

FINAL REPORT

CONTRACT NO. AB2766/ML06038

“25 CNG Street Sweeper Project”



CITY OF LOS ANGELES

**Department of General Services
Bureau of Street Services, Department of Public Works
Environmental Affairs Department**

January 2009

**Prepared for the Mobile Source Air Pollution Reduction Review Committee
(MSRC) under the AB2766 Discretionary Fund Work Program**

ABSTRACT

The City of Los Angeles Environmental Affairs Department was awarded AB 2766 Discretionary Fund Contract No. ML06038. The project was conducted in cooperation with the Department of General Services and the Public Works Department Bureau of Street Services. During the contract period, the Department of General Services purchased twenty five (25) alternative-fuel Elgin Broom Bear street sweepers equipped with compressed natural gas (CNG) Cummins 8.3 liter, C Series, Gas Plus, 250 horsepower engines on behalf of the Bureau of Street Services (BOSS). BOSS placed all 25 sweepers in service in the City of Los Angeles, which is part of the larger South Coast Air Basin. The estimated oxides of nitrogen (NO_x) and particulate matter (PM) emission reductions attributable to this project are 0.0484 tons/year/vehicle and 0.0038 tons/year/vehicle, respectively. Data were analyzed for an annualized period from vehicle deployment to November 6, 2008. The calculated cost-effectiveness of funding dollars for this grant project is \$33,540/ton of NO_x and weighted PM. This represents a substantial improvement in cost effectiveness over the previous City CNG street sweeper project (i.e., the "21 CNG Street Sweeper Project" at \$56,467/ton CE) in that cost effectiveness was improved by \$22,927/ton, due to increased vehicle mileage. As the City continues to build and upgrade more CNG medium to heavy-duty fueling and maintenance facilities, and as maintenance and performance issues are resolved, the annual street sweeper mileage and cost effectiveness are expected to continue to improve accordingly. Currently, the City always buys new CNG sweepers when replacing existing vehicles in its sweeper fleet.

ACKNOWLEDGEMENTS

This project was accomplished with the contributions and support of many employees of the City of Los Angeles, including those of the following departments:

- Department of Environmental Affairs: Ms. Detrich Allen, General Manager
- Department of General Services: Mr. Tony Royster, General Manager
- Department of Public Works, Bureau of Street Services: Mr. William Robertson, Director

This report was submitted in fulfillment of contract AB 2766/ML06038, the "25 CNG Sweeper Project," and conducted by the City of Los Angeles Environmental Affairs Department with input from the Technical Services Division of the Department of General Services and from the Bureau of Street Services, Department of Public Works. The project was performed under partial sponsorship by the Mobile Source Air Pollution Reduction Review Committee (MSRC). Work was completed as of November 6, 2008.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the MSRC or the South Coast Air Quality Management District (SCAQMD). The mention of commercial products and their sources or their uses, in connection with material reported herein, is not to be construed as either an actual or implied endorsement of such products.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS	iii
DISCLAIMER	iii
I. PROJECT DESCRIPTION & WORK PERFORMED	
A. Background	1
B. Purpose.....	1
C. Scope of Work	1
D. Vehicle Procurement.....	1
E. Vehicle Deployment	2
F. Vehicle Performance.....	2
II. CHALLENGES ENCOUNTERED	
A. Vehicle Maintenance & Repair.....	5
B. Vehicle Performance.....	5
III. EMISSION BENEFITS	
A. Emission Reductions.....	5
B. Cost Effectiveness.....	6
IV. PHOTOGRAPHS & OUTREACH	
A. Photographs	9
B. Outreach	9
IV. SUMMARY AND CONCLUSIONS	9
V. REFERENCES	10
VI. GLOSSARY OF TERMS AND ABBREVIATIONS	10

APPENDICES

A. PROJECT PHOTOGRAPHS	A-1
B. OUTREACH DOCUMENTATION	B-1
C. EXECUTIVE ORDER	C-1

LIST OF TABLES

1. Vehicle Deployment, Mileage and Fuel Use 3

2a. Engine Parameters and Annual NOx and PM Emission Reduction 7

2b. Cost Effectiveness..... 8

I. PROJECT DESCRIPTION AND WORK PERFORMED

A. Background

In June 2000, the Los Angeles City council adopted a Clean Fuel Policy in an effort to reduce air pollutant emissions generated by City fleet vehicles. Later that year, the South Coast Air Quality Management District (SCAQMD) adopted Rule 1186.1 (Less Polluting Sweepers). This rule requires public fleets with 15 or more heavy-duty sweepers operating in the District to acquire alternative-fuel heavy-duty sweepers when procuring or leasing these vehicles beginning July 1, 2002. In 2004, the City of Los Angeles Department of General Services ordered new street sweepers for Department of Public Works, Bureau of Street Services. The sweepers were to meet City specifications and run on an alternative fuel per Rule 1186.1. The street sweepers were certified to meet the emission standards mandated by the California Air Resources Board (CARB) and enforced by the SCAQMD. The decision was made to continue purchasing CNG sweepers as older vehicles were replaced.

B. Purpose

In 2006, the City of Los Angeles was awarded an AB 2766 Discretionary Fund contract by the Mobile Source Air Pollution Reduction Review Committee (MSRC). This contract (No. AB 2766/ML06038), executed in 2007, enabled the City of Los Angeles to receive partial funding under the MSRC On-Road Heavy-Duty Alternative Fuel Vehicle Program for the purchase of alternative fuel street sweepers. The street sweepers, operating on 100% natural gas, were certified by CARB to have lower emissions of oxides of nitrogen (NO_x), particulate matter (PM), and other toxic air contaminants (TACs) as compared to their diesel vehicle counterparts.

C. Scope of Work

Under the terms of Contract No. AB 2766/ML06038, the City of Los Angeles was to receive partial funding from the AB 2766 Discretionary Fund to purchase twenty five (25) new street sweeper vehicles with Cummins, 8.3 liter, C Gas Plus, 250 horsepower engines, operating on compressed natural gas. In addition, all vehicles funded by this contract were to be placed in service within the South Coast Air Basin and operate within the Basin at least 75% of the time. Since the City is within the Basin boundary, the sweepers operate in the Basin 100% of the time.

D. Vehicle Procurement

After the MSRC Program Announcement was released on September 9, 2005, the City placed a purchase order with Haaker Equipment Co. for twenty five (25) new street sweepers. Haaker delivered Model 2007 Elgin Broom Bear Sweepers with a Sterling Actera chassis and a Cummins C Gas Plus Natural Gas Engine (8.3 L: Model Year 2006), with onboard CNG tanks. All street sweepers purchased under this contract are powered by compressed natural gas (CNG).

According to invoices on record, the 25 sweepers were delivered to the City of Los Angeles, General Services Department from March 2007 through April 2007. In service dates for the sweepers indicate that they were placed into service from April through July 2007.

E. Vehicle Deployment

All twenty five (25) street sweeper vehicles are part of the City of Los Angeles, Bureau of Street Service's street sweeper fleet and operate entirely within the South Coast Air Quality Management District's jurisdiction. Sweepers stationed in the San Fernando Valley are mainly fueled at the West and East Valley Sanitation District Yards at 8840 Vanalden Avenue, Northridge, CA, 91324 and 11050 Pendleton Street, Sun Valley, CA, 91352, respectively. The vehicles stationed in the downtown Los Angeles and outlying areas are mainly fueled at the new South Los Angeles Fueling Yard at 786 South Mission Road, Los Angeles, CA 90023. Sweepers stationed in the San Pedro area are mainly fueled at the Harbor District Yard at 1400 North Gaffey Street, San Pedro, CA 90731. See Table 1 for a list of yards and yard locations assigned to each deployed sweeper for garaging, maintenance and fueling. In addition, vehicles removed from fleet service as a result of new AB 2766 funded vehicle deployment were disposed of in compliance with the City of Los Angeles Administrative Code.

F. Vehicle Mileage & Fuel Usage

In addition to vehicle yard assignments, Table 1 lists the accumulated mileage and estimated total volume of CNG consumed by the twenty five (25) street sweeper vehicles for a period starting from the vehicle in-service date to November 6, 2008. The final fuel usage and mileage have been annualized in Table 1, so that subsequent annual emissions reductions and annual cost effectiveness could be calculated. The data indicate an average annual mileage of 161,123 miles per year for all 25 vehicles, and for each vehicle, 6,455 miles per year. The data in Table 1 also indicate a fuel use of 1,864 gasoline gallon equivalents (GGE) of CNG per year per vehicle, which is equal to 1,696 diesel gallon equivalents (DGE) of CNG. Total fuel usage per year is estimated at 46,594 GGE of CNG for all 25 vehicles.

Table 1. Vehicle Deployment, Mileage and Fuel Use.

Sweeper ID No.	Assigned Yard ¹	Repair Yard ¹	Fueling Yard ¹	Project Start Date	Project Mileage (odometer reading - 11/06/08) ¹	Project Work Days in Excess of a Year ²	Annual Mileage Adjustment Factor ²	Annualized Mileage	Estimated Annual Fuel Usage in DGE ³	Estimated Annual Fuel Usage in CNG GGE
							where: (c) = 250/(250+b)	where: (d) = (a)(c)	where: (e) =(d/3.8)	where: (f) =(e)/.91
					(a)	(b)	(c)	(d)	(e)	(f)
24029	East	7 th St.	S.LA	8/02/07	12,772	64	79.62%	10,169	2,676	2,941
24032	GH	W.V.	W.V.	7/23/07	6,506	71	77.88%	5,067	1,333	1,465
24031	Central	7 th St.	S.LA	7/18/07	5,872	74	77.16%	4,531	1,192	1,310
24460	Harbor	Harbor	S.P./Car	7/05/07	6,923	84	74.85%	5,182	1,364	1,499
24452	N.H.	E.V.	E.V.	7/06/07	10,202	84	74.85%	7,636	2,010	2,208
24453	7 th St.	7 th St.	7 th St.	7/06/07	2,451 ¹	84	74.85%	1,835	483	531
24455	Reseda	W.V.	W.V.	6/27/07	12,112	89	73.75%	8,932	2,351	2,583
24457	Sunland	E.V.	E.V.	6/19/07	7,836	95	72.46%	5,678	1,494	1,642
24028	Harbor	Harbor	S.P./Car	6/13/07	6,727	99	71.63%	4,819	1,268	1,394
24456	Reseda	W.V.	W.V.	5/17/07	8,638	119	67.75%	5,852	1,540	1,692
24030	GH	W.V.	W.V.	5/18/07	12,807	119	67.75%	8,677	2,283	2,509
24042	N.H.	E.V.	E.V.	5/15/07	7,985	120	67.57%	5,395	1,420	1,560
24043	Reseda	W.V.	W.V.	5/15/07	3,399 ¹	120	67.57%	2,297	604	664
24041	N.H.	E.V.	E.V.	5/09/07	16,188	124	66.84%	10,821	2,848	3,129
24044	E.V.	E.V.	E.V.	5/10/07	9087	124	66.84%	6,074	1,598	1,757
24459	East	7 th St.	S.LA	5/04/07	10,454	129	65.96%	6,896	1,815	1,994
24454	East	7 th St.	S.LA	5/04/07	8,912	129	65.96%	5,879	1,547	1,700
24035	Harbor	Harbor	S.P./Car	4/17/07	9,178	140	64.10%	5,883	1,548	1,701
24039	Sunland	E.V.	E.V.	4/10/07	10,821	145	63.29%	6,849	1,802	1,981
24036	Reseda	W.V.	W.V.	4/09/07	11,167	146	63.13%	7,050	1,855	2,039
24037	Reseda	W.V.	W.V.	4/09/07	10,116	146	63.13%	6,386	1,681	1,847
24033	East	7 th St.	S.LA	4/06/07	10,178	149	62.66%	6,377	1,678	1,844

Sweeper ID No.	Assigned Yard ¹	Repair Yard ¹	Fueling Yard ¹	Project Start Date	Project Mileage (odometer reading - 11/06/08) ¹	Project Work Days in Excess of a Year ²	Annual Mileage Adjustment Factor ²	Annualized Mileage	Estimated Annual Fuel Usage in DGE ³	Estimated Annual Fuel Usage in CNG GGE
					(a)	(b)	where: (c) = 250/(250+b)	where: (d) = (a)(c)	where: (e) =(d/3.8)	where: (f) =(e)/.91
							(c)	(d)	(e)	(f)
24034	6 th St.	7 th St.	Wilton	4/06/07	10,401	149	62.66%	6,517	1,715	1,885
24040	N.H.	E.V.	E.V.	4/06/07	15,000	149	62.66%	9,398	2,473	2,718
24038	Harbor	Harbor	S.P./Car	3/30/07	11,326	159	61.12%	6,923	1,822	2,002
							TOTALS:	161,123	42,401	46,594
							AVG/VEHICLE:	6,445	1,696	1,864

Yard Key:

6th St. = 6th St. Yard, 1451 East 6th Street, Los Angeles, CA, 90021
7th St = 7th St. Yard, 2310 East 7th Street, Los Angeles, CA, 90023
Car = Carson Fueling, 2394 South Figueroa Street, Carson, CA, 90745
Central = Central Yard, 1274 West 2nd Street., Los Angeles, CA, 90031
E.V. = East Valley Sanitation Yard, 11050 Pendleton Street, Sun Valley, CA, 91352
East = East Yard, 425 San Fernando Road, Los Angeles, CA, 90031
G.H. = Granada Hills Yard, 10210 Etiwanda Avenue, Northridge, CA, 91324
Harbor = Harbor Yard, 1400 North Gaffey Street, San Pedro, CA, 90731
N.H.= North Hollywood Yard, 10811 Chandler Blvd., North Hollywood, CA, 91601
Reseda = Reseda Yard, 6015 Baird Avenue, Tarzana, CA, 91356
S.LA = South Los Angeles Yard, 786 South Mission Road, Los Angeles, CA, 90023
S.P.= San Pedro Fueling, 700 West Capitol Drive, San Pedro, CA, 90731
Sun = Sunland Yard, 9401 Wentworth Street, Sunland, CA, 91040
W.V = West Valley Sanitation Yard, 8840 Vanalden Avenue, Northridge, CA, 91324
Wilton = Wilton Fueling, 5860 South Wilton Place, Los Angeles, CA, 90047

Footnotes:

¹ Email and telephone communication with B. Bass, GSD, Technical Services on 11/7/08, which included BOSS odometer readings from 11/6/08 and follow-up vehicle yard assignment information. Low mileage for 24453 was due to loss of the vehicle in a fire and for 24043 low mileage was due to repeated vehicle malfunctions while under warranty.

²Based on a 250 workday year.

³Based on a 40% hilly and 60% flat terrain survey, using diesel sweepers, where a weighted average of 3.8 gallons of diesel per mile was calculated. This average was then converted to its energy equivalent in CNG. (i.e. DGE = diesel gallon equivalents = 117,200Btu/128,100Btu or DGE divided by .91 = CNG GGE (Gorski, 2006).

II. CHALLENGES ENCOUNTERED

The sweeper units work satisfactorily according to the Department of General Services maintenance supervisor. During the project term, however, the City did experience some fire safety and refueling issues, as described below.

A. Vehicle Maintenance & Repair

A fire safety issue was identified by a manufacturer recall following delivery of all 25 CNG street sweepers. Also, one of the street sweepers was destroyed by fire due to this problem. Prior to the fire, sweeping debris build up occurred in front of the rear axle and in the exhaust discharge pipe, where the CNG exhaust temperatures can exceed 800 degrees. The high exhaust temperature then ignited the debris. The National Highway Traffic Safety Administration issued a recall notification in January 2008 for this issue. Since then, the City worked with the vendor to repair and fix the sweepers so that future fires could be avoided. Precautions included rerouting wiring underneath the street sweeper and placing heat shielding where needed. Also, spark plug changes were increased to keep the exhaust heat down. Another sweeper (#24043) was down for approximately two months due to repeated problems with items still under warranty. This resulted in lower than average mileage reported for this vehicle. Except for the burned vehicle, all remaining sweepers are in service as of this reporting.

B. Vehicle Performance

A performance issue arose during the project term. It was found that vehicle performance declines appreciably at 1,000 psi, when the 3,600 psi fuel tank becomes less than one third full. As a routine, it became necessary to refuel the tank before a 1,000 psi fuel tank pressure was reached to ensure adequate vehicle performance. Unlike liquid fuel, gaseous fuel requires a certain minimum pressure to operate the engine properly. The need to refuel the CNG sweeper more frequently than a similar diesel sweeper has caused increased refueling events during a standard work shift, decreasing crew productivity. This issue has not been resolved to date.

III. EMISSION BENEFITS

A. Emission Reductions

Project emission reductions were based on fuel use estimates. As previously described, Table 1 indicates an average annual fuel use of an estimated 1,864 gasoline gallon equivalents (GGE) of CNG per year per vehicle under normal operation and a total estimated fuel usage per year for all 25 vehicles of 46,594 GGE of CNG. The annual fuel use per vehicle in diesel gallon equivalents (DGE) is estimated at 1,696 DGE.

Based on these fuel use estimates, the estimated oxides of nitrogen (NOx) and particulate matter (PM) emission reduction attributable to this project are 0.0484

tons/year/vehicle and 0.0038 tons/year/vehicle, respectively. These results were determined using the estimated miles achieved per diesel gallon, which was then adjusted to CNG gasoline gallon equivalents (GGE), using a conversion factor obtained from the MSRC (see Table 1). Subsequent emission reduction calculations followed the methodology suggested in the Carl Moyer Program Guidelines, 2008 revision, using fuel consumption for medium heavy-duty vehicles operating predominately in a stop-and-go application. Details of the calculations and references are provided in Table 2a.

B. Cost Effectiveness

Table 2b demonstrates the cost-effectiveness of funding dollars as determined using the following formula (CARB, 2008):

$$\text{Cost-Effectiveness of Funding Dollars} = (\text{CRF} * \text{Funding}) / (\text{NOx} + \text{weighted PM10})$$

Where:

$$\text{Capital Recovery Factor (CRF)} = [(1 + i)^n (i)] / [(1 + i)^n - 1],$$

in which:

i = discount rate (assume 4%),

n = project life (assume 7 years based on an estimated average of 6,445 miles per year and 45,115 miles lifetime)

$$\text{CRF} = [(1 + 0.04)^7 (0.04)] / [(1 + 0.04)^7 - 1] = 0.167^*$$

*0.167 also from Moyer Guidelines, 2008, Appendix B, Table B-1, Pg B-1.

Funding: \$25,000/vehicle, and

Annualized Cost (AC): $\text{CFR} \times \text{Funding}$ or $(0.167)(\$25,000) = \$4,175/\text{yr}$.

Total Weighted Annual Emission Reduction of Oxides of Nitrogen and Particulate Matter: $(\text{NOx} + 20 \times \text{PM10}) = (.0484 + 20 \times .0038041) = 0.12522$ tons/year

Cost-Effectiveness: $(\text{AC}) / (\text{Total Weighted Annual Emission Reduction of NOx and PM10}) = (\$4,175/\text{year}) / (0.12448 \text{ tons of NOx and weighted PM10}/\text{yr}) = \$33,540/\text{ton}$

Table 2a. Engine Parameters and Annual NOx and PM Emission Reduction.

Alternative Fuel Vehicle Engine Emissions (for stop and go application):	Fuel Consumption	NOx	PM
A. Total estimated CNG used per year per vehicle in DGE gallons (1,864 CNG gal x 0.91 = 1,696, where 0.91 = 117,200 btu per CNG gallon /128,100 btu per ULSD gallon)	1,696		
B. Energy consumption factor for all onroad applications (bhp-hr/gal) ⁽¹⁾	18.5		
C. Certification NOx + NMHC and PM emission rate (g/bhp-hr) ⁽²⁾		1.8	0.01
D. NOx fraction default values ⁽³⁾		0.8	
E. Adjusted NOx emission factor, where E = (C x D) ⁽⁴⁾ . No adjustment for PM.		1.44	0.01
F. Percent of time operated within the South Coast Air Basin, where 100% = 1		1	1
G. Total annual emissions per alt. fuel vehicle (grams), where G = (A x B x E x F) ⁽⁵⁾		45,181	313.76
H. Total annual emissions per alt. fuel vehicle (tons), where H =G/907,200 g/ton ⁽⁵⁾		0.0498	0.0003459
Baseline Vehicle Engine Emissions (for stop and go application):			
I. Total estimated diesel used per year per baseline vehicle (gallons)	1,696		
J. Baseline emission rate, including correction factor for ultra low sulfur diesel, for 2006 model year ⁽⁶⁾ (gram/mile)		5.12	0.216
K. Conversion from g/mile to g/bhp-hr, where K = J/1.8 ⁽⁷⁾		2.84	0.120
L. Baseline emissions per vehicle, NOx and PM (grams), where L = (I x B x K)		89,108	3,765.12
M. Total annual emission per baseline vehicle (tons), where M = L/907,200 g/ton		0.09822	0.004150
Total Annual Emission Reductions			
N. Annual emission reductions per pollutant (ton/yr./vehicle), where N = (M - H) ⁽⁸⁾		0.0484 N ₁	0.0038041 N ₂
O. Total annual emission reductions (ton/yr./vehicle), where O = N ₁ + N ₂		0.0522041	

Table 2a (continued)

Total Weighted Annual Emission Reductions	
P. Total weighted annual emission reductions (weighted ton/yr/vehicle), where $P = N_1 + (20 \times N_2)^{(9)}$	0.12448

Footnotes:

- ¹ California Air Resources Board (CARB), Moyer Guidelines, 2008, Appendix E, pg. E-3 and Table B-25, page B-19
- ² CARB, Executive Order A-021-0396, STD Emissions, 2006 Model Year (see Appendix C of MSRC report)
- ³ CARB, Moyer Guidelines, 2008, Appendix B, Table B-26, Pg. B-19.
- ⁴ CARB, Moyer, Appendix B, Table B-2, Pg.B-2.
- ⁵ CARB, Moyer, Appendix C, Pgs. C-3 to C-4.
- ⁶ CARB, Moyer, Appendix B, Table B-4, Pg. B-3.
- ⁷ CARB, Moyer, Appendix B, Table B-8, pg. B-5.
- ⁸ CARB, Moyer, Appendix C, Section II.A.4, Pg. C-5.
- ⁹ CARB, Moyer, Appendix C, Section II.A, Pg. C-1.
- ¹⁰ CARB, Moyer, Appendix B, Table B-1, Pg. B-1.
- ¹¹ CARB, Moyer, Appendix C, Pg. C-5.

Table 2b. Cost Effectiveness.

Cost Effectiveness Parameters	
Q. Grant funding received per vehicle (\$)	\$ 25,000
R. Cost recovery factor (7 year life) ⁽¹⁰⁾	0.167
S. Annualized cost, where $S = Q \times R$ ⁽¹¹⁾	4,175
Cost effectiveness of grant monies (CE) per vehicle, where $CE = (S \div P)^{(9)}$	\$ 33,540

IV. PHOTOGRAPHS AND OUTREACH

A. Photographs

Please see Appendix A for project photographs.

B. Outreach

Please see Appendix B for a record of outreach activities and associated documentation.

V. SUMMARY AND CONCLUSIONS

The City of Los Angeles, Environmental Affairs Department, in cooperation with the Department of General Services and the Public Works Department Bureau of Street Services, was awarded AB 2766 Discretionary Fund Contract No. ML06038. Under the terms of this contract, the City of Los Angeles Department of General Services Technical Services Division procured twenty five (25) alternative-fuel Elgin Broom Bear street sweepers equipped with compressed natural gas (CNG) Cummins 8.3 liter, C Series, Gas Plus, 250 horsepower engines. Once received, the City's Bureau of Street Services placed them in service. All 25 sweepers have been deployed in the City of Los Angeles and operate entirely within the geographical boundary of the South Coast Air Basin. One CNG sweeper was lost due to a fire safety problem that was resolved. Another CNG sweeper had lower mileage due to repeated maintenance repairs needed, while the vehicle was still under warranty. The fire safety issue was resolved by working with the manufacturer in properly shielding heat-exposed areas and wiring and lowering vehicle temperatures by more frequent spark plug changing.

During an annualized period from vehicle deployment to November 6, 2008, the estimated oxides of nitrogen (NO_x) and particulate matter (PM) emission reduction attributable to this project are 0.0484 tons/yr./sweeper and 0.0038 tons/yr./sweeper, respectively. Correspondingly, the cost-effectiveness (CE) of funding dollars for this project is \$33,540 per ton of NO_x reduced and weighted PM tonnage reduced, combined. This CE figure represents a substantial improvement over the CE figure for the City's previous MSRC-funded CNG street sweeper project (i.e., the "21 CNG Street Sweeper Project" which was at \$56,467/ton CE). The reason for the improved CE was increased mileage due to increased CNG sweeper use. Increased CNG sweeper use occurs as the City expands supporting CNG fueling and maintenance infrastructure and as performance and maintenance issues are resolved. For this reason, it is recommended that continued expansion of infrastructure occur and resolution of any remaining performance or maintenance issues be resolved.

One remaining performance issue is that more frequent fueling events are required per shift, than expected. More frequent refueling is necessary due to a loss of pressure that occurs during vehicle operation. When the fuel tank is less than about 1/3 full, the pressure drops below 1,000 psi, the street sweeper does not operate properly and, the

sweeper must be refueled before this point is reached. The need for more frequent refueling increases the number of refueling events per shift. A resolution of this issue could involve a manufacturer fuel tank(s) redesign or another engineering approach. Greater fuel storage capacity is needed. Resolving this issue is not likely to improve street sweeper mileage, but would lessen refueling events per shift and allow more street sweeping to be accomplished in less time. A final resolution of this issue would provide an indirect reduction in associated emissions per job performed, as more street sweeping would be performed per shift. Finding a resolution would also lower municipal costs for street sweeping and provide further incentive for using CNG street sweepers in municipal operations.

VI. REFERENCES

California Air Resources Board. The Carl Moyer Memorial Air Quality Standards Attainment Program Guidelines or "Moyer Guidelines." Approved Revision, 2008.

Parker, Dan. CNG street sweeper maintenance memorandum from Equipment Repair Supervisor, 7th Street Sweeper Shop, Department of General Services (GSD), City of Los Angeles to Larry Thompson, GSD. August 29, 2006.

Bass, Brian. CNG street sweeper maintenance, mileage, and garage location emails from Project Management Analyst II, Technical Services Department, GSD, City of Los Angeles. November 7, 2008.

Gorski, Ray. Email communication from MSRC Technical Advisor to H. Froelich, Environmental Affairs Dept. (EAD), City of LA, supplying 0.91 conversion factor from GGE to DGE. September 26, 2006.

Taguchi, Eric. Email communication containing diesel MPG data from Cleaning Coordinator, Bureau of Street Services, Dept. of Public Works, City of Los Angeles to H. Froelich, EAD. August 2 and 17, 2006 and September 20, 2006.

VII. GLOSSARY OF TERMS AND ABBREVIATIONS

CARB: California Air Resources Board

CNG: compressed natural gas

CE: cost effectiveness

DGE: diesel gallon equivalent

GGE: gasoline gallon equivalent

g: grams

g/bp-hr: grams per brake-horse power hour

MSRC: Mobile Source Air Pollution
Reduction Review Committee

NMHC: nonmethane hydrocarbons

NOx: oxides of nitrogen

PM: particulate matter

SCAQMD: South Coast Air Quality
Management District

(this page intentionally left blank)

APPENDIX A. PROJECT PICTURES



Figure A-1. One of the twenty five sweepers partially funded by the MSRC grant.
(Source: Bureau of Street Services, City of Los Angeles, 2008)



Figure A-2. Close-up of the MSRC Clean Transportation sticker on one of the sweepers.
(Source: Bureau of Street Services, City of Los Angeles, 2008)

(this page intentionally left blank)

APPENDIX B. PUBLIC OUTREACH ACTIVITIES & DOCUMENTATION

Newsletters and Websites:

Upon receiving the 25 CNG street sweepers and the successful startup of their use, a feature article was included in the newsletter prepared by the City of Los Angeles Environmental Affairs Department (EAD). EAD news items have recently gone paperless and are now available via the web. During the project term, the paper newsletter was made available to the public at various events such as fairs, conferences, trade shows, and other public events which the City sponsored and/or participated in. A copy of the newsletter article is attached and a direct link to the archived newsletter article is at:

<http://www.lacity.org/ead/EADWeb-Newsletters/2006%20Aug.pdf>

Also, a news article on the project appeared on the MSRC website with information provided by the City. A copy of the article is attached and a direct link is below:

<http://www.cleantransportationfunding.org/index.php?fa=news-article&na=69>

The U.S. Department of Energy also has an article on the sweeper acquisition in their quarterly publication entitled "Clean Cities Now." This publication has recently gone paperless and is now only available on the web. The publication is available to alternative fuel vehicle coordinators nationwide. A copy of this article is attached. Please follow this link to go directly to the newsletter (4th article down):

http://www.eere.energy.gov/cleancities/ccn/archive/ccn_10_4.html

Displays:

The Environmental Affairs Department periodically highlights projects and activities related to the City's alternative fuel vehicle fleet in a large publicly-accessible display, which is brought to many related alternative fuel outreach events throughout the year. The vehicle acquisition project has been included in the display throughout the contract period. Please see following for a record of events.

General:

Each component of the Public Outreach Plan described included and highlighted:

- The role of the MSRC and the AQMD in providing Clean Transportation™ grant funding for the project: For example: "This project was funded in part with a Clean Transportation Funding™ grant provided by the South Coast Air Quality Management District (SCAQMD) and the Mobile Source Air Pollution Reduction Review Committee (MSRC). These grants help fund various projects aimed at reducing air

pollution from motor vehicles within the South Coast Air Quality Management District in Southern California.”

- The City’s Alternative Fuel Fleet Vehicle Program.
- The new vehicles add to the growing fleet of clean-operating natural gas street sweepers.
- The current status of the City’s replacement of diesel-powered street sweepers to clean-operating natural-gas powered street sweepers.
- The positive impacts to the community resulting in the City’s increased use of alternative fuels.
- Other components of the City’s commitment to alternative fuels (e.g. number of fueling facilities installed and maintenance facilities upgraded).
- The City featured the appropriate MSRC logos on the project vehicles and in pictures displayed of the project vehicles.

See following pages for sample articles and a summary article on outreach events.

An Environmental Affair

Volume 17, Issue 8

August 2006

City of Los Angeles Receives Over \$2.5 Million to Reduce Air Pollution

The City of Los Angeles Environmental Affairs Department was established in 1990 to advise the city on environmental issues and provide a centralized source of environmental information. The Environmental Affairs Department seeks to protect and enhance the environmental quality of life for residents, workers and visitors in the City of Los Angeles.

Diesel engines emit significant amounts of air pollutants as well as soot or particles. This particulate matter (PM) was identified by the State of California as a toxic air contaminant that can cause cancer, premature deaths, and respiratory problems. Recent grant awards that target PM will therefore have a very beneficial impact on the health of Los Angeles residents.

The Mobile Source Air Pollution Reduction Review Committee (MSRC), the committee that recommends projects through Air Quality Management District (AQMD) for funding to reduce emissions from transportation sources, awarded \$1,250,000 toward the purchase of 50 new liquefied natural gas (LNG) refuse collection vehicles for the Bureau of Sanitation. An additional \$625,000 in grant funds from the MSRC will be applied toward the purchase of 25 new compressed natural gas (CNG) street sweepers for the Bureau of Street Services, and toward 6 new CNG articulated buses for the Los Angeles International Airport (LAX). In addition, \$533,000 in grant funds from the South Coast Air Quality Management District's Carl Moyer Program Fund will be used to purchase 52 diesel emission control devices (DECs) for installation on existing refuse collection vehicles that still have several remaining years of service. These will complement the 800 DECs already in operation that were funded through previous grants. The new vehicles will reduce diesel PM emissions by at least two-thirds (70% for refuse collection vehicles, 66% for street sweepers) compared to their counterparts with standard diesel engines, while the DECs will reduce PM by 85%. The new refuse collection vehicles will be deployed in South Los Angeles, the Harbor area, and the San Fernando Valley, while the new sweepers and DEC-equipped vehicles will be deployed on a citywide basis.

The City, which already owns the largest municipal alternative-fuel refuse truck fleet in the country, intends to replace *all* of its diesel-powered refuse collection vehicles and street sweepers with alternative-fuel vehicles in the next 4 to 5 years. In the interim, the City is updating its fueling and maintenance yards to accommodate more LNG- and CNG-fueled vehicles.

The latest grants will expand the City's alternative fuel vehicle fleet (already one of the nation's largest, at over 2,200 vehicles), contribute to better air quality, support the City's Clean Fuels Policy, and help fulfill the goals of the Clean Cities Program, of which Los Angeles is a member. The City of Los Angeles is one of the only large U.S. cities to focus its efforts on the replacement of diesel vehicles, which have greater health impacts than non-diesel vehicles, with cleaner natural gas models.

Inside this issue:

Using a Healthy and Safe System	2
California's Clean Air Act: Recycling and Emission Control	3
Asphalt Paving: Pollution	4
2006	5
Catalog of Events	5-7
EPA Issues and the City of Los Angeles: A Guide to Environmental Quality	7



Clean Transportation Funding Furthers City of L.A.'s Goal to Convert to an all Alternative-Fueled Fleet for Refuse Trucks and Street Sweepers

DIAMOND BAR, Calif. – The Mobile Source Air Pollution Reduction Review Committee (MSRC) is providing nearly \$1.9 million dollars in Clean Transportation Funding to the City of Los Angeles to purchase fifty liquefied natural gas (LNG) refuse trucks and twenty-five compressed natural gas (CNG) street sweepers. The MSRC is allocating the funding to the City through its Local Government Match Program, which contributes a "dollar-for-dollar" match toward qualifying projects.

With 307 of 676 trucks operating on LNG, the City of Los Angeles has the nation's largest municipal fleet of alternative fuel solid waste collection vehicles. The City has 54 CNG sweepers in its fleet of 162 street sweepers. The City's goal is to replace all of its diesel-fueled refuse trucks and street sweepers with alternative-fueled vehicles within the next three to five years.

"We are on track to meet this goal, thanks to Clean Transportation Funding from the MSRC," said Detrich Allen, General Manager of the Los Angeles Environmental Affairs Department. "As a critical and consistent source of funding, the MSRC has served as a major catalyst in helping the City to expand its fleet of alternative fuel vehicles."

The vehicles that will be replaced are typically about seven years old. Comparing the new LNG refuse trucks and CNG street sweepers to the model-year 2000 diesel trucks they will be replacing, these 75 new alternative fuel vehicles combined will reduce approximately 17.5 tons of nitrogen oxides and particulate matter emissions each year. Nitrogen oxides lead to the formation of smog and particulate matter emissions have been linked to asthma, lung disease, cancer, and premature death.

"Because refuse trucks and street sweepers are vehicles that travel in and out of our local neighborhoods each day, the resulting emission reductions will be significant to improving the City's air quality and quality of life for its residents," noted Gwenn Norton-Perry, Chair of the MSRC. "It's exciting to be a part of the City of Los Angeles' efforts to convert such a large fleet to alternative-fuels and to cleaning up our air."

These new vehicles will be deployed in the San Fernando Valley, the Harbor area, and South Los Angeles, all areas working hard to tackle localized air pollution challenges.

The MSRC allocates Clean Transportation Funding from a \$4 surcharge on vehicle license fees, specifically to be used for local projects designed to reduce air pollution from mobile sources such as cars, trucks and buses. Thirty cents of every surcharge dollar goes into the MSRC fund. More than \$220 million has been distributed for air pollution-reduction programs since the MSRC was established in 1990. Clean Transportation Funding is heavily leveraged with investments from government agencies, as well as private sources, with billions of additional dollars contributed to projects throughout the region.

Membership of the MSRC is made up of representatives from the transportation agencies of Los Angeles, Orange, Riverside, and San Bernardino Counties as well as the Southern California Association of Governments, a designated regional rideshare agency, the California Air Resources Board and the South Coast Air Quality Management District.

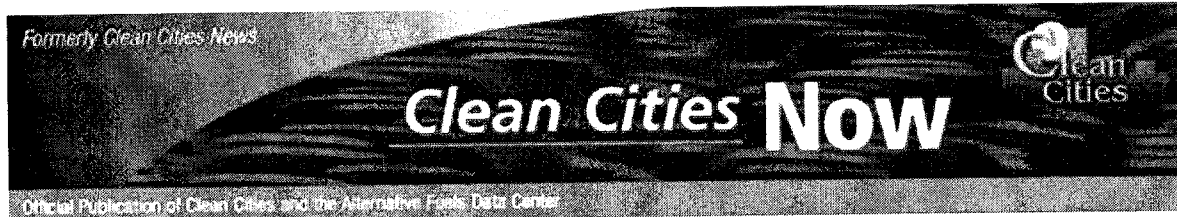
ABOUT THE MSRC

The Mobile Source Air Pollution Reduction Review Committee (MSRC) was formed in 1990 when Assembly Bill AB 2766 was signed into law authorizing a \$4 motor vehicle registration fee. Thirty percent of the \$4 fee or approximately \$12 million annually is used for programs administered by the MSRC. All of the programs eligible for funding must reduce air pollution from mobile sources.

Membership of the MSRC is made up of representatives from the transportation agencies of Riverside, Los Angeles, San Bernardino and Orange County, as well as the Southern California Association of Governments, Southern California Rideshare, California Air Resources Board and the South Coast Air Quality Management District.

CONTACT

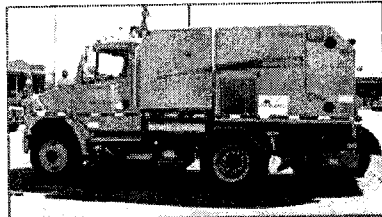
Cynthia Ravenstein
MSRC Contracts Administrator
(909) 396-3269
cynthia@cleantransportationfunding.org



Vol. 10, No. 4 - October 2006

Clean Cities Now (www.eere.energy.gov/cleancities/ccn) is the official publication of *Clean Cities*, an initiative of the U.S. Department of Energy designed to reduce petroleum consumption in the transportation sector by advancing the use of alternative fuel vehicles, idle reduction technologies, hybrid electric vehicles, fuel blends, and fuel economy.

Los Angeles Expands Nation-Leading Alternative Fuel Fleet



The City of Los Angeles will add 25 CNG street sweepers to its fleet.
City of Los Angeles Bureau of Street Services

The City of Los Angeles recently received \$2.56 million to purchase 50 liquefied natural gas (LNG) refuse trucks, 25 compressed natural gas (CNG) street sweepers, and six CNG articulated buses. The grants were received via the South Coast Air Quality Management District from the Mobile Source Air Pollution Reduction Review Committee and the Carl Moyer Program. The grants will also be used to purchase 82 diesel emission-control devices for installation on existing refuse trucks.

Los Angeles already has the nation's largest municipal alternative fuel refuse truck fleet, with 260 of 703 trucks operating on alternative fuels. The city's goal is to replace all its diesel refuse trucks and street sweepers—about 900 vehicles—with alternative fuel versions in the next four to six years. To accommodate the added vehicles, the city is updating its maintenance yards and adding two LNG/CNG fueling stations, with more to follow.

Los Angeles is concerned about vehicle emissions of particulate matter (PM), which a 2000 California study linked to cancer and respiratory ailments, and oxides of nitrogen (NOx), which contribute to smog formation. "Natural gas is one of the cleanest fuels for the types of problems in our air basin," says Heloise Froelich, Environmental Supervisor with the Los Angeles Environmental Affairs Department, Air Quality Division.

Froelich is also coordinator of the Los Angeles Clean Cities Coalition, which comprises Los Angeles' government fleets and public/private project partners. Since the coalition began in 1996, it has received almost \$14 million in grants for alternative fuel vehicles and infrastructure. More than 2,200 of the city's 15,000 non-emergency municipal vehicles run on alternative fuels. The acquisitions from this latest grant will be operational by spring 2007.

- Southern California Clean Vehicle Technology Expo (National Odyssey Day Event) - October 16 and 17 2007 and October 13 to 15, 2008
- Santa Monica Car and Transportation Expo - October 19 and 20, 2007 and September 26 and 27, 2008
- South Pasadena Clean Air Car Show and Film Festival - July 20, 2007 and July 20, 2008
- The Future is Green Conference & Expo –September 14 to 16, 2008
- Hydrogen Road Tour and Hydrogen Day – August 23, 2008

Southern California Clean Vehicle Technology Expo

The City government fleets are a member of the Los Angeles Clean Cities Coalition (LACCC). A U.S. Department of Energy (DOE) program dedicated to education and outreach in the area of alternative fuel vehicle deployment. LACCC was invited to share outreach table space at the Southern California Clean Vehicles Technology Expo twice during



the project period, in 2007 and 2008. Attendance was estimated at approximately 500 to 650 attendees each year. The Los Angeles Clean Cities Coalition/City of Los Angeles, Environmental Affairs Department manned an alternative fuel information booth, in partnership with the U.S. Department of Energy, South Coast Air Quality Management District (SCAQMD), the other Clean Cities Coalitions (SCAG, Long Beach, Western Riverside and the Coachella Valley), at the SCAQMD Clean Vehicle Technology Expo held at the Ontario Convention Center in Ontario, California, October 16 –17,

2007 and October 13-15, 2008. Focusing on alternative/clean fuel vehicle technology, the EXPO brought together Southern California's fleet operators, infrastructure technology providers, funding agencies, and other industry experts to share information on alternative/clean fuel vehicle funding, policies and regulations. The EXPO utilized a format designed to maximize the interaction between the public and private fleet operators, technology manufacturers, fuel suppliers, infrastructure providers, public officials and funding agencies. Some of the topics included using private funding for your project, the realities of selling greenhouse gas credits in carbon markets, and financial success stories from private and municipal fleet operators. Money Monday featured workshops, including one-on-one counseling sessions provided by agency staff, on how to secure funding for off-road emission reductions, and other high priority funding opportunities. Technology displays complimented these sessions in order that end users may learn about the programs and check out the details of the clean vehicle technologies the incentives are meant to purchase. For more information and an agenda of the 2008 event please follow this link: <http://www.cleanvehicleexpo.com/>

Santa Monica Alternative Fuel Car and Transportation Expo

The Los Angeles Clean Cities Coalition/City of Los Angeles, Environmental Affairs Department manned an alternative fuel information booth at the Santa Monica Alt Car Expo on October 19 and 20, 2007 and September 26 and 27, 2008 at the Santa Monica Airport and the Civic Auditorium, respectively. Attendance was estimated at 11,000 per event. A quick rundown of the 2008 event highlights are:

- Find your best immediate option to reduce your petroleum use, carbon footprint and transportation costs.
- Exhibition Hall featured an extensive presentation of manufacturers representing the latest choices of electric, hydrogen, biodiesel, natural gas, propane, hybrid, plug-in, ethanol and cycling transportation technologies
- Ride & Drive Lot for a hands-on experience with all technologies
- Explanation of tax rebates and credits for alternative technology choices
- Most all vehicles displayed are currently available for purchase
- Mass & alternative transportation, urban planning and alternative energy information
- Petitions were available for signatures and find out how to support pending legislation.
- Big Blue Bus unveiled THE BUS OF THE FUTURE & TRANSFORMING TRANSIT SYMPOSIUM which featured internationally renowned speakers provided a peak into the future of transit.
- Special Municipal Equipment Maintenance Association (MEMA) Fleet Event
- Saturday speakers series included some of the top decision makers in the State regarding our future transportation plans and legislation, all-technology debate, the latest success stories regarding large City adaptations, special address by Terry Tamminen - Cabinet Secretary, Chief policy Advisor to Governor Arnold Schwarzenegger and more

For more information please see this link: <http://www.altcarexpo.com/index.html>.



South Pasadena Clean Air Car Show and Film Festival



The Los Angeles Clean Cities Coalition/City of Los Angeles, Environmental Affairs Department manned an alternative fuel information booth at the first and second annual Clean Air Car Show and Film Festival events held in the City of South Pasadena on July 19, 2007 and July 20, 2008. The annual event raises awareness and educates the community about adverse effects of vehicles on the environment. Movies and presentations were held in the Historic Rialto Theater. This year's

event drew enthusiastic crowds to see next-generation technology vehicles as well hybrid, electric, and CNG cars that are already commercially available. Mini-seminars in the Program Tent and movies in the historic Rialto Theatre rounded out the activities. The City of South Pasadena Police Department appeared at the event with their T-3 mobile police vehicles. The Los Angeles Police Department (LAPD) also has several of these zero emission vehicles in its fleet. With gasoline prices at record highs and still climbing, community interest in alternative fuel vehicles is increasing. This year's event built on last year's to provide a family-friendly opportunity to also learn about other important environmental issues like global warming, health effects of air pollution and the latest in solar energy advancements. For more information about the event go to:

<http://www.aqmd.gov/news1/2008/08SoPasCarShow.html>

Hydrogen Road Tour and Hydrogen Day

The Los Angeles Clean Cities Coalition/City of Los Angeles, Environmental Affairs



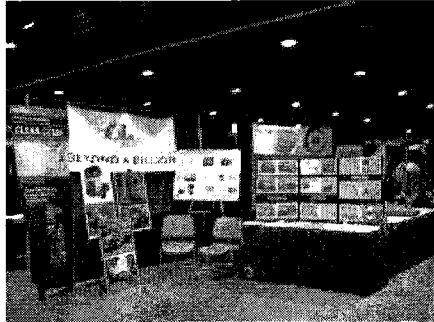
Department manned an alternative fuel information booth on Hydrogen Day 2008 at the California Science Center on Saturday, August 23, 2008. The information highlighted all of the City's AFV projects. The event was very well attended and everyone seemed really excited about California's hydrogen future. The Hydrogen Road Tour and Hydrogen Day 2008 gave Americans a unique opportunity to see what the future holds for hydrogen in the United States with the launch of an historic two-week, cross country trek of a fleet of

clean, efficient hydrogen vehicles. Nine auto manufacturers, the U.S. Department of Energy, California Fuel Cell Partnership, National Hydrogen Association, and U.S. DOT sponsored the Hydrogen Road Tour to show that hydrogen vehicle/fueling technologies are approaching commercial availability, even as new research and development breakthroughs continue.

Hydrogen vehicles produce virtually no greenhouse gas emissions, and their only byproduct is water. The tour made 31 stops in 18 states, stretching from Maine to California. Hydrogen vehicles from BMW, Daimler, Ford, GM, Honda, Hyundai-Kia, Nissan, Toyota, and Volkswagen made the journey, and were joined by hydrogen transit buses along the route. Air Products and Chemicals, Inc. and Linde provided mobile refueling stations and hydrogen fuel. For more information about the Hydrogen Road Tour and Hydrogen Day 2008 event, please follow <http://hydrogenroadtour08.dot.gov/Default.aspx>.

The Future is Green Conference & Expo

The Los Angeles Clean Cities Coalition/City of Los Angeles, Environmental Affairs Department, in partnership with the SCAG Clean Cities Coalition, manned an alternative fuel information booth at the California Air Pollution Control Officers Association (CAPCOA)



“The Future is Green Conference & Expo” on New and Emerging Clean Air Technologies and Innovations,” September 14-16, 2008, at the Long Beach Convention & Entertainment Center in Long Beach, California. For the event program see this link:

<http://www.capcoagreen.com/files/program.pdf>

Sessions included topics like: renewable power generation, on-road heavy-duty clean vehicles and technologies, green building and energy efficiency, on-road light-duty clean vehicles and technologies, green consumer products, off-road clean vehicles and

technologies, green agriculture equipment and operations, clean transportation system technologies, and clean fuel technologies. Each day featured exhibits and sessions on a variety of clean air technology topics and more than 70 exhibitors and 30 clean fuel vehicles. Event speakers, panelist and moderators were well known and knowledgeable individuals like Monday's keynote speaker T. Boone Pickens, Chairman and Chief Executive Officer (CEO) of BP Capital and author of "The Pickens Plan: A Conversation with T. Boone Pickens".

(this page intentionally left blank)

