAPTER 7: Conclusions

This project, funded by CEC's Clean Transportation Program grant agreement ARV-15-019, met the anticipated goals set by KCSoS and the project team. The primary objective was to purchase the portable CNG refueling trailer and install the necessary dispenser and infrastructure to support the trailer as well as any other entity needing to fill tube trailers. The trailer in its first 6 months of operation distributed nearly 2,600 lbs. of CNG with an equivalent of 430 DGE. With careful planning and detailed construction specifications on this project, school bus downtime was zero and there were no negative effects on student achievement.

KCSoS marketed the availability of the CNG station and the new dispenser to private and public entities by attending and hosting CNG workshops and by sending flyers to CNG users around the region (Figures 1 and 2). KCSoS worked with the Fruitvale School District located about 6 miles away in Rosedale by housing the tube trailer dispenser on its site to fuel its existing 2 CNG buses.

Figure 1: CNG Services Flyer

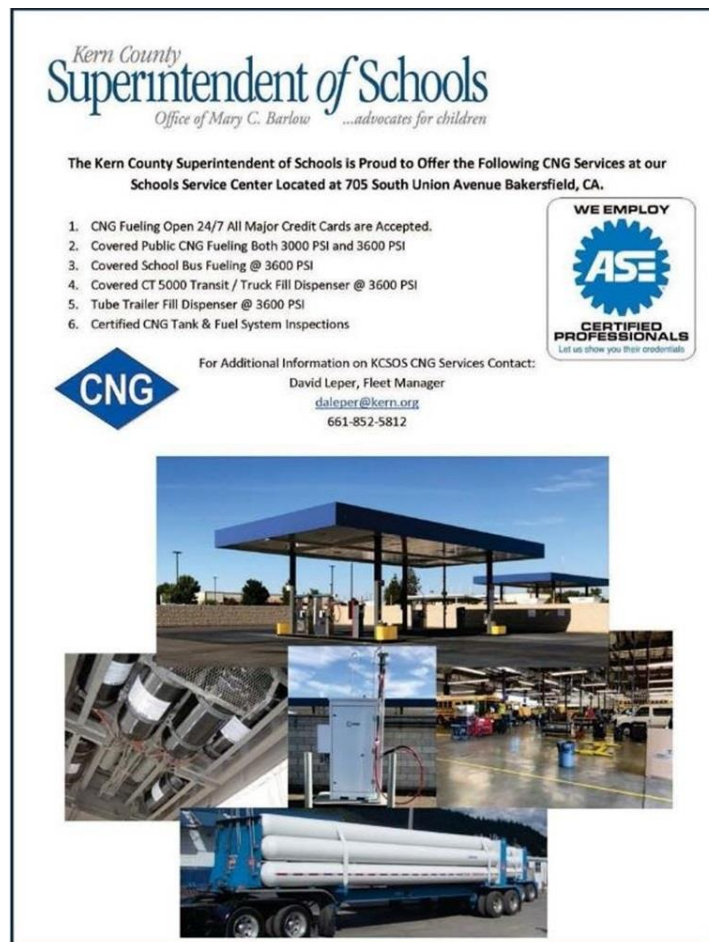


Photo credit: Kern County Superintendent of Schools

Figure 2: San Joaquin Valley Natural Gas Partnership Flyer

															
<p align="center">Natural Gas MeetiNG</p> <p align="center">Tuesday, June 12, 2018</p> <p align="center">Kern County Superintendent of Schools</p> <p align="center">9:30am to 12:00pm</p>															
	<p align="center"><i>Kern County</i> Superintendent of Schools</p> <p align="center">Schools Service Center Classroom, 2nd Floor 705 S. Union Ave Bakersfield, CA 93301</p> <p align="center">Refreshments will be provided.</p>														
<p align="center">If interested in attending, please RSVP with Courtney Velasco at 661-847-9756 or projectcleanairoffice@gmail.com.</p>															
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Photo credit: [San Joaquin Valley Natural Gas Partnership](http://projectcleanair.us/sjvngp/)
(<http://projectcleanair.us/sjvngp/>)

The KCSoS CNG Fueling facility is located next to California State Route 58 with easy on and off ramps. Highway 58 then connects to both north- and south-bound California State Route 99, making access to the KCSoS facility from this busy highway easy. The main CNG facility is outside of the gated KCSoS transportation facility and is open 24 hours, 7 days a week, and is designed and built to allow easy access for both cars and large vehicles. The high-volume dispenser is located within the secured transportation facility and is only accessible from 6:00 AM to 7:00 PM. KCSoS can also make this dispenser available to customers outside of the normal operating hours if staff is on site to operate the dispenser.

KCSoS made the commitment to replace a significant portion of its diesel school bus fleet with cleaner burning CNG buses and to support other school districts as they do the same. CNG engines provide significant improvements to Kern County's air quality, and specifically to the children who are riding school buses daily. KCSoS transports special education children who travel long distances and who could be at a higher risk for respiratory illnesses. Natural gas buses reduce emissions of particular matter and carbon monoxide, which can exacerbate asthma. These environmental risks are significant for this high-risk population in addition to the long-term impact of reducing air pollution in the community at large.

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

Funding for the Commission'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. CO₂ 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).

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

FRUITVALE ELEMENTARY SCHOOL DISTRICT – A school district serving northwest Bakersfield, California. It has 3,200 students spread across four elementary schools and a junior high school.

GALLON – A unit of volume. A U.S. gallon has 231 cubic inches or 3.785 liters.

DIESEL GALLON EQUIVALENT (DGE) – The amount of alternative fuel it takes to equal the energy content of one liquid gallon of diesel gasoline. DGE allows consumers to compare the energy content of competing fuels against a commonly known fuel—diesel. DGE also compares diesel to fuels sold as a gas (natural gas, propane, and hydrogen) and electricity.

GREENHOUSE GASES (GHG) – Any gas that absorbs infrared 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).

POUND (lb.) – A unit of mass. A U.S. pound is equal to 0.45359237 kilograms.⁴

STANDARD CUBIC FOOT (SCF) – One cubic foot of gas at standard temperature and pressure (60°F [15.6°C] at sea level). Since both temperature and air pressure affect the energy content of a cubic foot of natural gas, the SCF is a way of standardizing. One SCF = 1,020 BTUs.

VENDOR USE TAX – Tax collected by the retailer here in California is called sales tax, and the retailer is responsible for reporting and paying the tax to the state. When an out-of-state or online retailer doesn't collect the tax for an item delivered to California, the purchaser may owe "use tax," which is simply a tax on the use, storage, or consumption of personal property in California.⁵

⁴ [Pound \(weight\)](https://en.wikipedia.org/wiki/Pound_(mass)) (https://en.wikipedia.org/wiki/Pound_(mass))

⁵ [California Department of Tax and Fee Administration](https://www.cdtfa.ca.gov/taxes-and-fees/use-tax.htm) (https://www.cdtfa.ca.gov/taxes-and-fees/use-tax.htm)

APPENDIX A:

Project Photographs

The following photographs show the construction of the CNG infrastructure, the completed infrastructure, and the CNG dispensing trailer.

Construction Photos

Figure 3: Construction and Installation of CNG Infrastructure



Photo credit: Kern County Superintendent of Schools

Figure 4: Construction and Installation of CNG Infrastructure



Photo credit: Kern County Superintendent of Schools

Figure 5: Construction and Installation of CNG Infrastructure



Photo credit: Kern County Superintendent of Schools

Figure 6: Construction and Installation of CNG Infrastructure



Photo credit: Kern County Superintendent of Schools

Figure 7: Construction and Installation of CNG Infrastructure



Photo credit: Kern County Superintendent of Schools

Figure 8: Construction and Installation of CNG Infrastructure

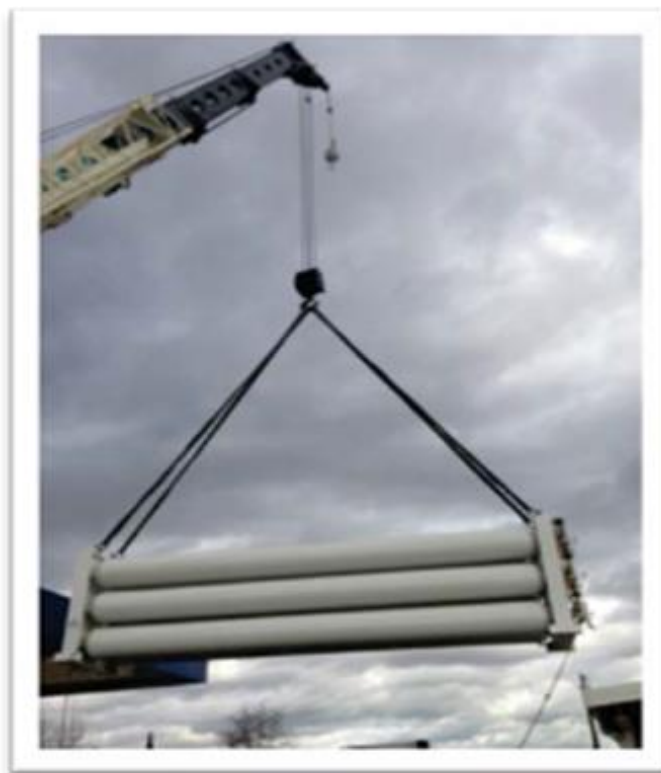


Photo credit: Kern County Superintendent of Schools

Figure 9: CNG Piping and Electrical Conduit



Photo credit: Kern County Superintendent of Schools

Figure 10: CNG Piping and Electrical Conduit



Photo credit: Kern County Superintendent of Schools

Completed CNG Storage Tanks and Dispenser

Figure 11: CNG Storage Tanks with Canopy



Photo credit: Kern County Superintendent of Schools

Figure 12: CNG Storage Tanks with Canopy



Photo credit: Kern County Superintendent of Schools

Figure 13: CNG Fueling Dispenser



Photo credit: Kern County Superintendent of Schools

Figure 14: CNG Fueling Dispenser



Photo credit: Kern County Superintendent of Schools

Figure 15: CNG Fueling Dispenser



Photo credit: Kern County Superintendent of Schools

CNG Dispensing Trailer

Figure 16: Luxfer GTM 1350 Tube Trailer Dispenser



Photo credit: Kern County Superintendent of Schools

Figure 17: Luxfer GTM 1350 Tube Trailer Dispenser



Photo credit: Kern County Superintendent of Schools

Figure 18: Luxfer GTM 1350 Tube Trailer Dispenser



Photo credit: Kern County Superintendent of Schools