APPENDIX G

Estimated Emission Reductions and Costs of
Enhanced Conventional (ECO) Nozzle Proposal

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California Environmental Protection Agency

Air Resources Board

Cost Effectiveness Report:

Estimated Emission Reductions and Costs of Enhanced Conventional (ECO) Nozzle Proposal

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Introduction

California Air Resources Board (CARB) staff conducted a cost effectiveness analysis of the proposed regulation adopting Certification Procedures for Enhanced Conventional (ECO) Nozzles at gasoline dispensing facilities (GDFs) that serve a fleet of vehicles that are equipped with On-board Refueling Vapor Recovery (ORVR)[1] systems. Staff determined the cost effectiveness for the proposed ECO Nozzle regulation over a five year period to be a net savings of approximately of $1.04 per pound of reactive organic gases (ROG) reduced. Attachment 1 (page 12) provides a summary table of the numbers used in calculating cost effectiveness.

Staff based cost effectiveness calculations on ORVR fleet facility population and gasoline throughput estimates for 2013. ECO Nozzle requirements are not expected to be fully implemented until 2019, but staff does not expect the ORVR fleet fueling facility population or throughput to change significantly between 2013 and 2019.

Cost of GDF Hanging Hardware

Staff spoke with several nozzle manufacturers and GDF equipment distributors to determine the cost to ORVR fleet fueling facility owners of switching from their current dispensing hardware to the proposed ECO Nozzle and associated hardware. Some ORVR fleet GDFs are currently equipped with Phase II EVR equipment and others are equipped with conventional equipment, so costs for both equipment types were analyzed. The cost of the ECO Nozzle and associated hardware was also established based on estimates from nozzle manufacturers who have expressed interest in manufacturing ARB-certified ECO Nozzles.

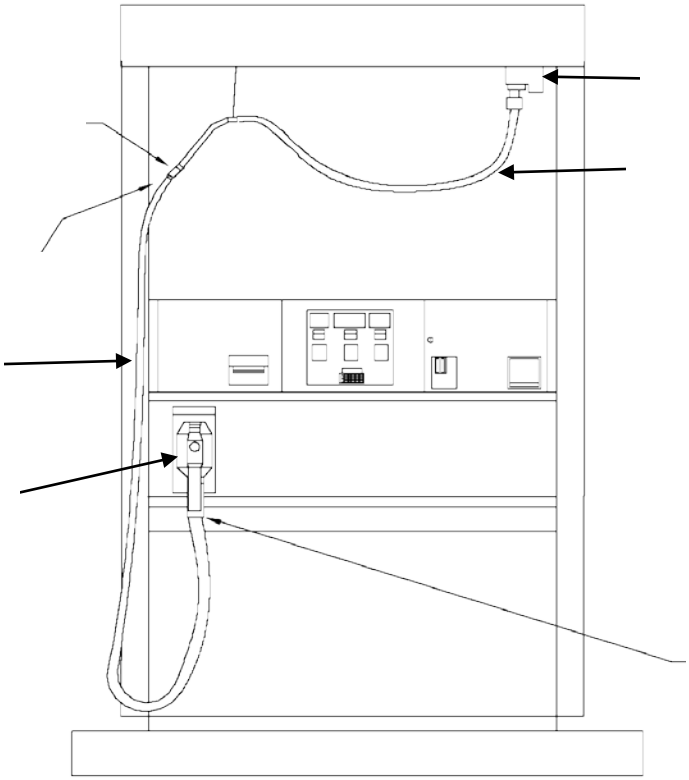
Some of the nozzle manufacturers and equipment distributors contacted by staff provided “list pricing” for equipment, while others provided a “suggested retail price” that is significantly lower than list pricing. Everyone contacted by staff in this process indicated that a typical GDF operator will pay significantly less than list pricing, and will often pay slightly less than the suggested retail price. The level of discount provided to the GDF operator depends on several factors such as equipment distributor, the quantity of equipment purchased, and whether the equipment is re-sold by a service contractor or middleman. Staff attempted to be conservative with cost estimates, so the suggested retail price (with no discount applied) was used when available.

When calculating the cost of converting an existing GDF to meet the ECO Nozzle standards, staff had to consider what equipment was currently installed at the GDF and which of those components would need to be replaced when converting to ECO

[1] ORVR is a vehicle emission control system that captures gasoline vapors displaced from the vehicle gas tank during refueling. It controls the same emissions as a Phase II vapor recovery system. In 2008, ARB issued a letter allowing air districts to not require Phase II system when a non-retail GDF is refueling ORVR vehicles.

Nozzles. Figure 1, below, shows the location of common hanging hardware components that were considered in this evaluation.

Figure 1 - Hanging Hardware Components



GDFs in some locations are required by local air district rules to use Phase II EVR hanging hardware with the vapor return piping capped off. For these GDFs, converting to the ECO Nozzle standards will require replacement of the nozzle, adaptor, curb hose, breakaway, and whip hose. It is assumed that an optional swivel connector will be used at these facilities. Swivel connectors are integrated into Phase II EVR hoses, but would have to be purchased separately when converting to ECO Nozzles.

GDFs in some locations are allowed by local air district rules to use conventional nozzles. For these GDFs, only the nozzle will need to be replaced. The existing conventional curb hose, breakaway, whip hose, adaptor, and optional swivel(s) are likely to be compatible with the ECO Nozzle and could remain in use.

Average Life of Dispensing Equipment

Staff interviewed several GDF equipment manufactures and facility owners and determined the average life of GDF hanging hardware at an ORVR fleet facility is four

years. Although there are many cases of hanging hardware components lasting longer than four years, components can be damaged by drive-offs and vehicles driving over hoses or nozzles, resulting in a shorter expected life.

In previous EVR rulemaking documents, hanging hardware component life was estimated to be an average of two years. However, that estimate assumes that a majority of the components are installed at retail fueling facilities and are being handled and operated by the general public. ECO Nozzles and their associated hanging hardware will only be used by individuals who are authorized to dispense gasoline from the non-retail ORVR fleet fueling facilities where such components are installed. Staff expects that limiting the handling of the nozzle to authorized individuals would significantly reduce the frequency of component damage due to misuse or vandalism. Further, ORVR feet facilities typically have much lower throughput than retail fueling facilities. This means that the hanging hardware components are generally used less frequently, resulting in a longer average life expectancy.

Cost of Replacing Existing Hanging Hardware with ECO Nozzle Hanging Hardware

Health and Saf. Code §41956.1 establishes that current vapor recovery equipment can remain in use for up to four years beginning from the effective date of a new requirement. Given that the average estimated life of hanging hardware at ORVR fleet fueling facilities is four years, it is expected that ECO Nozzle hanging hardware would be phased in during this four year period. As such, it is logical to consider the difference in costs between ECO Nozzle hanging hardware and the hanging hardware that would otherwise be purchased and installed at these ORVR fleet fueling facilities.

In general, most hanging hardware can be replaced by either the GDF operator, maintenance person, or an outside contractor. No additional labor time or cost is usually required based on the type of hanging hardware being removed or replaced. This means that labor cost is not a factor because labor costs are equal regardless of the type of equipment being replaced.

Table 1 contains a breakdown of costs of converting a single fueling point at a facility that is currently equipped with Phase II EVR hanging hardware, while Table 2 contains a breakdown of costs of converting a single fueling point at a facility currently equipped with conventional hanging hardware.

Table 1 – Cost of Converting a Single Fueling Point from Phase II EVR Hanging Hardware to ECO Nozzle Hanging Hardware

Component	Phase II EVR Cost ($)	ECO Nozzle Cost ($)	Difference ($)
Adaptor	N/A[2]	20	20
Whip Hose[3]	70	40	-30
Breakaway	120	60	-60
Curb Hose[4]	190	115	-75
Swivel	N/A[5]	30	30
Nozzle	440	250	-190
Total	**820**	**515**	**-305**

Negative (-) numbers indicate a savings compared to replacing an existing EVR component with a new EVR component

Table 2 – Cost of Converting a Single Fueling Point from Conventional Hanging Hardware to ECO Nozzle Hanging Hardware

Component	Conventional Nozzle Cost ($)	ECO Nozzle Cost ($)	Difference ($)
Adaptor	N/A[2]	N/A[2]	N/A
Whip Hose[6]	40	40	0
Breakaway	60	60	0
Curb Hose[7]	115	115	0
Swivel	30	30	0
Nozzle	65	250	185
Total	**310**	**495**	**185**

ORVR Fleet Fueling Facility Population

In 2010, staff surveyed air districts within California to determine which districts had rules exempting ORVR fleet fueling facilities from Phase II vapor recovery. Based on that survey, staff identified six air districts with such a rule: Bay Area AQMD, Sacramento Metro AQMD, San Diego County APCD, San Joaquin Valley APCD, South Coast AQMD, and Ventura County APCD. Of those six air districts, only South Coast AQMD and Bay Area AQMD provided a detailed count of the number of exempted ORVR fleet facilities.

To estimate the number of exempted ORVR fleet facilities in districts that did not provide a detailed count, staff extrapolated the ORVR fleet facility counts provided by South Coast AQMD and Bay Area AQMD to the other districts. The number of ORVR fleet facilities is 131 in South Coast AQMD, while 39.0% of all California's

[2] Component is not needed for this hanging hardware configuration
[3] Whip Hose costs for both EVR and ECO are for low perm hose
[4] Curb Hose costs for both EVR and ECO are for low perm hose
[5] Component is integrated into the EVR hose assembly
[6] Whip Hose cost for ECO is for low perm hose
[7] Curb Hose cost for ECO is for low perm hose

GDFs are located in this district. Bay Area AQMD has 89 ORVR fleet fueling facilities and about 18.5% of California's GDFs. Together, these two districts have 220 ORVR fleet facilities and together have about 57.5% of all California GDFs. This ratio of ORVR fleet facilities to the percentage of total GDF population was applied to each of the four districts to estimate their number of ORVR fleet fueling facilities. For example, San Joaquin Valley APCD contains 13.6% of all California's GDFs so staff used the following equation to estimate that they have 52 ORVR fleet facilities.

South Coast & Bay Area		San Joaquin	
220 ORVR Facilities 57.5% of all GDFs	=	**X** ORVR Facilities 13.6% of all GDFs	**X = 52**

Using this methodology, a number of exempt ORVR fleet fueling facilities was estimated for each district that has a rule exempting ORVR fleet fueling facilities from Phase II EVR requirements. Results are found in Table 3.

Table 3 – Number of ORVR Fleet Facilities, by District

District	% of Total GDFs	Number of ORVR Fleet Facilities	Source of Number
South Coast	39.0	131	Provided by District
Bay Area	18.5	89	Provided by District
Sacramento	3.6	14	Extrapolated
San Joaquin	13.6	52	Extrapolated
San Diego	7.6	29	Extrapolated
Ventura	1.7	7	Extrapolated
Total	**84%**[8]	**322**	

ORVR Fleet Fueling Nozzle Count

South Coast AQMD and Bay Area AQMD provided ARB staff with a count of the total number of nozzles at each of the ORVR fleet fueling facilities within their jurisdictions. South Coast AQMD facilities had an average of 3.20 nozzles per facility, while Bay Area AQMD facilities had an average of 2.54 nozzles per facility. Based on these averages, staff has assumed an average of three nozzles per ORVR fleet fueling facility statewide.

In order to properly account for the cost of the proposed ECO Nozzle requirements, it is important to estimate how many of the existing nozzles at ORVR fleet fueling facilities are Phase II EVR nozzles and how many are conventional nozzles. Based on ARB staff inquiries to the six districts who exempt ORVR fleet fueling facilities,

[8] The remaining 16% of California's GDFs are located in districts that do not have a rule exempting ORVR fleet facilities from Phase II requirements

only South Coast AQMD and Sacramento Metro AQMD require the use of Phase II EVR nozzles and hanging hardware. The other four districts do not specify what equipment must be used, so it is assumed that ORVR fleet facilities in those districts are currently equipped with conventional nozzles and hanging hardware. The number and type of existing nozzles at ORVR fleet fueling facilities is shown in Table 4.

Table 4 – Existing Nozzles at ORVR Fleet Fueling Facilities

District	Number of ORVR Fleet Facilities	Number of Nozzles (3 per facility)	Current Nozzle Type
South Coast	131	393	EVR
Sacramento	14	42	EVR
Sum of EVR	**145**	**435**	**EVR**
Bay Area	89	267	Conventional
San Joaquin	52	156	Conventional
San Diego	29	87	Conventional
Ventura	7	21	Conventional
Sum of Conventional	**177**	**531**	**Conventional**
Total	**322**	**966**	**All**

Estimated Throughput of ORVR Fleet Fueling Facilities

South Coast AQMD provided a list of the permitted maximum allowable monthly throughput for 55 of the ORVR fleet fueling facilities within their jurisdiction. Staff assumed that each of the other facilities within the South Coast AQMD have a permitted maximum throughput of 5000 gallons per month. By totaling all of these permitted throughput values and dividing by the total number of South Coast AQMD's ORVR fleet fueling facilities, staff calculated an average maximum permitted throughput of 39,196 gallons per month at each facility.

Staff assumed that the actual throughput of each facility is exactly 50% of the maximum permitted throughput. Based on this assumption, the actual monthly throughput per facility is:

39,196 gallons per month x 0.50 = 19,598 gallons per month at each facility

This average throughput value is based on data from South Coast AQMD, but is assumed to be representative of ORVR fleet fueling facilities throughout California.

Uncontrolled Spillage Rate for Conventional Nozzles

Staff estimates that spillage from conventional nozzles to be 0.61 pounds per 1000 gallons of fuel dispensed. This number is derived from a study[1] conducted by ARB

staff in 1989-1990. Although the study took place many years ago, the technology used in conventional nozzles has not changed significantly. Staff believes that 0.61 pounds per 1000 gallons dispensed is a conservative estimate of actual spillage from conventional nozzles. It is below the rate specified in EPA AP-42[2], the Environmental Protection Agency document containing air pollutant emission factors (July, 2008), which lists spillage of gasoline from vehicle refueling at service stations as 0.7 pounds per 1000 gallons of throughput.

Statewide Uncontrolled Emissions from Conventional Nozzles

In order to estimate statewide uncontrolled emissions for conventional nozzles at ORVR fleet fueling facilities, staff simply applied the uncontrolled spillage rate of 0.61 pounds per 1000 gallons dispensed to the estimated throughput of the 177 ORVR fleet fueling facilities where conventional nozzles are currently in use. The total annual statewide uncontrolled emissions from conventional nozzles are:

$$\frac{0.61 \text{ pounds}}{1000 \text{ gallons}} \times \frac{19{,}598 \text{ gallons}}{\text{facility (monthly)}} \times \frac{12 \text{ months}}{\text{year}} \times 177 \text{ facilities} = 25{,}392 \frac{\text{pounds}}{\text{year}}$$

Proposed Controlled Spillage Rate for ECO Nozzles

Staff has proposed to adopt a maximum allowable spillage standard of 0.12 pounds per 1000 gallons dispensed for ECO Nozzles. This standard is a 50% reduction from the current requirement for Phase II EVR nozzles. Based on the performance of EVR nozzles during certification testing, staff believes that actual spillage rates from ECO Nozzles will be lower than the new maximum allowable rate of 0.12 pounds per 1000 gallons. However, to be conservative, staff has chosen to base all emissions estimates on the proposed maximum allowable rate. Since all current EVR nozzles certified under CP-201 met the new 0.12 pounds per 1000 gallons dispensed spillage standard, it is expected that CP-201 will be updated with new spillage criteria at some point in the future. This would result in further reduction in emissions from fueling operations throughout the state with no additional costs, therefore improving the cost effectiveness of the existing EVR program.

Statewide Reductions from Converting to ECO Nozzles

To calculate the emission reductions associated with converting conventional nozzles to ECO Nozzles, staff subtracted the controlled spillage rate from the uncontrolled spillage rate.

$$\underset{\text{Uncontrolled}}{\frac{0.61 \text{ pounds}}{1000 \text{ gal.}}} - \underset{\text{Controlled}}{\frac{0.12 \text{ pounds}}{1000 \text{ gal.}}} = \underset{\text{Reduction}}{\frac{0.49 \text{ pounds}}{1000 \text{ gal.}}}$$

To calculate the total annual statewide emissions reductions associated with converting to ECO Nozzles at the 177 ORVR fleet facilities currently equipped with conventional nozzles, staff simply applied the reduction in spillage rate (0.49 pounds per 1000 gallons) to the estimated throughput of the 177 ORVR fleet fueling facilities where conventional nozzles are currently in use. The annual reduction in statewide emissions that will be achieved by converting from conventional nozzles to ECO Nozzles is:

$$\frac{0.49 \text{ pounds}}{1000 \text{ gallons}} \times \frac{19{,}598 \text{ gallons}}{\text{facility (monthly)}} \times \frac{12 \text{ months}}{\text{year}} \times 177 \text{ facilities} = 20{,}397 \frac{\text{pounds}}{\text{year}}$$

Note that no emission reduction would be achieved at the 145 ORVR fleet fueling facilities that are currently using EVR nozzles. As mentioned earlier, EVR nozzles can easily comply with the 0.12 pounds per 1000 gallons. For that reason staff is assuming that EVR nozzles would emit no more than 0.12 pounds per 1000 gallons. This is the reason that it is assumed that there is no emission benefit when converting from EVR nozzles to ECO Nozzles.

Cost and Cost Savings

Equipment Costs

Staff determined the annualized cost of the regulation by estimating the number of ECO Nozzles that would be purchased and operated in each of the first five years that the regulation is in effect. For purposes of this analysis, it is assumed that ECO Nozzles will be available starting in 2015. Based on the estimated four-year life of current nozzles, staff estimates that one fourth (25%) of nozzles at ORVR fleet fueling facilities will be replaced with will be replaced with ECO Nozzles in 2015. An additional 25% of nozzles at ORVR fleet fueling facilities will be replaced in each of the next three years, such that all ORVR fleet fueling nozzles are ECO Nozzles by the end of 2018. Staff calculated the replacement cost of an average hanging hardware set across the ORVR fleet fueling facility population, with replacement cost calculated separately for EVR and conventional hanging hardware.

For the 177 facilities converting from conventional to ECO Nozzle hanging hardware, staff determined the replacement cost for all required hanging hardware to be $185 per fueling point. This cost would be experienced on average every four years, and there are approximately 531 affected fueling points. Refer to Table 5. Similarly, For the 145 facilities converting from Phase II EVR to ECO Nozzle hanging hardware, staff determined the replacement cost for all required hanging hardware to be a savings of $305 per fueling point as compared to replacing with all new EVR hanging hardware. This savings would be experienced on average every four years as existing equipment wears out, and there are 435 affected fueling points. Refer to Table 6.

Table 5 – Cost of Converting from Conventional to ECO Nozzles

Year	# ECO Nozzles Sold annually (total of 531; 132.75/year)	$185 unit cost amortized over 4-year life of nozzle, 5-year life of regulation	ECO Nozzles Providing Benefits in any given year	Annual Cost of Regulatory Compliance	Present Value of Regulatory Compliance Cost
2015	132.75	$52.17	132.75	$6,926	$6,926
2016	132.75	$52.17	265.5	$13,852	$13,192
2017	132.75	$52.17	398.25	$20,778	$18,846
2018	132.75	$52.17	531	$27,703	$23,931
2019	132.75	$52.17	531	$27,703	$22,792
				Total	**$85,687**

Table 6 – Savings of Converting from EVR to ECO Nozzles

Year	# ECO Nozzles Sold annually (total of 435; 108.75/year)	$305 cost savings amortized over 4-year life of hose	ECO Nozzles Installed in any given year	Annual Cost (Savings) of Regulatory Compliance	Present Value of Regulatory Compliance Cost (savings)
2015	108.75	$-86.01	108.75	$-9,354	$-9,354
2016	108.75	$-86.01	217.5	$-18,708	$-17,817
2017	108.75	$-86.01	326.25	$-28,062	$-25,453
2018	108.75	$-86.01	435	$-37,416	$-32,321
2019	108.75	$-86.01	435	$-37,416	$-30,782
				Total	**$-115,728**

Fuel Savings

The ECO Nozzle proposal will result in a fuel savings for owners of ORVR fleet fueling facilities that have replaced their current conventional nozzles with ECO Nozzles. The reduction in spillage achieved by ECO Nozzles results in more fuel successfully transferred from the storage tank to the vehicles being fueled, so it is appropriate to offset the ECO Nozzle hanging hardware replacement costs with the value of fuel savings. Staff determined the annual value of statewide fuel savings due to ECO Nozzles by multiplying the annual fuel savings of this proposal by the average value per gallon of the fuel saved. Staff estimates that the value of fuel that will be saved in 2017 will be approximately $3.37 per gallon. This is based upon averaging the 2015-2019 "Low Price" case of the June, 2013, California Energy Commission forecast[3] and adjusting from inflation to determine the value of in 2014 (current) dollars. The "Low Price" was chosen because savings are proportional to fuel costs and staff does not want to overstate the value of fuel saved. By multiplying the $3.37 price per gallon by the statewide emissions reductions of 20,397 pounds per year, and a conversion factor of 6.2 pounds per gallon of gasoline, staff estimates the value of the statewide annual fuel savings from ECO Nozzles to be approximately $11,100 upon full implementation of the ECO Nozzle regulation in 2018. See Table 7 for calculations of the value of fuel saved.

Table 7 – Value of Fuel Saved

Year	Sites Experiencing Benefits from ECO Nozzle in any given year	Lbs. of ROG Emissions Reduced	Gallons of Fuel Saved Per Year	Annual Fuel Savings @ $3.37/gallon	Present Value of Regulatory Fuel savings (discounted @ 5%)
2015	44.25	5,099	822.5	$-2,772	$-2,772
2016	88.5	10,198	1,645	$-5,544	$-5,280
2017	132.75	15,298	2,468	$-8,317	$-7,542
2018	177	20,397	3,290	$-11,086	$-9,578
2019	177	20,397	3,290	$-11,086	$-9,122
Total		**71,389**			**$-34,293**

By combining the annual statewide hanging hardware replacement costs and fuel savings related to upgrading to ECO Nozzles, staff determined the net annual statewide cost for the proposed ECO Nozzle regulation for each of the first five years of the requirement. This is shown in Table 8, using present value (2014) dollars.

Table 8 – Total Cost (Savings) of ECO Nozzle Proposal over 5 Years

Year	Cost of Replacing Conventional Nozzles with ECO Nozzles	Savings of Replacing EVR Nozzles with ECO Nozzles	Value of Fuel Saved	Total (In 2014 Dollars)
2015	$6,926	$-9,354	$-2,772	$-5,200
2016	$13,192	$-17,817	$-5,280	$-9,905
2017	$18,846	$-25,453	$-7,542	$-14,149
2018	$23,931	$-32,321	$-9,578	$-17,968
2019	$22,792	$-30,782	$-9,122	$-17,112
Total	**$85,687**	**$-115,728**	**$-34,293**	**$-64,334**

Cost Effectiveness of the ECO Nozzle Proposal

To compare regulations on a cost effective basis, staff uses the measure of dollars spent per pound of emissions reduced ($/lb). This was determined by dividing the net annualized statewide cost of the regulation by the average annual emissions reductions of the regulation for the first five years that the regulation is in effect. Because nozzles will be replaced as they wear out over their expected four year service life, the benefits of the ECO Nozzle proposal increase in each of the first four years of the regulation. Full implementation is reached after four years, so the expected costs and emissions benefits stabilize at that point. Staff estimates the cost effectiveness of the proposed ECO Nozzle regulation over five years to be a savings of $0.90 per pound of ROG emissions reduced.

$-14,859 per year / 14,278 pounds per year = $-1.04 / pound

Works Cited

[1] *Comparison of Spill Frequencies and Amounts at Vapor Recovery and Conventional Service Stations in California,* by J. Morgester, R. Fricker, and H. Jordan, 1991

[2] EPA AP-42, available online at http://www.epa.gov/ttn/chief/ap42/ch05/final/c05s02.pdf

[3] California Energy Commission,
Transportation Energy Office, Fuels and Transportation Division
Crude Oil and Transportation Fuel Price Cases for the 2013 IEPR
Inputs and Methods for the Transportation Energy Demand Forecast
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http://www.energy.ca.gov/2013_energypolicy/documents/2013-06-26_workshop/presentations/04_Price_Forecasts-Ryan_RAS_21Jun2013.pdf

Attachment 1

ECO Nozzle Cost Effectiveness Summary Table

ORVR Fleet Fueling Facility Population[9]	Currently EVR	Currently Conventional	Total	
Number of Facilities	145	177	322	
Nozzles per Facility	3	3	3	
Number of Nozzles	435	531	966	
AVERAGE HANGING HARDWARE LIFE	4	4	N/A	yr
EMISSION LIMIT FACTOR				
Current	0.12	0.61	N/A	lb/1000 gal.
Proposed	0.12	0.12	N/A	lb/1000 gal.
Change	0	0.49	N/A	lb/1000 gal.
AVERAGE FUEL THROUGHPUT				
Annually Per Facility	235,176	235,176	N/A	Gal./year
Annually Statewide	34,100,520	41,626,152	75,726,672	Gal./year
ANNUAL BASELINE EMISSIONS (After ECO Nozzle is Fully Implemented)				
Annually Per Facility	28.2	143.46	N/A	Lbs./year
Annually Statewide	4,092	25,392	29,484	Lbs./year
ANNUAL CONTROLLED EMISSIONS (After ECO Nozzle is Fully Implemented)				
Annually Per Facility	28.2	28.2	N/A	Lbs./year
Annually Statewide	4,092	4,995	9,087	Lbs./year
ANNUAL EMISSION REDUCTIONS (After ECO Nozzle is Fully Implemented)				
Reduction in Statewide Emissions of ROG	0	20,397	20,397	Lbs./year
ANNUAL GASOLINE SAVINGS (After ECO Nozzle is Fully Implemented)				
Statewide Gallons Saved	0	3290	3290	Gal./year
Statewide $ Saved (Assumes 2017 Gasoline priced at $3.37 per gallon)	0	11,087	11,087	$/year

[9] Population estimates based on 2013 data, and may change by 2019 when ECO Nozzles will be fully implemented.