Establishing Graffiti Emissions as a Nonpoint Source Sector

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ABSTRACT

Nationally, the annual cost of monitoring, detecting, removing, and repairing graffiti damage has been estimated as high as $15 to $18 billion. In Clark County, Nevada, it has been estimated that the costs to the public and private sectors are $30 million annually. These significant costs emphasize the importance of educating young people about the consequences of graffiti.

Yet noticeably missing from many graffiti education campaigns is detailed discussion about the impact graffiti has on air quality. In 1994, former EPA Deputy Administrator, Alvin Alm, observed that the United States was ". . . nurturing a new generation that has much more knowledge and a different ethic about the relationship of man to the environment . . . ." That environmental ethic is arguably even more focused today as we learn about the serious consequences of climate change.

Within Clark County, it has been estimated that volatile organic compound (VOC) emissions from graffiti can be greater than emissions from several nonpoint sectors typically tracked by EPA. In 2008, an estimated 31 tons were emitted within Clark County, and 4,862 tons nationwide. By including graffiti-related emissions in EPA's triennial effort to establish a national emissions inventory, policymakers would be in a better position to understand graffiti's impact on air quality.

To achieve that purpose, this paper proposes a unique set of source classification codes (SCCs) for emissions proximally related to the actual act of graffiti, and methodologies for estimating those emissions. Collectively, these SCCs constitute the graffiti nonpoint sector.

INTRODUCTION

The U.S. Department of Justice classifies graffiti into several categories: tagging; gang-related; artistic; isolated or spontaneous acts; malicious or vindictive acts; and ideological.[1] Tagging is the most common form of graffiti. It involves the placement of a signature marking identified with a person or persons—for the primary purpose of being seen by others. At a national level, it has been estimated that 80 percent of all graffiti is a result of tagging activity, 10 percent is gang-related, and 5 percent is artistic.[2]

Minors play a significant role in generating graffiti. In 2008, approximately 107,300 juveniles were arrested for vandalism nationwide. Of that total, approximately 40 percent were 14 years old or younger.[3] A substantial portion of vandalism arrests are related to graffiti. In Clark County, Nevada, there were over 500 arrests in 2007 that were graffiti-related.[4]

"He paints, they tag, he paints, they tag . . . ."[5] This has been described as the dance that takes place between persons whose job it is to abate graffiti and those who generate the graffiti. Phrased in air quality terms, the dance might go like this:

"He emits VOCs, they emit VOCs, he emits VOCs, they emit VOCs . . . ."

VOCs are precursors of ozone. Since emissions related to graffiti are primarily VOC-based, they contribute to the formation of ground-level ozone. To better understand the impact that graffiti emissions have on air quality, this paper attempts to accomplish the following objectives: (i) to propose changes to the SCC framework for the purpose of facilitating tracking of emissions from the graffiti sector; (ii) to propose methodologies for calculating graffiti emissions; and (iii) to quantify graffiti-related emissions at both a local and national level.

At the local level, graffiti sector emissions were estimated for Clark County. Located in the Mojave Desert, Clark County has a residential population of approximately 2 million. In 2004, most of the populated area of the county was designated nonattainment for ozone. Therefore quantifying VOC emissions from graffiti is of interest.

Using the methodologies described in this paper, it was estimated that during 2008 approximately 31 tons of VOC emissions were emitted in Clark County from the graffiti sector. Nationally, approximately 4,862 tons of VOC emissions were emitted from the graffiti sector.

The emissions estimate for Clark County is relatively modest compared to contributions from significant nonpoint source sectors such as industrial surface coating, degreasing, and consumer products. However, the graffiti sector emissions were greater than that from several nonpoint sectors routinely included in national emissions inventories and for which EPA has established default values and historically tracked. Specifically, the graffiti sector emissions were greater than those emitted from auto body refinishing (28 tons), traffic marking (25 tons), structure fires (13 tons), pesticide (9 tons), vehicle fires (6 tons), and open burning (< 1 ton) nonpoint sectors.

The arrest records for graffiti-related incidents demonstrate the significant role that an impressionable youth have in generating graffiti. Yet the attentiveness of younger people toward environmental issues should not be underestimated. A discussion about environmental impacts should be an important element of campaigns to educate minors and young adults about the deleterious aspects of graffiti. In particular, people should be made aware of graffiti's contribution towards the degradation of our air quality environment.

BODY

The body of this paper is divided into four sections: background information; classification of the individual emissions making up the graffiti sector; methodologies for calculating emissions; and a summary of the emissions estimates.

Background Costs Involved and Regulatory Efforts to Mitigate Graffiti

To appreciate the economic impact that graffiti has on society—especially upon the numerous fiscally constrained state and local governments—it is useful to provide some background information about estimated costs and regulatory mitigation efforts associated with graffiti.

Costs of Graffiti

Graffiti has been broadly defined to mean " . . . any unauthorized inscription, word, figure or design that is marked, etched, scratched, drawn or painted on the public or private property, real or personal, of another, which defaces such property."[6] The types of property typically damaged by graffiti include: commercial and residential walls/fences adjacent to a public space; transportation systems including trains, buses, monorails, subways, and transit stations; schools; bridges; storm drains; culverts;

washes; utility poles; utility boxes; traffic signs; sidewalks; public tables; public benches; parking garages; billboards; vending machines; and public restrooms.

Within Clark County, the obligation placed on property owners to remove graffiti varies depending on whether it is a residential or commercial property. For example, the County will pay to remove graffiti located on residential property that is visible from a public right of way or located around the perimeter of the property.[7] However, "[b]usiness or commercial property owners are responsible for graffiti removal from commercial properties including apartments, townhomes, gated communities, power easements, utility boxes and mailboxes."[8] Though the aesthetic and socioeconomic impacts of graffiti can be difficult to quantify, various state and local governments have attempted to estimate costs associated with damage and abatement.

In 2006, local government agencies spent $3,690,876 to abate graffiti within Clark County.[9] These costs include preemptive actions such as budgeting $0.3 million to retrofit five bridges with fences to deter acts of graffiti.[10] Damages to public property were estimated to be $5.2 million, and were even greater for private property.[11] In 2009, the governor of the State of Nevada issued a proclamation stating that ". . . more than 30 million dollars in public and private funds are expended annually addressing the crime of graffiti vandalism in southern Nevada . . . ."[12]

In Phoenix, Arizona, it was estimated that more than $6 million is spent annually by city departments, local utilities, and other governmental entities to clean graffiti.[13] The City's Neighborhood Services Department alone has 14 full-time employees working seven days per week in 10-hour shifts to clean graffiti throughout the city.

At the national level, the costs associated with graffiti vary widely and have been estimated to be as high as $15 to $18 billion dollars.[14] A report published by the U.S. Department of Justice estimated that $12 billion a year is spent to clean up graffiti nationally.[15] Other estimates have placed the national figure at $8 billion.[16]

Regulatory Efforts

Back in 1992, the Chicago City Council banned the sale of spray paint and indelible jumbo markers to private citizens.[17] In response, manufacturers, wholesalers, and retailers of the banned products brought suit in federal district court (*National Paint & Coatings Assoc. v. City of Chicago*, 835 F.Supp. 421 (N.D. Ill. 1993)). The federal district court found that the sales ban violated the dormant commerce clause, violated plaintiff's substantive due process rights, and exceeded the city's home-rule powers. The court held for the plaintiffs, arguing that those participating in the act of graffiti would seek supplies elsewhere and that the ban would deprive law-abiding users of the products.[18]

The City of Chicago appealed this decision to the 7th Circuit Court. The appellate court concluded that the lower court had erred in its findings and determined that the sales ban was lawful.[19] A subsequent appeal by the National Paint & Coatings Association to the U.S. Supreme Court was denied.[20]

In response to the ban on spray paint, the National Paint & Coating Association formed the National Council to Prevent Delinquency (NCPD). Though the name conveys the impression of a governmental organization, the NCPD is funded by members of the National Paint & Coatings Association's spray paint manufacturing committee.[21]

NCPD has been active in graffiti mitigation efforts. They have created a Web site dedicated to addressing the negative impacts of graffiti.[22] Their research has also been cited by several organizations. However, it is not unreasonable to suggest that concurrent with their efforts to mitigate graffiti, they have a significant interest in minimizing potential impacts on the sale of spray paint.

To date, Chicago remains the only city that has a sales ban on spray paint that applies to all private citizens.[23] However, numerous municipalities and even states have attempted to mitigate graffiti by enacting laws restricting the sale of spray paint and other related contraband to minors and young adults.

For example, in New York City there is a ban on the sale of spray paint, indelible markers, and etching acids to persons under the age of 21.[24] In Albuquerque, New Mexico, there is a ban on the sale of spray paint and glass etching cream to persons under 18 years of age.[25] In Pueblo, Colorado, there are extensive anti-graffiti regulations that, *inter alia*, ban the sale of spray paint, paint sticks, and broad-tipped markers to minors.[26] In California, there are state-wide regulations restricting the sale of spray paint and etching creams to minors.[27]

Numerous municipalities have also adopted laws mandating abatement of graffiti. Some of the abatement requirements in Clark County were previously discussed. In Portland, Oregon, a graffiti nuisance code stipulates that:

> "[t]he owner or occupant of any property in the City shall remove any graffiti from such property within ten (10) days of the graffiti's appearance."[28]

Some municipalities have imposed preemptive requirements. For example, the Los Angeles Municipal Code presently requires that:

> "In all buildings, the first nine feet, measured from grade, of exterior walls and doors shall be built and maintained with a graffiti resistant finish consisting of either a hard, smooth impermeable surface such as ceramic tile or baked enamel, or a renewable coating of an approved anti-graffiti material, or a combination of both." [29]

An exception is made for building owners that agree to file a document titled *Covenant and Agreement Regarding Maintenance of Building (Graffiti Removal)* where, upon filing, the owner is obliged to remove graffiti within seven days of its application or within 72 hours of being notified.[30]

Classification of Graffiti Sector Emissions

EPA classifies emissions using source classification codes (SCCs). To understand the rationale behind the selection of new proposed SCCs for graffiti-related emissions, it is useful to provide some background information about nonpoint sources, to define the scope of graffiti emissions, and to describe the structural framework of the SCC system.

Nonpoint Sources

Anthropogenic emissions are divided into mobile, nonroad, point, and nonpoint sources. In 2008, EPA defined nonpoint sources to mean the collective representation of ". . . individual sources that have not been inventoried as specific point or mobile sources . . . [they] are typically too small, numerous, or difficult to inventory using the methods for the other classes of sources."[31] Due to their ubiquitous nature, graffiti emissions fall under the category of nonpoint sources.

Prior to EPA's formal definition, nonpoint sources were widely known as area sources, and are often still referred to in that manner. To prevent confusion it may be useful to explain that Congress has already defined an area source to mean ". . . any stationary source of hazardous air pollutants [HAPs] that is not a major source."[32] So long as HAP emissions inventory developments were infrequent, the dual use of the phrase was not an issue. However, EPA eventually determined that efforts to develop HAP emission inventories were increasing to an extent that the two meanings of "area source" would eventually cause unacceptable confusion.[33]

Scope of the Graffiti Sector

The Clean Air Act describes the lifecycle of greenhouse gas emissions as the aggregate quantity of emissions associated with a source. These include both direct and significant indirect emissions.[34] Consistent with this view is the notion that emissions from the graffiti sector should include not only emissions from the actual act of graffiti (e.g., spray from an aerosol spray paint can), but also those that are proximally related to the act.

There is precedent for an aggregate perspective toward emissions with other nonpoint sectors. As an example, the portable fuel container (PFC) sector includes not only emissions emitted from the PFC, but also spillage emissions that occur when PFCs are filled. Even though spillage is not a direct emission from the PFC, it is proximally related.

Though a proximal requirement can be subjective, the following emission sources appear to fall comfortably within the ambit of the graffiti sector: (i) anti-graffiti coatings used to protect structures from graffiti; (ii) paints used to cover graffiti; (iii) solvents and paint strippers used to remove graffiti; and (iv) aerosol spray paints used to produce graffiti. (Note: Indelible and broad-tipped markers, etching acids, and creams have either zero or negligible VOC emissions and do not warrant classification).

There are also several indirect emissions related to graffiti that would not otherwise be emitted. However, in the context of a national emissions inventory effort, they are arguably too attenuated and therefore not proximal to the actual act of graffiti. The following emissions arguably fall into this category: (i) portable generators that power paint spray guns, pressure water-washing systems, and abrasive blasting systems used to abate graffiti; (ii) portable fuel containers used to store refueling gasoline for the portable generators; (iii) solvents used to clean painting equipment; and (iv) vehicles used to transport equipment and graffiti clean-up crews. These emissions should also already be accounted for in other nonpoint sectors.

Current Classification

Currently there are 1,230 nonpoint SCCs that are active and 1,006 nonpoint SCCs that have been retired.[35] Among the active SCCs, there are none identified with graffiti-related emissions. As a result, all graffiti-related emissions are lumped with other emissions and there is no mechanism for identifying their contribution. To understand why graffiti emissions are classified the way they are, and how proposed SCCs identified with graffiti emissions may logically fit within the existing SCC framework, it is useful to provide background information about the organizational structure of nonpoint SCCs.

Nonpoint SCCs are identified by ten-digit codes. They can be partitioned into four levels. For nonpoint SCC, *abcdefghij*; "*ab*" represents level one, "*cd*" represents level two, "*efg*" represents level three, and "*hij*" represents level four.

At the first level, nonpoint SCCs are divided into seven categories. SCCs having the form: (i) 21*cdefghij* represent stationary source fuel combustion sources; (ii) 22*cdefghij* represent mobile sources; (iii) 23*cdefghij* represent industrial processes sources; (iv) 24*cdefghij* represent solvent utilization sources; (v) 25*cdefghij* represent storage and transport sources; (vi) 26*cdefghij* represent waste disposal, treatment, and recovery sources; and (vii) 28*cdefghij* represent miscellaneous area sources.

All graffiti-related emissions are included within solvent utilization classification 24*cdefghij*. At the second level, graffiti-related emissions are included within two subcategories. The emissions associated with paints, anti-graffiti coating, and solvents used to remove graffiti are classified under the "surface coating" subcategory 2401*efghij*. Emissions from aerosol spray paint are classified under the "miscellaneous non-industrial: consumer and commercial" subcategory 2460*efghij*.

The following table describes the SCCs under which emissions from the graffiti sector are likely currently included.

Table 1. Current classification of graffiti sector emissions

Graffiti Sector Emission	Currently Classified under SCC	1st Level Description	2nd Level Description	3rd Level Description	4th Level Description
Anti-graffiti coating used to expedite abatement	2401001050	Solvent Utilization	Surface Coating	Architectural Coatings	Total: All Solvent Types
Water-based paint used to cover graffiti	2401003000	Solvent Utilization	Surface Coating	Architectural Coatings – Water-based	All Other Architectural Categories
Solvent used to remove graffiti	2401100000	Solvent Utilization	Surface Coating	Industrial Maintenance Coatings	Total: All Solvent Types Thinning and Clean-Up of Solvent-Based
Aerosol spray paint used to generate graffiti	2460510000	Solvent Utilization	Miscellaneous Non-Industrial: Consumer and Commercial	Coatings and Related Products: Aerosol Spray Paints	Total: All Solvent Types

Proposed Classification

There are several possible ways to create SCCs for the purpose of individually classifying graffiti emissions. One approach would be to create a separate second-level SCC under which all graffiti emissions could be categorized, e.g., SCC 2466*efghij*. However, this approach would require subtracting emissions from SCCs that currently include graffiti emissions. For example, emissions from the water-based paint used to cover graffiti would need to be subtracted from the total amount of water-based paint emissions categorized under SCC 2401003000.

Another approach would be to classify graffiti emissions under the SCCs that they are currently categorized. This would require changes only at the fourth SCC level in order to individualize the emissions. This seems to be the more reasonable approach and the proposed SCCs are described in the table below.

Table 2. Proposed SCCs to classify graffiti sector emissions

Emission Source	Proposed New SCCs	1st Level Description	2nd Level Description	3rd Level Description	4th Level Description
Anti-graffiti coating to expedite abatement (publicly funded)	2401001012	Solvent Utilization	Surface Coating	Architectural Coatings	Anti-Graffiti Coating (publicly funded)
Anti-graffiti coating to expedite abatement (privately funded)	2401001013	Solvent Utilization	Surface Coating	Architectural Coatings	Anti-Graffiti Coating (privately funded)
Water-based paint used to cover graffiti (publicly funded)	2401003100	Solvent Utilization	Surface Coating	Architectural Coatings – Water-based	Graffiti (publicly funded)
Water-based paint used to cover graffiti (privately funded)	2401003200	Solvent Utilization	Surface Coating	Architectural Coatings – Water-based	Graffiti (privately funded)
Solvent to remove graffiti (publicly or privately funded)	2401100100	Solvent Utilization	Surface Coating	Industrial Maintenance Coatings	Graffiti Removal (publicly and privately funded)
Aerosol spray paint used to generate graffiti (on public or residential property)	2460510100	Solvent Utilization	Miscellaneous Non-Industrial: Consumer and Commercial	Coatings and Related Products: Aerosol Spray Paints	Graffiti (public or residential property)
Aerosol spray paint used to generate graffiti (on commercial or industrial property)	2460510200	Solvent Utilization	Miscellaneous Non-Industrial: Consumer and Commercial	Coatings and Related Products: Aerosol Spray Paints	Graffiti (commercial or industrial property)

The SCCs proposed in Table 2 are divided between emissions that are emitted as a result of public funding and those emitted as a result of private funding. Emissions from spray paint are categorized based on whether the resulting graffiti appears on public or residential property (where abatement is generally publicly funded) or on commercial or industrial property (where abatement is generally privately funded). Solvent emissions are not partitioned because they are based on a California Air Resources Board (CARB) inventory that does not distinguish between funding sources.

Methodologies

The methodologies for calculating emissions of sources listed in Table 2 are described in the following sections. Each SCC is discussed separately except for the anti-graffiti coating SCCs, which are combined since they rely on the same inventory information.

Methodology: Paint – Publicly Funded – SCC 2401003100

Paints are composed of pigments, binder materials, and a solvent that facilitates application of the pigment/binder mixture. As the solvent evaporates, the mixture solidifies. Most paints sold today, flat and non-flat, are water-based. For the purpose of estimating emissions from paint used to cover graffiti, it is assumed that only water-based paints are utilized, however, even water-based paints emit VOCs.

Emissions from paint can be estimated by multiplying the activity data (i.e., throughput), an emission factor, and the control efficiency.[36] Activity data for paint can be obtained from the U.S. Census Bureau's survey of paint and allied products.[37] For this paper it is assumed that exterior water-based paint used for structures (i.e., product code 3255101131) is the predominant paint type used to cover graffiti.

In 2008, a total of 96,136,000 gallons of this paint were shipped nationally, and approximately 627,320 gallons (population-weighted) were shipped to Clark County.[38] The estimated amount of paint purchased with public funds used to cover graffiti within Clark County was approximately 35,833 gallons in 2006. For the purpose of establishing an inventory for 2008, it is assumed that paint consumption in 2006 is relatively constant from year to year. The table below provides the basis for the paint usage estimate.

Table 3. Estimated amount of paint used to cover graffiti in Clark County (2006)

Entity	Publicly Funded Paint to Cover Graffiti (gallons)	Source
Unincorporated Clark County	17,000	Mike Kalil, Las Vegas Review Journal, *Graffiti: Penalty sought to intimidate*, p. 10A (August 4, 2006).
City of Las Vegas	7,000	Reported amount for unincorporated Clark County and City of Las Vegas was 24,000 gallons. M. Johnson, Las Vegas Review Journal, *By the Numbers*, p. 10A (August 4, 2006).
City of North Las Vegas	4,312	Maria Phelan, Southwest View, *Police Ask Public to Help Stop Taggers*, http://www.viewnews.com/2006/VIEW-Dec-05-Tue-2006/SWest/11106841.html.
City of Henderson	(est.) 6,800	Based on number of Henderson and Clark County FTE positions tasked to abate graffiti .
Boulder City	(est.) 337	Population weighted.
City of Mesquite	(est.) 384	Population weighted.
TOTAL:	**35,833**	

In 1995, EPA's emission inventory improvement program (EIIP) set forth a 0.74 lbs per gallon emission factor for water-based paints.[39] Three years later, EPA issued VOC emissions standards for architectural coatings pursuant to section 183(e) of the Clean Air Act. The standards resulted in a 20 percent VOC reduction compared to emissions that would have been emitted without the standard. This reduction has occasionally been presumed to apply uniformly to all architectural coatings emissions. Reducing 0.74 lbs per gallon by 20 percent results in an emissions factor of 0.59 lbs per gallon.

Since 1998, additional control limits have been adopted by various agencies so that manufacturers of paint have further reduced the average VOC content. The results of a small survey of water-based paint products are provided in the table below, and suggest that the average VOC content is less than 0.59 lbs per gallon.

Table 4. Survey of VOC emission factors for water-based paint

Description	Product Code	VOC Content (g/l)	VOC Emission Factor (lbs/gallon)
Glidden endurance exterior latex semi-gloss house paint - black	DX6079N	48.82	0.41
Glidden exterior latex semi-gloss paint base 2	GL 6812	48.73	0.41
Glidden spread exterior latex satin paint base 2	SP 2913	47.97	0.40
A-100® Exterior Satin Latex Paint, White	A82W510	--	0.36
A-100® Exterior Flat Latex Paint, Extra White	A6W151	--	0.41
A-100® Exterior Gloss Latex Paint, Light Yellow	A8Y56	--	0.52
Benjamin Moore Profinish® Exterior Latex 100% Acrylic Flat Finish	PF14	--	0.50
AURA waterborne exterior paint low lustre finish	634	--	0.50
		AVERAGE:	**0.44**

In determining which emission factor to apply, it was observed that many municipalities use recycled paint to cover graffiti.[40] Yet the average VOC content of recycled paint is not well documented. It was also noted that there are likely instances when solvent-based, rather than water-

based paint, is utilized to cover graffiti. Lacking definitive data, the 0.59 lbs per gallon emission factor was chosen to estimate paint emissions.

The following equations were used to estimate VOC emissions from water-based paint and from paint used to cover graffiti. Estimates were provided for Clark County and nationwide.

Equation (1) $E_{Cwbp2008} = [(T_{Nwbp2008}) \cdot (P_{C2008}) / (P_{N2008})] \cdot (EF_1) \cdot K_1$
Equation (2) $E_{Nwbp2008} = (T_{Nwbp2008}) \cdot (EF_1) \cdot K_1$
Equation (3) $E_{Cp(pub)} = (E_{Cwbp2008}) \cdot [(T_{Cp}) / (T_{Cwbp2008})]$
Equation (4) $E_{Np(pub)} = (E_{Cp(pub)}) \cdot [(P_{N2008}) / (P_{C2008})]$

where

$E_{Cp(pub)}$ = Emissions from paint used to cover graffiti (publicly funded), Clark County [tons/year]
$E_{Np(pub)}$ = Emissions from paint used to cover graffiti (publicly funded), U.S. [tons/year]
$E_{Cwbp2008}$ = Emissions from all water-based paint, Clark County [tons/year]
$E_{Nwbp2008}$ = Emissions from all water-based paint, U.S. [tons/year]
$T_{Nwbp2008}$ = Throughput of water-based paint, U.S. (2008) [gallons/year][41]
T_{Cp} = Throughput of paint used for graffiti, Clark County [gallons/year]
P_{N2008} = Population, U.S. (2008)
P_{C2008} = Population, Clark County (2008)
EF_1 = Emission factor [lbs/gallon]
K_1 = Conversion factor: (ton/2,000 lbs)

so that

$E_{Cwbp2008}$ = [(96,136,000 gallons/year) · (1,986,145) / (304,374,846)] · (0.59 lbs/gallon) · (ton/2,000 lbs)
= 185.06 tons/year

$E_{Nwbp2008}$ = (96,136,000 gallons/year) · (0.59 lbs/gallon) · (ton/2,000 lbs)
= 28,360 tons/year

$E_{Cp(pub)}$ = (185.06 tons/year) · [(35,833 gallons/year) / (627,320 gallons/year)]
= 10.57 tons/year

$E_{Np(pub)}$ = (10.57 tons/year) · [(304,374,846) / (1,986,145)]
= 1,619.84 tons/year

These results are documented in Table 9. Another method of estimating emissions is by utilizing land-based emission factors. The units of these land-based factors are of the form weight/area/time, e.g., lbs/acre/year. When estimating emissions by this means, one must account for graffiti being primarily present in urban environments rather than rural and sparsely populated areas.

For example, Clark County is comparable to the size of New Jersey.[42] Most of the county is sparsely populated with 89 percent of the land administered by federal agencies.[43] Approximately 97.2 percent of the population is located within the Bureau of Land Management (BLM) disposal boundary, a region that is approximately 291.4 square miles, but which compromises only 3.7 percent of the entire county.

The following equations can be used to calculate the land-based emission factors for the entire area of the Clark County and only its urbanized portion.

Equation (5) $EF_C = (T_{Cp} / A_C) \cdot EF_1 \cdot K_2$

Equation (6) $EF_{CUE} = (T_{CUEp} / A_{CUE}) \cdot EF_1 \cdot K_2$

where

EF_C = Land-based emission factor for all Clark County [lbs/acre/year]
EF_{CUE} = Land-based emission factor for Clark County urban environment [lbs/acre/year]
T_{Cp} = Throughput of paint used for graffiti, Clark County [gallons/year]
T_{CUEp} = Throughput of paint used for graffiti, Clark County urban environment [gallons/year][44]
A_C = Area, Clark County (land only) [sq. miles]
A_{CUE} = Area, Clark County urban environment (land only) [sq. miles]
EF_1 = Emission factor [lbs/gallon]
K_2 = Conversion factor: (sq. miles/640 acres)

so that

EF_C = ((35,833 gal/year) / (7,910 sq. mi.)) · (0.59 lbs/gal) · (sq. mi./640 acres)
= 0.0042 lbs/acre/year

EF_{CUE} = ((35,449 gal/year) / (291.4 sq. mi.)) · (0.59 lbs/gal) · (sq. mi./640 acres)
= 0.11 lbs/acre/year

The land-based emission factor for the urbanized portions of Clark County is 27 times greater than that for the entire area of Clark County. The importance of including only urbanized environments is made even more clear when noting the emissions disparity that results when the 0.11 lbs/acre/year factor is applied to the entire land mass of the U.S. as opposed to only its urbanized portion:

Equation (7) $E_{Np(pub)} = (A_N) \cdot (EF_{CUE}) \cdot K_3$

where

$E_{Np(pub)}$ = Emissions from paint used to cover graffiti (publicly funded), U.S. [tons/year]
A_N = Area, U.S. (land only) [sq. miles]
EF_{CUE} = Land-based emission factor for Clark County urban environment [lbs/acre/year]
K_3 = Conversion factor: (ton/2,000 lbs) · (640 acres/sq. miles)
= 0.32 (ton·acres)/(lbs·sq.miles)

so that

$E_{Np(pub)}$ = (3,511,023 sq. mi.) · (0.11 lbs/acre/yr) · 0.32 (ton·acres)/(lbs·sq.mi.)
= 123,588 tons/year

When comparing the 123,588 tons/year emissions total with the nationwide emissions estimate based on the EIIP emission factor (i.e., 1,620 tons/year—see Equation (4)), the emissions are approximately 76 times greater. To apply the land-based emission factor at the national level, the size of the urban portions of the U.S. must be calculated. One means of accomplishing this is to include only agency-defined urban areas and urban clusters.

The U.S. Census Bureau defines an *urban area* to mean a densely settled territory with a population of at least 50,000.[45] An *urban cluster* is defined as a densely settled territory with a population of at least 2,500, but less than 50,000. Data for urban areas and urban clusters are collected decennially by the U.S. Census Bureau.

During the census in 2000, collected data indicated that there were a total of 453 urban areas and 3,134 urban clusters nationwide.[46] To account for only urban land-based areas in the U.S., it is assumed that neither the increase in urban land-based areas since 2000, nor the amount of graffiti located in urban environments with populations less than 2,500, are significant. The statistical data is collected in the table below.

Table 5. Urban areas and urban clusters in the U.S. (2008)

Parameter	Urban Areas for populations ≥ 50,000	Urban Clusters for 2,500 ≤ populations < 50,000	Urban Areas and Urban Clusters for populations ≥ 2,500	Area of U.S. for entire population
Number	453	3,134		
Population	208,141,828	32,395,768	240,537,596	304,374,846
Area (sq. mi.)	72,081	20,472	92,552	3,511,023
Average Population Density	2,888	1,582	2,599	87

When the 0.11 lbs/acre/year emission factor is applied to the urbanized area of the U.S. (i.e., 92,552 sq. miles—see row 4, column 4 of Table 5), the result is 3,258 tons/year of VOC emitted nationally from paints used to cover graffiti. This compares favorably with the 1,620 tons/year estimate and demonstrates again the importance of including only urbanized environments.

Table 6 provides land-based emission factors for other geographical areas—relying on either reporting of publicly funded paint coverage or paint consumption data. Emissions from publicly funded paint constitute about a third of all emissions from the graffiti sector (see Table 9). If the other graffiti sector emission sources are included, the overall land-based emission factors are approximately three times higher (see last column in Table 6).

Table 6. Land-based emission factors

Location	Area (sq. mi.)	Paint Usage (gallons) *	Reported Paint Coverage (sq. ft.)	Year	Land-based Emission Factor for Paint (lbs/acre/year)	Overall Land-based Emission Factor (lbs/acre/year) ***
Within Los Angeles, California (near Hollywood)	0.2	(reported) 30,000		1993	137.00	400.00
Los Angeles County, California (urban environment only) [47]	732.5	167,000	50,000,000	2007	0.21	0.61
Denver, Colorado	153.3	19,100	** 5,720,000	2010	0.11	0.32
Clark County, Nevada (urban environment only)	291.4	(excludes Mesquite, see Table 3) 35,449		2006	0.11	0.32
U.S. (urban environment only)	92,552.3	5,500,000		2008	0.05	0.15

* Assumed paint coverage area is 300 square feet per gallon.

** Reported paint coverage was for the City of Denver only. Second -half year's usage was extrapolated based on first-half year's usage.[48]

*** Incorporates all emissions found in Table 9.

To establish the land-based emission factor for the City of Denver, it was assumed that the entire city's area (153.3 square miles) is an urban environment. To establish the land-based emission factor for Los Angeles County, it was assumed that the population density of the county's urbanized areas is approximately the same as that for Clark County, so that:

Equation (8) $A_{LUE} = (A_L) \cdot (A_{CUE} / A_C) \cdot (P_{L2007} / P_{C2007})$

where

A_{LUE} = Area, Los Angeles County urban environment (land only) [sq. miles]
A_L = Area, Los Angeles County (land only) [sq. miles]
A_C = Area, Clark County (land only) [sq. miles]
A_{CUE} = Area, Clark County urban environment (land only) [sq. miles]
P_{L2007} = Population, Los Angeles County (2007)
P_{C2007} = Population, Clark County (2007)

and

A_{LUE} = (4,061 sq. miles) · (291.4 sq. miles / 7,910 sq. miles)
· (9,774,971 / 1,996,542)
= 732.5 sq. miles

The land-based emission factors for Denver and Los Angeles County can be derived using Equation (6). Since paint consumption data for graffiti abatement is not available at the national level, U.S. throughput data is based on U.S. Census Bureau reports of water-based paint shipments and correlated with Clark County paint consumption data for the purpose of abating graffiti (see Equations (3) and (4)). The U.S. land-based emission factor is 0.05 lbs/acre/year, and is derived below.

Equation (9) $EF_{NUE} = (E_{Np(pub)}) / (A_{NUE}) \cdot K_4$

where

EF_{NUE} = Land-based emission factor, U.S. urban environment [lbs/acre/year]
$E_{Np(pub)}$ = Emissions from paint used to cover graffiti (publicly funded), U.S. [tons/year]
A_{NUE} = Area, U.S. urban environment (land only) [sq. miles]
K_4 = Conversion factor
= (2,000 lbs/ton) · (sq. miles/640 acres)
= 3.125 (lbs·sq.miles)/(ton·acres)

so that

EF_{NUE} = (1,619.84 tons/year) / (92,552 sq. miles) · 3.125 (lbs·sq.mi.)/(ton·acres)
= 0.05 lbs/acre/year

As shown in Table 6, the land-based emission factors for publicly funded paint can range from 0.05 to 0.21 lbs/acre/year for relatively large geographical areas. However there are also small areas within a city that experience particularly high amounts of graffiti activity. One publicized example of an area where extensive abatement activity resulted in high VOC emissions is located in Los Angeles, California, near Hollywood.[49]

Approximately 30,000 gallons of paint were used over the course of a year to cover graffiti in this 130-acre (0.2 sq. mile) area.[50] Using the methodology previously described in Equation (7), the

resulting land-based emission factor for publicly funded paint was approximately 137 lbs/acre/year—or four orders of magnitude larger than the other land-based emission factors. This reflects the relatively large amount of pollution that can be generated in areas where there is intense graffiti activity. Over the course of a year, the estimated amount of graffiti sector emissions from the 130-acre area were about 27 tons based on the 400 lbs/acre/year land-based emission factor from Table 6.

Methodology: Paint – Privately Funded – SCC 2401003200

Businesses and commercial owners are generally required by ordinance or code to abate graffiti that occurs on their property. This obligation extends to owners of telecommunication and private utility companies, private schools, shopping malls, owners of billboards, and the numerous other businesses located in all parts of a community.

In 2006, a Las Vegas Chamber of Commerce spokeswoman stated that the annual cost to the County to remove graffiti was several million dollars, and that the private sectors costs were even greater.[51] However, it is unclear whether the majority of the costs were associated with actual abatement or diminution in property value. In addition, there is a lack of data documenting the amount of paint and solvent used by businesses and commercial property owners to abate graffiti.

In the absence of readily available data, it was assumed that the amount of paint purchased by the private sector correlated with the number of establishments having at least five employees. The U.S. Census Bureau defines an establishment as " . . . a single physical location at which business is conducted or services or industrial operations are performed."[52] The table below provides data on the number of establishments within Clark County and at the national level.

Table 7. Number of establishments by employment size (2008)[53]

No. of Employees *	No. of Clark County Establishments	No. of U.S. Establishments
≥ 1	41,203	7,601,169
≥ 5	19,721	3,493,198
≥ 50	2,680	408,510

* The size group "1 to 4" provided by the U.S. Census Bureau was not relied upon because it includes establishments that did not report any paid employees during the March pay period, but paid wages to at least one employee some time during the year.

It was assumed that half of the establishments having at least five employees did not use any paint, and that the other half used an average of one gallon per year. Within Clark County, this amounted to 9,861 gallons of paint consumption during 2008. If it is assumed that the average paint coverage of one gallon is 300 square feet, and there were 41,023 total establishments, then this equates to approximately 25 percent of the establishments (i.e., 9,861/41,023) abating a 5' x 5' area once per month for a year. This may not be an unreasonable figure when considering the large number of establishments that rarely experience graffiti, and those that experience it quite frequently.

Using this methodology, the estimated combined total of publicly funded paint (35,833 gallons/year) and privately funded paint (9,861 gallons/year) was 45,694 gallons/year. This represents approximately 7.2 percent of all water-based paints shipped to Clark County during 2008. The emissions estimates from paint purchased by the private sector in Clark County (2.91 tons per year) and nationally (515 tons per year) are described below.

Equation (10) $E_{Cp(pri)} = (EST_C) \cdot (T_1) \cdot (EF_1) \cdot K_1$

Equation (11) $E_{Np(pri)} = (EST_N) \cdot (T_1) \cdot (EF_1) \cdot K_1$

where

$E_{Cp(pri)}$ = Emissions from paint used to cover graffiti (privately funded), Clark County [tons/year]
$E_{Np(pub)}$ = Emissions from paint used to cover graffiti (privately funded), U.S. [tons/year]
EST_C = No. establishments w/ at least 5 employees, Clark County [tons/year]
EST_N = No. establishments w/ at least 5 employees, U.S. [tons/year]
T_1 = Throughput of paint used for graffiti, Clark County [gallons/year]
EF_1 = Emission factor [lbs/gallon]
K_1 = Conversion factor: (ton/2,000 lbs)

so that

$E_{Cp(pri)}$ = (19,721/2) · (1 gal/yr) · (0.59 lbs/gal) · (ton/2,000 lbs)
= 2.91 tons/year

$E_{Np(pri)}$ = (3,493,198/2) · (1 gal/yr) · (0.59 lbs/gal) · (ton/2,000 lbs)
= 515.25 tons/year

Methodology: Spray Paint – Used on Public or Residential Property – SCC 2460510100

Spray paint is the primary source of VOC emissions from the assorted devices used to generate graffiti. However, estimating the amount of spray paint utilized to produce graffiti is complicated due to the absence of tracking information. An indirect means of arriving at an estimate can be achieved by knowing the amount of paint used to cover graffiti, and establishing a surface area correlation between the paint and the graffiti itself. To accomplish this, estimates must be obtained for the: (i) average amount of surface area covered by a can of spray paint; (ii) average amount of surface area covered by a gallon of paint; (iii) average VOC content of aerosol spray paint; and (iv) average ratio of paint used to cover graffiti and the surface area of the graffiti markings.

(i) Average amount of surface area covered by a can of spray paint

Manufacturer-advertised surface area coverage of aerosol spray paint varies depending on the volume of the can and the type of product being emitted. A brief review of advertised data available online suggests that the typical coverage of a 10 oz. spray paint can ranges from 11 to 15 square feet. Based on this information, it was assumed that a 10 oz. can of spray paint covers approximately 13 square feet of surface area.

(ii) Average amount of surface area covered by a gallon of paint

The advertised surface area coverage of a gallon of paint varies depending on paint type, temperature, and the surface area being covered. Typically, manufacturer claims vary from 300 to 400 square feet. However, graffiti is often scrawled on surfaces that contain fractures, voids, and other defects that lead to increased paint consumption. Paint used to cover graffiti can also require repeated opening and closing of paint containers—resulting in premature drying. Together, these factors reduce paint coverage. Based on these observations, it was assumed that a gallon of paint covers only about 300 square feet of surface area.

(iii) Average VOC content of aerosol spray paint

New reactivity-based national emission standards for aerosol coatings went into effect in 2009.[54] However, estimating ozone formation potential based on reactivity is complicated and outside the scope of this paper. Therefore, the methodology for calculating spray paint emissions was mass-based. The average VOC content of spray paint was based on a small survey of available data on MSDS sheets found online:

Table 8. Survey of aerosol spray paint products

Description	VOC Content (g/l)
ECO-SURE WHITE 37875 AEROSOL PAINT	584
Rust-Oleum, ID No. 1922830, PTOUCH +SSPR 6PK GLOSS NAVY BLUE 12 OZ	509
DEM-KOTE, Black Gloss, PRODUCT CODE: GR1VKA2000	481
KRYLON, Indoor/Outdoor Paint, Gloss Black, PRODUCT No.: 51601	413
KRYLON, OUTDOOR SPACES, Satin Finish, Black Onyx, PRODUCT No.: 2926	388
Rust-Oleum, ID No. 240251, PTOUCH +SSPR 6PK SATIN SLATE BLUE 12 OZ	532
AVERAGE:	**485**

(iv) Average ratio of paint used to cover graffiti and the surface area of the graffiti markings

Survey data that might assist in establishing a ratio between the surface areas of the paint used to cover graffiti, and the graffiti itself, were not readily available. Lacking such information, it was assumed that the average ink coverage density appearing on standard paper (i.e., 8 ½ x 11 inch) could be used to approximate the unmarked spaces between graffiti letters, and within the letters themselves.

The industry average ink coverage density is five percent.[55] In other words, approximately five percent of the average printed page is covered with ink. After accounting for the typical one-inch margins of a printed page, the ink coverage density inside the margins is approximately eight percent. This equates to a ratio of 12.5.

Other factors also have a significant influence on this ratio. For example, graffiti that takes the form of art usually minimizes unmarked spaces inside the outer boundaries of the graffiti. The type of font used in graffiti is also often denser than that typically found on printed paper. These factors suggest a lower ratio may be more appropriate. On the other hand, the paint used to cover graffiti extends beyond the outer boundary of the graffiti marking. It can cover spaces between adjacent graffiti markings, and occasionally covers an entire wall or fence in order to maintain uniformity of color. Since the extent of cancelling of these factors is not known, it seemed reasonable to use the 12.5 ratio based on empirical observations.

The following equation was used to calculate emissions from spray paint:

Equation (12) $$E_s = \frac{(T_p \cdot A_p \cdot EF_s)}{(R \cdot A_s)} \cdot K_5$$

where

E_s = Emissions from spray paint [tons/year]
T_p = Paint used to cover graffiti [gallons/year]
A_s = Surface area coverage of spray paint [sq.ft./oz.]
A_p = Surface area coverage of paint [sq.ft./gallons]
EF_s = Average VOC content of spray paint [g/l]
R = Ratio between the coverage densities of paint and graffiti
K_5 = Conversion factor: (liter/33.8 oz.)·(lb/454 g)·(ton/2,000 lb)

$= 3.26 \times 10^{-8}$ (liter·ton)/(oz.·g)

Using Clark County as an example, the reported amount of paint used by local government agencies in 2006 was 35,833 gallons. Utilizing the factors described above, the estimated quantity of VOC emissions from spray paint used to generate graffiti on public or residential property in Clark County, and nationwide, are described below (see also Table 9).

$$E_{Cs(pub)} = \frac{(35{,}833 \text{ gal/year}) \cdot (300 \text{ sq.ft./gal}) \cdot (485 \text{ g/liter})}{(12.5) \cdot (13 \text{ sq.ft./10 oz.})} \cdot (3.26 \times 10^{-8} \frac{\text{(liter·ton)}}{\text{(oz.·g)}})$$

$= 10.46$ tons/year

$$E_{Ns(pub)} = \frac{(5{,}490{,}992 \text{ gal/yr}) \cdot (300 \text{ sq.ft./gal}) \cdot (485 \text{ g/liter})}{(12.5) \cdot (13 \text{ sq.ft./10 oz.})} \cdot (3.26 \times 10^{-8} \frac{\text{(liter·ton)}}{\text{(oz.·g)}})$$

$= 1{,}602.80$ tons/year

Methodology: Spray Paint – Used on Commercial or Industrial Property – SCC 2460510200

Since spray paint emissions are based on paint utilization, the same methodology used to estimate emissions in Equation (10) also applies to emissions emitted when spray paint is used to generate graffiti on commercial or industrial property. The estimated throughput of privately funded paint in Clark County is 9,861 gallons per year, and nationally is 1,746,599 gallons per year (see methodology subsection discussing privately funded paint). The emissions are:

$$E_{Cs(pri)} = \frac{(9{,}861 \text{ gal/year}) \cdot (300 \text{ sq.ft./gal}) \cdot (485 \text{ g/liter})}{(12.5) \cdot (13 \text{ sq.ft./10 oz.})} \cdot (3.26 \times 10^{-8} \frac{\text{(liter·ton)}}{\text{(oz.·g)}})$$

$= 2.88$ tons/year

$$E_{Ns(pri)} = \frac{(1{,}746{,}599 \text{ gal/yr}) \cdot (300 \text{ sq.ft./gal}) \cdot (485 \text{ g/liter})}{(12.5) \cdot (13 \text{ sq.ft./10 oz.})} \cdot (3.26 \times 10^{-8} \frac{\text{(liter·ton)}}{\text{(oz.·g)}})$$

$= 509.82$ tons/year

Methodology: Anti-Graffiti Coating – Total – SCCs 2401001012, 2401001013

Anti-graffiti coating is a material applied to a building or structure that deters adhesion of graffiti to the substrate surface. The coating protects the substrate from solvents and scouring agents used to remove graffiti.[56] Within Clark County, the Nevada Department of Transportation has used coating to facilitate graffiti removal at a cost of about $40 per square yard.[57] Nevada Energy—a private utility company selling power to Clark County residents—uses anti-graffiti coating on 20-foot tall outdoor lighting decorative concrete poles.[58]

In 1998, CARB conducted a survey of architectural coatings that were sold in 1996. The survey indicated that a total of 2,573 gallons of anti-graffiti coating were sold in California.[59] Lacking additional survey data, consideration was given to tracking its use with the national usage of architectural coatings.

However, nationwide architectural coating shipments were lower in 2008 than they were in 1998.[60] Yet there is a pragmatic economic rationale for investing in the use of anti-graffiti coating in that less time is spent abating graffiti. Since this coating appears to have a long-term cost savings

benefit, it seems reasonable to assume that its usage has increased from year to year. Consumption of anti-graffiti coating was therefore assumed to be proportional to population growth.

Since the City of Los Angeles graffiti-resistant building code requirements did not begin until the end of 2009, increased usage of anti-graffiti coating are not taken into account for the 2008 emissions inventory. If such building codes prove to be a cost-effective means of abatement and mitigation of graffiti occurrences, it is foreseeable that these regulations may be adopted by other municipalities. The emissions associated with anti-graffiti coatings would correspondingly increase.

The overall VOC content of anti-graffiti coating was estimated to be 225 grams per liter.[61] The following equations were used to calculate anti-graffiti emissions:

Equation (13) $E_{Cag} = (T_{CA1998}) \cdot (EF_2) \cdot (P_{C2008} / P_{CA1998}) \cdot K_6$

Equation (14) $E_{Nag} = (T_{CA1998}) \cdot (EF_2) \cdot (P_{N2008} / P_{CA1998}) \cdot K_6$

where

E_{Cag} = Emissions from anti-graffiti coating, Clark County 2008 [tons/year]
E_{Nag} = Emissions from anti-graffiti coating, U.S. 2008 [tons/year]
T_{CA1998} = Throughput of anti-graffiti coating, in California [gallons/year]
P_{CA1998} = Population, California (1998)
P_{C2008} = Population, Clark County (2008)
P_{N2008} = Population, U.S. (2008)
EF_2 = Emission factor [lbs/gallon]
K_6 = Conversion factor: (3.785 liter/gal) · (lbs/454 g) · (tons/2,000 lb)
= 4.17×10^{-6} (liter·tons)/(gal·g)

so that

E_{Cag} = (2,573 gal/yr)·(225 g/l)·(1,986,145 /31,780,829)·4.17×10^{-6}(l·ton)/(gal·g)
= 0.15 tons/yr

E_{Nag} = (2,573 gal/yr)·(225g/l)·(304,986,145/31,780,829)·4.17×10^{-6}(l·ton)/(gal·g)
= 23.12 tons/yr

The anti-graffiti coating emissions are partitioned among publicly and privately funded sources based on the ratio of public and private funding of paint used to cover graffiti:

Equation (15) $E_{Cag(pub)} = E_{Cag} \cdot (E_{Cp(pub)}) / (E_{Cp(pub)} + E_{Cp(pri)})$

Equation (16) $E_{Cag(pri)} = E_{Cag} \cdot (E_{Cp(pri)}) / (E_{Cp(pub)} + E_{Cp(pri)})$

where

E_{Cag} = Emissions from anti-graffiti coating (total), Clark County 2008 [tons/year]
$E_{Cp(pub)}$ = Emissions from paint used to cover graffiti (publicly funded), Clark County [tons/year]
$E_{Cp(pri)}$ = Emissions from paint used to cover graffiti (privately funded), Clark County [tons/year]
$E_{Cag(pub)}$ = Emissions from anti-graffiti coating (publicly funded), Clark County 2008 [tons/year]
$E_{Cag(pri)}$ = Emissions from anti-graffiti coating (privately funded), Clark County 2008 [tons/year]

so that

$E_{Cag(pub)}$ = 0.15 tons/yr · (10.57 tons/yr) / (10.57 tons/yr + 2.91 tons/yr)
= 0.12 tons/yr

$E_{Cag(pri)}$ = 0.15 tons/yr · (2.91 tons/yr) / (10.57 tons/yr + 2.91 tons/yr)
= 0.03 tons/yr

Using the same methodology, the national estimates are 18.13 tons/year resulting from public funding, and 4.99 tons/year from private funding (see Table 9).

Methodology: Solvent – Total – SCC 2401100100

Emissions from solvent used to remove graffiti are based on a consumer and commercial products survey performed by CARB. The last available survey for all graffiti removal products was conducted in 2003.[62] The survey included 89 products emitting an estimated total of 68.62 tons per year.[63] In order to determine 2008 emissions within Clark County, the California throughput was correlated with populations for the respective years.

Equation (17) $E_{Cs} = (E_{CAs}) \cdot (P_{C2008} / P_{CA2003})$
Equation (18) $E_{Ns} = (E_{CAs}) \cdot (P_{N2008} / P_{CA2003})$

where

E_{CAs} = Emissions from solvent to remove graffiti, California 2003 [tons/yr]
E_{Cs} = Emissions from solvent to remove graffiti, Clark County 2008 [tons/yr]
E_{Ns} = Emissions from solvent to remove graffiti, U.S. 2008 [tons/yr]
P_{CA2003} = Population, California (2003)
P_{C2008} = Population, Clark County (2008)
P_{N2008} = Population, U.S. (2008)

so that

E_{Cs} = (68.62 tons/year) · (1,986,145 / 35,307,398)
= 3.86 tons/year

E_{Ns} = (68.62 tons/year) · (304,374,846 / 35,307,398)
= 591.55 tons/year

Graffiti Sector Emissions Estimates

A summary of the graffiti sector emissions for Clark County and nationally are provided in the following table.

Table 9. Graffiti sector emissions estimates, U.S. and Clark County (2008)

Graffiti Sector Emission	SCC	U.S. Graffiti Sector Emissions (tons/year)	Clark County Graffiti Sector Emissions (tons/year)
Anti-graffiti coating to expedite abatement (publicly funded)	2401001012	18.13	0.12
Anti-graffiti coating to expedite abatement (privately funded)	2401001013	4.99	0.03
Water-based paint used to cover graffiti (publicly funded)	2401003100	1,619.84	10.57
Water-based paint used to cover graffiti (privately funded)	2401003200	515.25	2.91
Solvent used to remove graffiti (publicly or privately funded)	2401100100	591.55	3.86
Aerosol spray paint used to generate graffiti (on public or residential property)	2460510100	1,602.80	10.46
Aerosol spray paint used to generate graffiti (on commercial or industrial property)	2460510200	509.82	2.88
	TOTALS:	**4,862.38**	**30.83**

CONCLUSIONS

Using the methodologies described in this paper, it was estimated that during 2008 approximately 31 tons of VOC emissions were emitted in Clark County from the graffiti sector. Nationally, VOC emissions from the graffiti sector during 2008 were estimated to be approximately 4,862 tons.

Within Clark County, the graffiti sector emissions were greater than several nonpoint sectors routinely included in national emissions inventories and for which EPA has established default values and historically tracked. Specifically, the graffiti sector emissions were greater than those emitted from auto body refinishing (28 tons), traffic marking (25 tons), structure fires (13 tons), pesticide (9 tons), vehicle fires (6 tons), and open burning (< 1 ton) nonpoint sectors.

By including these emissions in EPA's triennial effort to establish a national emissions inventory, policymakers would be in a better position to understand graffiti's impact on air quality, and public agencies would be able to provide important environmental information to a younger generation that could play a significant role in attempts to mitigate the costs associated with graffiti.

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KEY WORDS

Graffiti, Graffiti Sector, Aerosol Spray Paint, Paint, Solvent, Anti-Graffiti Coating, Land-based Emission Factors

DISCLAIMER

The author is an employee of the Clark County Department of Air Quality and Environmental Management. However, the views and ideas of this paper do not necessarily express the views and ideas of the Department.

TABLES